



# Appendix G Integrated Pest Management Program

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## Appendix G. Integrated Pest Management Program

### G.1 Background

Integrated pest management (IPM) is an interdisciplinary approach using methods to prevent, eliminate, contain, and/or control pest and invasive species (herein collectively referred to as pests) in concert with other management activities on refuge lands and waters to achieve wildlife and habitat management goals and objectives. IPM is a scientific adaptive management process where available scientific information and best professional judgment of the refuge staff and other resource experts would be used to identify and implement appropriate management strategies that can be modified and/or changed over time to ensure effective, site-specific management of pest species to achieve desired outcomes. In accordance with [43 Code of Federal Regulations \(CFR\) 46.145](#), adaptive management would be particularly relevant where long-term impacts may be uncertain, and future monitoring would be needed to make adjustments in subsequent implementation decisions. After a tolerable pest population (threshold) is determined considering achievement of refuge resource objectives and the ecology of pest species, one or more methods, or combinations thereof, would be selected that are feasible, efficacious, and most protective of nontarget resources, including native species (fish, wildlife, and plants) and U.S. Fish and Wildlife Service (Service) personnel, Service-authorized agents, volunteers, and the public. Staff time and available funding would be considered when determining feasibility/practicality of various treatments.

IPM techniques to address pests are presented as comprehensive conservation plan (CCP) strategies (see Chapter 2 of this CCP/Environmental Assessment [EA]) in an adaptive management context to achieve resource objectives of the Tualatin River National Wildlife Refuge (the refuge). To satisfy requirements for IPM planning as identified in the Service director's memo (dated September 9, 2004) titled *Integrated Pest Management Plans and Pesticide Use Proposals: Updates, Guidance, and an Online Database*, the following elements of an IPM program have been incorporated into this CCP:

- Habitat and/or wildlife objectives that identify pest species and appropriate thresholds to indicate the need for and successful implementation of IPM techniques; and
- Monitoring before and/or after treatment to assess progress toward achieving objectives including pest thresholds.

Where pesticides would be necessary to address pests, this appendix provides a structured procedure to evaluate potential effects of proposed uses involving ground-based applications to refuge biological resources and environmental quality in accordance with effects analyses presented in Chapter 6 (Environmental Consequences) of this CCP/EA. Only pesticide uses that likely would cause minor, temporary, or localized effects to refuge biological resources and environmental quality with appropriate best management practices (BMPs), where necessary, would be allowed for use on the refuge.

This appendix does not describe the more detailed process of evaluating potential effects associated with aerial applications of pesticides. However, the basic framework to assess potential effects to refuge biological resources and environmental quality from aerial application of pesticides would be similar to the process described in this appendix for ground-based treatments of other pesticides.

## G.2 Pest Management Laws and Policies

In accordance with Service policy [569 FW 1](#) (Integrated Pest Management), plant, invertebrate, and vertebrate pests on units of the National Wildlife Refuge System (Refuge System) can be controlled to ensure balanced wildlife and fish populations in support of refuge-specific wildlife and habitat management objectives. Pest control on Federal (refuge) lands and waters also is authorized under the following legal mandates:

- National Wildlife Refuge System Administration Act of 1966, as amended (16 U.S. Code [U.S.C.] 668dd-668ee);
- Plant Protection Act of 2000 (7 U.S.C. 7701 et seq.);
- Noxious Weed Control and Eradication Act of 2004 (7 U.S.C. 7781-7786, Subtitle E);
- Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) of 1996 (7 U.S.C. 136-136y);
- National Invasive Species Act of 1996 (16 U.S.C. 4701);
- Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (16 U.S.C. 4701);
- Food Quality Protection Act of 1996 (7 U.S.C. 136);
- Executive Order 13148, Section 601(a);
- Executive Order 13112; and
- Animal Damage Control Act of 1931 (7 U.S.C. 426-426c, 46 Stat. 1468).

Pests are defined as "... living organisms that may interfere with the site-specific purposes, operations, or management objectives or that jeopardize human health or safety" according to Department Policy [517 DM 1](#) (Integrated Pest Management Policy), published by the U.S. Department of the Interior. Similarly, [569 FW 1](#) defines pests as "... invasive plants and introduced or native organisms, that may interfere with achieving our management goals and objectives on or off our lands, or that jeopardize human health or safety." [517 DM 1](#) also defines an invasive species as "a species that is non-native to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health." Throughout the remainder of this CCP/EA, the terms pest and invasive species are used interchangeably because both can prevent/impede achievement of refuge wildlife and habitat objectives and/or degrade environmental quality.

In general, control of pests on the refuge would conserve and protect the nation's fish, wildlife, and plant resources as well as maintain environmental quality. From [569 FW 1](#), animal or plant species that are considered pests may be managed if the following criteria are met:

- There is threat to human health and well being or private property, the acceptable level of damage by the pest has been exceeded, or state or local government has designated the pest as noxious;
- It is detrimental to resource objectives as specified in a refuge resource management plan (e.g., CCP, habitat management plan), if available; and
- Control would not conflict with attainment of resource objectives or the purposes for which the refuge was established.

The specific justifications for pest management activities on the refuge are the following:

- Protect human health and well being;
- Prevent substantial damage to important refuge resources;

- Protect newly introduced or reestablished native species;
- Control nonnative (exotic) species to support existence of populations of native species;
- Prevent damage to private property; and
- Provide the public with quality, compatible wildlife-dependent recreational opportunities.

In accordance with Service policy [620 FW 1](#) (Habitat Management Plans), there are additional management directives regarding invasive species found on the refuge:

- “We are prohibited by Executive Order, law, and policy from authorizing, funding, or carrying out actions that are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere.”
- “Manage invasive species to improve or stabilize biotic communities to minimize unacceptable change to ecosystem structure and function and prevent new and expanded infestations of invasive species. Conduct refuge habitat management activities to prevent, control, or eradicate invasive species ....”

Animal species damaging/destroying Federal property and/or detrimental to the management program of a refuge may be controlled as described in [50 CFR 31.14](#) (Official Animal Control Operations). For example, the incidental removal of beaver damaging refuge infrastructure (e.g., clogging with subsequent damaging of water control structures) and/or negatively affecting habitats (e.g., removing woody species from existing or restored riparian areas) managed on refuge lands may be conducted without a pest control proposal. We recognize beavers are a native species and most of their activities on refuge lands represent a natural process beneficial for maintaining wetland habitats. Exotic nutria, whose denning and burrowing activities in wetland dikes causes cave-ins and breaches, can also be controlled using the most effective techniques considering site-specific factors without a pest control proposal. Along with the loss of quality wetland habitats associated with breaching of impoundments, the safety of refuge staff, volunteers, contractors, and public driving on structurally compromised levees and dikes can be threatened by sudden and unexpected cave-ins. Disposed wildlife specimens may be donated or loaned to public institutions. Donation or loans of resident wildlife species would only be made after securing state approval ([50 CFR 31.11](#) [Donation and Loan of Wildlife Specimens]). Surplus wildlife specimens may be sold alive or butchered, dressed, and processed subject to Federal and state laws and regulations ([50 CFR 31.12](#) [Sale of Wildlife Specimens]).

Trespass and feral animals also may be controlled on refuge lands. Based upon [50 CFR 28.43](#) (Destruction of Dogs and Cats), dogs and cats running at large on a national wildlife refuge and observed in the act of killing, injuring, harassing, or molesting humans or wildlife may be disposed of in the interest of public safety and protection of wildlife. Feral animals should be disposed of by the most humane method available and in accordance with relevant Service directives (including Executive Order 11643).

### G.3 Strategies

To fully embrace IPM as identified in [569 FW 1](#), the following strategies, where applicable, would be carefully considered on the refuge for each pest species:

- **Prevention.** This would be the most effective and least expensive long-term management option for pests. It encompasses methods to prevent new introductions or the spread of the

established pests to uninfested areas. It requires identifying potential routes of invasion to reduce the likelihood of infestation. Hazard Analysis and Critical Control Points (HACCP) planning can be used to determine if current management activities on a refuge may introduce and/or spread invasive species in order to identify appropriate BMPs for prevention. See <http://www.haccp-nrm.org/> for more information about HACCP planning.

Prevention may include source reduction, using pathogen-free or weed-free seeds or fill, exclusion methods (e.g., barriers), and/or sanitation methods (e.g., wash stations) to prevent reintroductions by various mechanisms including vehicles and personnel. Because invasive species are frequently the first to establish newly disturbed sites, prevention would require a reporting mechanism for early detection of new pest occurrences with quick response to eliminate any new pest populations. Prevention would require consideration of the scale and scope of land management activities that may promote pest establishment within uninfested areas or promote reproduction and spread of existing populations. Along with preventing initial introduction, prevention would involve halting the spread of existing infestations to new sites (Mullin et al. 2000). The primary reason for prevention would be to keep pest-free lands or waters from becoming infested. Executive Order 11312 emphasizes the priority for prevention with respect to managing pests.

The following would be methods to prevent the introduction and/or spread of pests on refuge lands:

- Before beginning ground-disturbing activities (e.g., discing, scraping), inventory and prioritize pest infestations in project operating areas and along access routes. Refuge staff would identify pest species on-site or within reasonably expected potential invasion vicinity. Where possible, the refuge staff would begin project activities in uninfested areas before working in pest-infested areas.
- Refuge staff would locate and use pest-free project staging areas. They would avoid or minimize travel through pest-infested areas, or restrict travel to those periods when the spread of seed or propagules of invasive plants would be least likely.
- Refuge staff would determine the need for, and when appropriate identify, sanitation sites where equipment can be cleaned of pests. Where possible, refuge staff would clean equipment before entering lands at on-refuge approved cleaning site(s). This practice does not pertain to vehicles traveling frequently in and out of the project area that would remain on roadways. Refuge staff would remove mud, dirt, and plant parts from project equipment before moving it into a project area.
- Refuge staff would clean all equipment before leaving the project site, if operating in areas infested with pests. Refuge staff would determine the need for, and when appropriate identify, sanitation sites where equipment can be cleaned.
- Refuge staff, their authorized agents, and refuge volunteers would, where possible, inspect, remove, and properly dispose of seed and parts of invasive plants found on their clothing and equipment. Proper disposal means bagging the seeds and plant parts and then properly disposing of them.
- Refuge staff would evaluate options, including closure, to restrict traffic on sites with ongoing restoration of desired vegetation. Refuge staff would revegetate disturbed soil (except travelways on surfaced projects) to optimize native plant establishment for each specific site. Revegetation may include topsoil replacement, planting, seeding, fertilization, liming, and weed-free mulching as necessary. The refuge staff would use native material where appropriate and feasible. They would also use

certified weed-free or weed-seed-free hay or straw where certified materials are reasonably available.

- Refuge staff would provide information, training, and appropriate pest identification materials to permit holders and recreational visitors. They would educate them about pest identification, biology, impacts, and effective prevention measures.
- Refuge staff would require grazing permittees to use preventative measures for their livestock while on refuge lands.
- Refuge staff would inspect borrow material for invasive plants prior to use and transport onto and/or within refuge lands.
- Refuge staff would consider invasive plants in planning for road maintenance activities.

The following methods would be used to prevent the introduction and/or spread of pests into refuge waters:

- Refuge staff would inspect boats, trailers, other boating equipment, and waders or boots. Where possible, refuge staff would remove any visible plants, animals, or mud before leaving any waters or boat launching facilities. Where possible, the refuge staff would drain water from motor, live well, bilge, and transom wells while on land before leaving the site. If possible, the refuge staff would wash and dry boats, anchors, nets, floors of boats, propellers, axles, trailers, and other boating equipment to kill pests not visible at the boat launch. Waders and boots would be cleaned and disinfected as necessary.
  - Where feasible, the refuge staff would maintain a 100-foot buffer of aquatic pest-free clearance around boat launches and docks or quarantine areas when cleaning around culverts, canals, or irrigation sites. Where possible, refuge staff would inspect and clean equipment before moving to new sites or from one project area to another.
- **Mechanical/Physical Methods.** These methods would remove and destroy, disrupt the growth of, or interfere with the reproduction of pest species. For plants species, these treatments can be accomplished by hand, hand tools (manual), or power tools (mechanical) and include pulling, grubbing, digging, tilling/discing, cutting, swathing, grinding, shearing, girdling, mowing, and mulching of the pest plants.

For animal species, Service employees or their authorized agents could use mechanical/physical methods (including trapping) to control pests as a refuge management activity. Based upon [50 CFR 31.2](#), trapping can be used on a refuge to reduce surplus wildlife populations for a “balanced conservation program” in accordance with Federal or state laws and regulations. In some cases, non-lethally trapped animals would be relocated to off-refuge sites with prior approval from the state.

Each of these tools would be efficacious to some degree and applicable to specific situations. In general, mechanical controls can effectively control annual and biennial pest plants. However, to control perennial plants, the root system has to be destroyed or it would resprout and continue to grow and develop. Mechanical controls are typically not capable of destroying a perennial plant’s root system. Although some mechanical tools (e.g., discing, plowing) may damage root systems, they may also stimulate regrowth producing a denser plant population that may aid in the spread depending upon the target species (e.g., Canada

thistle). In addition, steep terrain and soil conditions would be major factors that can limit the use of many mechanical control methods.

Some mechanical control methods (e.g., mowing), which would be used in combination with herbicides, can be very effective at controlling perennial species. For example, mowing perennial plants followed sequentially by treating the plant regrowth with a systemic herbicide often would improve the efficacy of the herbicide compared to herbicide treatment alone.

- **Cultural Methods.** These methods would involve manipulating habitat to increase pest mortality by reducing its suitability to the pest. Cultural methods would include water-level manipulation, mulching, planting winter cover crops, changing planting dates to minimize pest impact, prescribed burning (which facilitates revegetation, increases herbicide efficacy, and removes litter to assist in emergence of desirable species), flaming with propane torches, trap crops, crop rotations that include nonsusceptible crops, moisture management, addition of beneficial insect habitat, reducing clutter, proper trash disposal, planting or seeding desirable species to shade or outcompete invasive plants, applying fertilizer to enhance desirable vegetation, prescriptive grazing, and other habitat alterations.
- **Biological Control Agents.** Classical biological control would involve the deliberate introduction and management of natural enemies (parasites, predators, or pathogens) to reduce pest populations. Many of the most ecologically or economically damaging pest species in the United States originated in foreign countries. These newly introduced pests, which are free from natural enemies found in their country or region of origin, may have a competitive advantage over cultivated and native species. This competitive advantage often allows introduced species to flourish, and they may cause widespread economic damage to crops or outcompete and displace native vegetation. Once the introduced pest species population reaches a certain level, traditional methods of pest management may be cost-prohibitive or impractical. Biological controls typically are used when these pest populations have become so widespread that eradication or effective control would be difficult or no longer practical.

Biological control has advantages as well as disadvantages. Benefits include reducing pesticide use, host specificity for target pests, long-term self-perpetuating control, low cost per acre, capacity for searching and locating hosts, synchronizing biological control agents to hosts' life cycles, and the unlikelihood that hosts would develop resistance to agents. Disadvantages include limited availability of agents from their native lands, the dependence of control on target species' density, the slow rate at which control occurs, biotype matching, the difficulty and expense of conflicts over control of the target pest, and host specificity when host populations are low.

A reduction in target species populations from biological controls is typically a slow process, and efficacy can be highly variable. It may not work well in a particular area although it does work well in other areas. Biological control agents would require specific environmental conditions to survive over time. Some of these conditions are understood, whereas others are only partially understood or not understood at all.

Biological control agents would not eradicate a target pest. When using biological control agents, residual levels of the target pest typically are expected; the agent's population level or

survival would be dependent upon the density of its host. After the pest population decreases, the population of the biological control agent would decrease correspondingly. This is a natural cycle. Some pest populations (e.g., invasive plants) tend to persist for several years after a biological control agent becomes established due to seed reserves in the soil, inefficiencies in the agent's search behavior, and the natural lag in population buildup of the agent.

The full range of pest groups potentially found on refuge lands and waters includes diseases, invertebrates (insects, mollusks), vertebrates, and invasive plants (the most common group). Often it is assumed that biological control would address many if not most of these pest problems. There are several well-documented success stories of biological control of invasive weed species in the Pacific Northwest including Mediterranean sage, St. John's wort (Klamath weed), and tansy ragwort. Emerging success stories include Dalmatian toadflax, diffuse knapweed, leafy spurge, purple loosestrife, and yellow star thistle. However, historically, each new introduction of a biological control agent in the United States has only about a 30 percent success rate (Coombs et al. 2004).

Introduced species without desirable close relatives in the United States would generally be selected as biological controls. Natural enemies that are restricted to one or a few closely related plants in their country of origin are targeted as biological controls (Center et al. 1997; Hasan and Ayres 1990).

Refuge staff would ensure introduced agents are approved by the applicable authorities. Except for a small number of formulated biological control products registered by the U.S. Environmental Protection Agency (EPA) under FIFRA, most biological control agents are regulated by the U.S. Department of Agriculture (USDA)-Animal Plant Health Inspection Service, Plant Protection and Quarantine (APHIS-PPQ). State departments of agriculture and, in some cases, county agricultural commissioners or weed districts have additional approval authority.

Federal permits (USDA-APHIS-PPQ Form 526) are required to import biocontrol agents from another state. Form 526 may be obtained through the Internet at: <http://www.aphis.usda.gov/ppq/permits/biological/weedbio.html>.

The Service strongly supports the development and legal and responsible use of appropriate, safe, and effective biological control agents for nuisance and nonindigenous or pest species.

State and county agriculture departments may also be sources for biological control agents or they may have information about where biological control agents may be obtained. Commercial sources should have an Application and Permit to Move Live Plant Pests and Noxious Weeds to release specific biological control agents in a state and/or county. Furthermore, certification regarding the biological control agent's identity (genus, specific epithet, subspecies, and variety) and purity (e.g., parasite-free, pathogen-free, and biotic and abiotic contaminants) should be specified in purchase orders.

Biological control agents are subject to 7 Refuge Manual (RM) 8 (Exotic Species Introduction and Management). In addition, refuge staff would follow the International Code of Best Practice for Classical Biological Control of Weeds (<http://invasives.wsu.edu/Code.htm>) as ratified by delegates to the Tenth International

Symposium on Biological Control of Weeds in Bozeman, Montana, on July 9, 1999. This code states the following:

- Release only approved biological control agents,
- Use the most effective agents,
- Document releases, and
- Monitor for impact to the target pest, non-target species, and the environment.

Biological control agents formulated as pesticide products and registered by the EPA (e.g., *Bacillus thuringiensis* var. *israelensis* [*B.t.i.i.*]) are also subject to pesticide use proposal (PUP) review and approval (see below).

A record of all releases would be maintained with date(s), location(s), and environmental conditions of the release site(s); the identity, quantity, and condition of the biological control agents released; and other relevant data and comments such as weather conditions. Systematic monitoring to determine the establishment and effectiveness of the release is also recommended.

National Environmental Policy Act (NEPA) documents regarding biological and other environmental effects of biological control agents prepared by another Federal agency, where the scope is relevant to evaluation of releases on refuge lands, would be reviewed. Possible source agencies for such NEPA documents include the Bureau of Land Management, U.S. Forest Service (USFS), the National Park Service, the USDA-APHIS, and the military services. It might be appropriate to incorporate by reference parts or all of existing document(s) from the review. Incorporating by reference ([43 CFR 46.135](#)) is a technique used to avoid redundancies in analysis. It also can reduce the bulk of a Service NEPA document, which only must identify the documents that are incorporated by reference. In addition, relevant portions must be summarized in the Service NEPA document to the extent necessary to provide the decision maker and public with an understanding of the relevance of the referenced material to the current analysis.

- **Pesticides.** The selective use of pesticides would be based upon pest ecology (including mode of reproduction), the size and distribution of pest populations, site-specific conditions (e.g., soils, topography), known efficacy under similar site conditions, and the capability to use BMPs to reduce/eliminate potential effects to nontarget species and sensitive habitats, and prevent contamination of surface and groundwater. All pesticide use (pesticide, target species, application rate, and method of application) would comply with the applicable Federal (FIFRA) and state regulations pertaining to pesticide use, safety, storage, disposal, and reporting. Before pesticides can be used to eradicate, control, or contain pests on refuge lands and waters, PUPs would be prepared and approved in accordance with [569 FW 1](#). PUP records would provide a detailed, time-, site-, and target-specific description of the proposed use of pesticides on the refuge. All PUPs would be created, approved or disapproved, and stored in the Pesticide Use Proposal System (PUPS), which is a centralized database only accessible on the Service's intranet (<https://systems.fws.gov/pups>). Only Service employees would be authorized to access PUP records for a refuge in this database.

Application equipment would be selected to provide site-specific delivery to target pests while minimizing/eliminating direct or indirect (e.g., drift) exposure to non-target areas and degradation of surface and groundwater quality. Where possible, target-specific equipment

(e.g., backpack sprayer, roller, wiper) would be used to treat target pests. Other target-specific equipment used to apply pesticides include soaked wicks or paint brushes for wiping vegetation and lances, hatchets, or syringes for direct injection into stems. Granular pesticides may be applied using seeders or other specialized dispensers. In contrast, aerial spraying (e.g., fixed-wing or helicopter) would only be used where access is difficult (due to remoteness) and/or the size and distribution of infestations precludes practical use of ground-based methods.

Because repeated use of one pesticide may allow resistant organisms to survive and reproduce, multiple pesticides with variable modes of action would be considered for treatments on refuge lands and waters. This is especially important if multiple applications within years and/or over a growing season likely would be necessary for habitat maintenance and restoration activities to achieve resource objectives. Integrated chemical and non-chemical controls also are highly effective, where practical, because pesticide-resistant organisms can be removed from the site.

Cost may not be the primary factor in selecting a pesticide for use on a refuge. If the least expensive pesticide would potentially harm natural resources or people, then a different product would be selected, if available. The most efficacious pesticide available with the least potential to degrade environmental quality (soils, surface water, and groundwater) as well as the least potential effect to native species and communities of fish, wildlife, plants, and their habitats would be acceptable for use on refuge lands in the context of an IPM approach.

- Habitat Restoration/Maintenance.** Restoration and/or proper maintenance of refuge habitats associated with achieving wildlife and habitat objectives would be essential for long-term prevention, eradication, or control (at or below threshold levels) of pests. Promoting desirable plant communities through the manipulation of species composition, plant density, and growth rate is an essential component of invasive plant management (Brooks et al. 2004; Masters et al. 1996; Masters and Sheley 2001). The following three components of succession could be manipulated through habitat maintenance and restoration: site availability, species availability, and species performance (Cox and Anderson 2004). Although a single method (e.g., herbicide treatment) may eliminate or suppress pest species in the short term, the resulting gaps and bare soil create niches that are conducive to further invasion by the species and/or other invasive plants. On degraded sites where desirable species are absent or in low abundance, revegetation with native/desirable grasses, forbs, and legumes may be necessary to direct and accelerate plant community recovery, and achieve site-specific objectives in a reasonable time frame. The selection of appropriate species for revegetation would be dependent on a number of factors including resource objectives and site-specific, abiotic factors (e.g., soil texture, precipitation/temperature regimes, and shade conditions). Seed availability and cost, ease of establishment, seed production, and competitive ability also would be important considerations.

## G.4 Priorities for Treatments

For many refuges, the magnitude (number, distribution, and sizes of infestations) of pest problems is too extensive and beyond the available capital resources to effectively address during any single field season. To manage pests on a refuge, it is essential to prioritize treatment of infestations. Highest

priority treatments are focused on early detection and rapid response to eliminate infestations of new pests, if possible. This is especially important for aggressive pests potentially impacting species, species groups, communities, and/or habitats associated with the refuge purpose(s), Refuge System resources of concern (federally listed species, migratory birds, and interjurisdictional fish), and native species important for maintaining/restoring biological integrity, diversity, and environmental health.

The next priority would be treating established pests that appear in one or more previously uninfested areas. Moody and Mack (1988) demonstrated through modeling that small, new outbreaks of invasive plants eventually would infest an area larger than the established source population. They also found that control efforts focusing on the large, main infestation rather than the new, small satellites reduced the chances of overall success.

The lowest priority would be treating large infestations (sometimes monotypic stands) of well-established pests. In this case, initial efforts would focus upon containment of the perimeter followed by work to control/eradicate the established infested area. If containment and/or control of a large infestation is not effective, then efforts would focus upon halting pest reproduction or managing source populations. Maxwell et al. (2009) found that treating fewer populations that are sources represents an effective long-term strategy to reduce total number of invasive populations and decreasing population growth rates.

Although state-listed noxious weeds would always be of high priority for management, other pest species known to cause substantial ecological impact would also be considered. For example, reed canarygrass may not be listed by a state as noxious, but it can greatly alter wetland plant composition by forming monotypic stands. Pest control would likely require a multiyear commitment from refuge staff. Essential to the long-term success of pest management would be pretreatment and posttreatment monitoring, assessment of the successes and failures of treatments, and development of new approaches when proposed methods do not achieve desired outcomes.

## **G.5 Best Management Practices**

BMPs can minimize or eliminate possible effects associated with pesticide usage to non-target species and/or sensitive habitats as well as degradation of water quality from drift, surface runoff, or leaching. Based upon the Department of Interior Pesticide Use Policy ([517 DM 1](#)) and the Service Pest Management Policy and Responsibilities ([30 AM 12](#)), the use of applicable BMPs also would likely ensure that pesticide uses do not adversely affect federally listed species and/or their critical habitats through determinations made using the process described in [50 CFR 402](#).

The following are BMPs pertaining to mixing/handling and applying pesticides for all ground-based treatments of pesticides, which would be considered and used, where feasible, based upon target- and site-specific factors and time-specific environmental conditions.

### **G.5.1 Pesticide Handling and Mixing**

- As a precaution against spilling, spray tanks would not be left unattended during filling.
- All pesticide containers would be triple-rinsed and the rinsate would be used as water in the sprayer tank and applied to treatment areas.
- All pesticide spray equipment would be properly cleaned. Where possible, rinsate would be used as part of the make-up water in the sprayer tank and applied to treatment areas.

- The refuge staff would triple-rinse and recycle (where feasible) pesticide containers.
- All unused pesticides would be properly discarded at a local “safe send” collection.
- Pesticides and pesticide containers would be lawfully stored, handled, and disposed of in accordance with the label and in a manner safeguarding human health and fish and wildlife, and preventing soil and water contamination.
- Refuge staff would consider the water quality parameters (e.g., pH, hardness) that are important to ensure greatest efficacy where specified on the pesticide label.
- All pesticide spills would be addressed immediately using procedures identified in the refuge spill response plan.

## **G.5.2 Applying Pesticides**

- Pesticide treatments would only be conducted by or under the supervision of Service personnel and non-Service applicators with the appropriate state certification to safely and effectively conduct these activities on refuge lands and waters.
- Refuge staff would comply with all Federal, state, and local pesticide use laws and regulations as well as Departmental, Service, and Refuge System pesticide-related policies.
- Before each treatment season and prior to mixing or applying any product for the first time each season, all applicators would review the labels, material safety data sheets (MSDS), and PUPs for each pesticide, determining the target pest, appropriate mix rate(s), required personal protective equipment (PPE), and other requirements listed on the pesticide label.
- Low-impact herbicide application techniques (e.g., spot treatment, cut stump, oil basal, Thinvert system applications) would be used rather than broadcast foliar applications (e.g., boom sprayer other larger tank wand applications), where practical.
- Low-volume rather than high-volume foliar applications would be used where low-impact methods described above are not feasible or practical, to maximize herbicide effectiveness and ensure correct and uniform application rates.
- Applicators would use and adjust spray equipment to apply the coarsest droplet size spectrum with optimal coverage of the target species while reducing drift.
- Applicators would use the largest droplet size that results in uniform coverage.
- Applicators would use drift reduction technologies such as low-drift nozzles, where possible.
- Where possible, spraying would occur during low (average <7 miles per hour [mph] and preferably 3 to 5 mph) and consistent direction wind conditions with moderate temperatures (typically <80°F).
- Where possible, applicators would avoid spraying during inversion conditions (often associated with calm and very low wind conditions), which can cause large-scale herbicide drift to nontarget areas.
- Equipment would be calibrated regularly to ensure that the proper rate of pesticide is applied to the target area or species.
- Spray applications would be made at the lowest height for uniform coverage of target pests to minimize/eliminate potential drift.
- If windy conditions frequently occur during afternoons, spraying (especially boom treatments) would typically be conducted during early morning hours.
- Spray applications would not be conducted on days with >30 percent forecast for rain within 6 hours, except for pesticides that are rapidly rain fast (e.g., glyphosate in 1 hour) to minimize/eliminate potential runoff.

- Where possible, applicators would use drift retardant adjuvants during spray applications, especially adjacent to sensitive areas.
- Where possible, applicators would use a non-toxic dye to aid in identifying target area treated as well as potential overspray or drift. A dye can also aid in detecting equipment leaks. If a leak is discovered, the application would be stopped until repairs can be made to the sprayer.
- For pesticide uses associated with cropland and facilities management, buffers, as appropriate, would be used to protect sensitive habitats, especially wetlands and other aquatic habitats.
- When drift cannot be sufficiently reduced through altering equipment setup and application techniques, buffer zones may be identified to protect sensitive areas downwind of applications. Refuge staff would only apply pesticide adjacent to sensitive areas when the wind is blowing in the opposite direction.
- Refuge staff would consider timing of application so native plants are protected (e.g., senescence) while effectively treating invasive plants.
- Rinsate from cleaning spray equipment after application would be recaptured and reused or applied to an appropriate pest plant infestation.
- Application equipment (e.g., sprayer, all-terrain vehicle [ATV], tractor) would be thoroughly cleaned and PPE would be removed/disposed of on-site by applicators after treatments to eliminate the potential spread of pests to uninfested areas.

## **G.6. Safety**

### **G.6.1 Personal Protective Equipment**

All applicators would wear the specific PPE identified on the pesticide label. The appropriate PPE would be worn at all times during handling, mixing, and application. PPE can include the following: disposable (e.g., Tyvek) or laundered coveralls; gloves (latex, rubber, or nitrile); rubber boots; and/or a National Institute for Occupational Safety and Health (NIOSH)-approved respirator. Because exposure to concentrated product is usually greatest during mixing, extra care should be taken while preparing pesticide solutions. Persons mixing these solutions can be best protected if they wear long gloves, an apron, footwear, and a face shield.

Coveralls and other protective clothing used during an application would be laundered separately from other laundry items. Transporting, storing, handling, mixing, and disposing of pesticide containers would be consistent with label requirements, EPA and Occupational Safety and Health Administration (OSHA) requirements, and Service policy.

If a respirator is necessary for a pesticide use, then the following requirements would be met in accordance with Service safety policy: a written Respirator Program, fit testing, physical examination (including pulmonary function and blood work for contaminants), and proper storage of the respirator.

### **G.6.2 Notification**

The restricted entry interval (REI) is the time period required after application after which someone may safely enter a treated area without PPE. Refuge staff, authorized management agents of the Service, volunteers, and members of the public who could be in or near a pesticide-treated area within the stated re-entry time period on the label would be notified about treatment areas. Posting

would occur at any site where individuals might inadvertently become exposed to a pesticide during other activities on the refuge. Where required by the label and/or state-specific regulations, signs would also be posted on the perimeter of treatment areas and at other likely locations of entry. Refuge staff would also notify appropriate private property owners of an intended application, including any private individuals who have requested notification. Special efforts would be made to contact nearby individuals who are beekeepers or who have expressed chemical sensitivities.

### **G.6.3 Medical Surveillance**

Medical surveillance may be required for Service personnel and approved volunteers who mix, apply, and/or monitor use of pesticides (see [242 FW 7](#) [Pesticide Users] and [242 FW 4](#) [Medical Surveillance]). In accordance with [242 FW 7.12A](#), Service personnel would be medically monitoring if one or more of the following criteria is met: exposed or may be exposed to concentrations at or above the published permissible exposure limits or threshold limit values (see [242 FW 4](#)); pesticide use is considered “frequent pesticide use”; or pesticide use requires a respirator (see [242 FW 14](#) for respirator use requirements). According to [242 FW 7.7A](#), “frequent pesticide use means when a person applying pesticide handles, mixes, or applies pesticides, with a Health Hazard rating of 3 or higher, for 8 or more hours in any week or 16 or more hours in any 30-day period.” Under some circumstances, individuals who use pesticides infrequently, experience an acute exposure (sudden, short term), or use pesticides with a health hazard ranking of 1 or 2 may also be medically monitored. This decision would consider the individual’s health and fitness level, the pesticide’s specific health risks, and the potential risks from other pesticide-related activities. Refuge cooperators (e.g., cooperative farmers) and other authorized agents (e.g., state and county employees) would be responsible for their own medical monitoring needs and costs.

Standard examinations (at refuge expense) of appropriate refuge staff would be provided by the nearest certified occupational health and safety physician as determined by Federal Occupational Health.

### **G.6.4 Certification and Supervision of Pesticide Applicators**

Appropriate refuge staff or approved volunteers handling, mixing, and/or applying, or directly supervising others engaged in pesticide use activities, would be trained and state or federally licensed to apply pesticides to refuge lands or waters. In accordance with [242 FW 7.18A](#) and [569 FW 1.10B](#), certification is required to apply restricted use pesticides based upon EPA regulations. For safety reasons, all individuals participating in pest management activities with general use pesticides also are encouraged to attend appropriate training or acquire pesticide applicator certification. New staff unfamiliar with proper procedures for storing, mixing, handling, applying, and disposing of pesticides and containers would receive orientation and training before handling or using any products. Documentation of training would be kept in the files at the refuge office.

### **G.6.5 Record Keeping**

#### **G.6.5.1 Labels and Material Safety Data Sheets**

Pesticide labels and MSDSs would be maintained at the refuge shop. A written reference (e.g., note pad, chalk board, dry erase board) for each tank to be mixed would be kept in the mixing area for quick reference while mixing is in progress. In addition, approved PUPs stored in the PUPS database typically contain website links to pesticide labels and MSDSs.

### **G.6.5.2 Pesticide Use Proposals**

A PUP would be prepared for each proposed pesticide use associated with annual pest management on refuge lands and waters. A PUP would include specific information about the proposed pesticide use including the common and chemical names of the pesticide(s), target pest species, size and location of treatment site(s), application rate(s) and method(s), and federally listed species determinations, where applicable.

In accordance with Service guidelines (Service Director's memo [December 12, 2007]), refuge staff may receive up to 5-year approvals for Service Washington Office and field-reviewed proposed pesticide uses based upon meeting identified criteria including an approved IPM plan, where necessary (see <http://www.fws.gov/contaminants/Issues/IPM.cfm>). For a refuge, an IPM plan (requirements described herein) can be completed independently or in association with a CCP or a habitat management plan (HMP) if IPM strategies and potential environmental effects are adequately addressed within appropriate NEPA documentation.

### **G.6.5.3 Pesticide Usage**

In accordance with [569 FW 1](#), the refuge project leader would be required to maintain records of all pesticides annually applied on lands or waters under refuge jurisdiction. This would encompass pesticides applied by other Federal agencies, state and county governments, and nongovernment applicators including cooperators and their pest management service providers with Service permission. For clarification, pesticide means all insecticides, insect and plant growth regulators, desiccants, herbicides, fungicides, rodenticides, acaricides, nematocides, fumigants, avicides, and piscicides.

The following usage information can be reported for approved PUPs in the PUPS database:

- Pesticide trade name(s)
- Active ingredient(s)
- Total acres treated
- Total amount of pesticides used (lbs or gallons)
- Total amount of active ingredient(s) used (lbs)
- Target pest(s)
- Efficacy (% control)

To determine whether treatments are efficacious (eradicating, controlling, or containing the target pest) and achieving resource objectives, habitat and/or wildlife response would be monitored both pretreatment and posttreatment, where possible. Considering available annual funding and staffing, appropriate monitoring data regarding characteristics (attributes) of pest infestations (e.g., area, perimeter, degree of infestation density, percent cover, density) as well as habitat and/or wildlife response to treatments may be collected and stored in a relational database (e.g., Refuge Habitat Management Database), preferably a georeferenced data management system (e.g., Refuge Lands Geographic Information System [GIS]) to facilitate data analyses and subsequent reporting. In accordance with adaptive management, data analysis and interpretation would allow treatments to be modified or changed over time, as necessary, to achieve resource objectives considering site-specific conditions in conjunction with habitat and/or wildlife responses. Monitoring could also identify short- and long-term impacts to natural resources and environmental quality associated with IPM treatments in accordance with adaptive management principles identified in [43 CFR 46.145](#).

## **G.7 Evaluating Pesticide Use Proposals**

Pesticides would only be used on refuge lands for habitat management and croplands/facilities maintenance after approval of a PUP. In general, proposed pesticide uses on refuge lands would only be approved where there would likely be minor, temporary, or localized effects to fish and wildlife species as well as minimal potential to degrade environmental quality. Potential effects to listed and nonlisted species would be evaluated with quantitative ecological risk assessments and other screening measures. Potential effects to environmental quality would be based upon pesticide characteristics of environmental fate (water solubility, soil mobility, soil persistence, and volatilization) and other quantitative screening tools. Ecological risk assessments and characteristics of environmental fate and potential of pesticides to degrade environmental quality would be documented in chemical profiles (see Section G.7.6). These profiles would include threshold values for quantitative measures of ecological risk assessments and screening tools for environmental fate that represent minimal potential effects to species and environmental quality. In general, only pesticide uses with appropriate BMPs (see Section G.5) for habitat management and cropland/facilities maintenance on refuge lands that would potentially have minor, temporary, or localized effects on refuge biological and environmental quality (threshold values not exceeded) would be approved.

### **G.7.1 Overview of Ecological Risk Assessment**

An ecological risk assessment process would be used to evaluate potential adverse effects to biological resources as a result of a pesticide proposed for use on refuge lands. It is an established quantitative and qualitative methodology for comparing and prioritizing risks of pesticides and conveying an estimate of the potential risk for an adverse effect. This quantitative methodology provides an efficient mechanism to integrate best available scientific information regarding hazards, patterns of use (exposure), and dose-response relationships in a manner that is useful for ecological risk decision making. It would provide an effective way to evaluate potential effects where there is missing or unavailable scientific information (data gaps) to address reasonable, foreseeable adverse effects in the field as required under [40 CFR 1502.22](#). Protocols for ecological risk assessment of pesticide uses on the refuge were developed through research and established by the EPA (2004).

The toxicological data used in ecological risk assessments are typically results of standardized laboratory studies provided by pesticide registrants to the EPA to meet regulatory requirements under FIFRA. These studies assess the acute (lethality) and chronic (reproductive) effects associated with short- and long-term exposure to pesticides on representative species of birds, mammals, freshwater fish, aquatic invertebrates, and terrestrial and aquatic plants. Other effects data publicly available would also be used for risk assessment protocols described herein. Toxicity endpoint and environmental fate data are available from a variety of resources. Some of the more useful resources can be found in Section G.7.6.

### **G.7.2 Determining Ecological Risk to Fish and Wildlife**

The potential for pesticides used on the refuge to cause direct adverse effects to fish and wildlife would be evaluated using the EPA's ecological risk assessment process (EPA 2004). This deterministic approach, which is based upon a two-phase process involving estimation of environmental concentrations and then characterization of risk, would be used for ecological risk assessments. This method integrates exposure estimates (estimated environmental concentration

[EEC] and toxicological endpoints [e.g., LC<sub>50</sub> and oral LD<sub>50</sub>]) to evaluate the potential for adverse effects to species groups (birds, mammals, and fish) representative of legal mandates relevant for managing units of the Refuge System. This integration is achieved through risk quotients (RQs) calculated by dividing the EEC by acute and chronic toxicity values selected from standardized toxicological endpoints or published effects (Table G-1).

$$RQ = EEC/Toxicological\ Endpoint$$

**Table G-1. Ecotoxicity Tests Used to Evaluate Potential Effects to Birds, Fish, and Mammals to Establish Toxicity Endpoints for Risk Quotient Calculations**

Species Group	Exposure	Measurement Endpoint
Bird	Acute	Median Lethal Concentration (LC <sub>50</sub> )
	Chronic	No Observed Effect Concentration (NOEC) or No Observed Adverse Effect Concentration (NOAEC) <sup>1</sup>
Fish	Acute	LC <sub>50</sub>
	Chronic	NOEC or NOAEC <sup>2</sup>
Mammal	Acute	Oral Lethal Dose (LD <sub>50</sub> )
	Chronic	NOEC or NOAEC <sup>3</sup>

<sup>1</sup>Measurement endpoints typically include a variety of reproductive parameters (e.g., number of eggs, number of offspring, eggshell thickness, and number of cracked eggs).

<sup>2</sup>Measurement endpoints for early life stage/life cycle typically include embryo hatch rates, time to hatch, growth, and time to swim-up.

<sup>3</sup>Measurement endpoints include maternal toxicity, teratogenic effects or developmental anomalies, evidence of mutagenicity or genotoxicity, and interference with cellular mechanisms such as DNA synthesis and DNA repair.

The level of risk associated with direct effects of pesticide use would be characterized by comparing calculated RQs to the appropriate Level of Concern (LOC) established by the EPA (1998b) (Table G-2). The LOC represents a quantitative threshold value for screening potential adverse effects to fish and wildlife resources associated with pesticide use. The following are four exposure-species group scenarios that would be used to characterize ecological risk to fish and wildlife on the refuge: acute-listed species, acute-nonlisted species, chronic-listed species, and chronic-nonlisted species.

**Table G-2. Presumption of Unacceptable Risk for Birds, Fish, and Mammals (EPA 1998b)**

Risk Presumption		Level of Concern	
		Listed Species	Nonlisted Species
Acute	Birds	0.1	0.5
	Fish	0.5	0.5
	Mammals	0.1	0.5
Chronic	Birds	1.0	1.0

**Table G-2. Presumption of Unacceptable Risk for Birds, Fish, and Mammals (EPA 1998b)**

Risk Presumption		Level of Concern	
		Listed Species	Nonlisted Species
	Fish	1.0	1.0
	Mammals	1.0	1.0

Acute risk would indicate the potential for mortality associated with short-term dietary exposure to pesticides immediately after an application. For characterization of acute risks, median values from LC<sub>50</sub> and LD<sub>50</sub> tests would be used as toxicological endpoints for RQ calculations. In contrast, chronic risks would indicate the potential for adverse effects associated with long-term dietary exposure to pesticides from a single application or multiple applications over time (within a season and over years). For characterization of chronic risks, the no observed adverse effect concentration (NOAEC) or no observed effect concentration (NOEC) for reproduction would be used as toxicological endpoints for RQ calculations. Where available, the NOAEC would be preferred over a NOEC value.

Listed species are those federally designated as threatened, endangered, or proposed in accordance with the Endangered Species Act of 1973. For listed species, potential adverse effects would be assessed at the individual level because loss of individuals from a population could detrimentally impact a species. In contrast, risks to nonlisted species would consider effects at the population level. A RQ < LOC would indicate the proposed pesticide use “may affect, not likely to adversely affect” individuals (listed species) and it would not pose an unacceptable risk for adverse effects to populations (nonlisted species) for each taxonomic group (Table G-2). In contrast, an RQ > LOC would indicate a “may affect, likely to adversely affect” for listed species, and it would also pose unacceptable ecological risk for adverse effects to nonlisted species.

### **G.7.2.1 Environmental Exposure**

Following release into the environment through application, pesticides would experience several different routes of environmental fate. Pesticides that would be sprayed can move through the air (e.g., particle or vapor drift) and may eventually end up in other parts of the environment such as nontarget vegetation, soil, or water. Pesticides applied directly to the soil may be washed off the soil into nearby bodies of surface water (e.g., surface runoff) or may percolate through the soil to lower soil layers and groundwater (Baker and Miller 1999; Butler et al. 1998; Extension Toxicology Network [EXTOXNET] 1993; Pope et al. 1999; Ramsay et al. 1995). Pesticides that would be injected into the soil may also be subject to the latter two fates. The aforementioned possibilities are by no means complete, but do indicate that movement of pesticides in the environment is very complex, with transfers occurring continually among different environmental compartments. In some cases, these exchanges occur not only between areas that are close together, but may also involve transportation of pesticides over long distances (Barry 2004; Woods 2004).

#### **G.7.2.1.1 Terrestrial Exposure**

The ECC for exposure to terrestrial wildlife would be quantified using an EPA screening-level approach (EPA 2004). This screening-level approach is not affected by product formulation because

it evaluates pesticide active ingredient (a.i.). This approach would vary depending upon the proposed pesticide application method: spray or granular.

#### ***G.7.2.1.1.1 Terrestrial—spray application***

For spray applications, exposure would be determined using the Kanaga nomogram method (EPA 2004, 2005a; Pfleeger et al. 1996) through the EPA's Terrestrial Residue Exposure model (T-REX) version 1.2.3 (EPA 2005b). To estimate the maximum (initial) pesticide residue on short grass (<20 centimeter [cm] tall) as a general food item category for terrestrial vertebrate species, T-REX input variables would include the following from the pesticide label: maximum pesticide application rate (pounds a.i. [acid equivalent]/acre) and pesticide half-life (days) in soil. Although there are other food item categories (tall grasses; broadleaf plants and small insects; and fruits, pods, seeds and large insects), short grass was selected because it would yield maximum EECs (240 parts per million [ppm] per lb a.i./acre) for worst-case risk assessments. Short grass is not representative of forage for carnivorous species (e.g., raptors), but it would characterize the maximum potential exposure through the diet of avian and mammalian prey items. Consequently, this approach would provide a conservative screening tool for pesticides that do not biomagnify.

For RQ calculations in T-REX, the model would require the weight of surrogate species and Mineau scaling factors (Mineau et al. 1996). Body weights of bobwhite quail and mallard are included in T-REX by default, but body weights of other organisms (Table G-3) would be entered manually. The Mineau scaling factor accounts for small-bodied bird species that may be more sensitive to pesticide exposure than would be predicted only by body weight. Mineau scaling factors would be entered manually with values ranging from 1 to 1.55 that are unique to a particular pesticide or group of pesticides. If specific information to select a scaling factor is not available, then a value of 1.15 would be used as a default. Alternatively, zero would be entered if it is known that body weight does not influence toxicity of pesticide(s) being assessed. The upper bound estimate output from the T-REX Kanaga nomogram would be used as an EEC for calculation of RQs. This approach would yield a conservative estimate of ecological risk.

**Table G-3. Average Body Weight of Selected Terrestrial Wildlife Species Frequently used in Research to Establish Toxicological Endpoints (Dunning 1984)**

Species	Body Weight (kilogram [kg])
Mammal (15 g)	0.015
House sparrow	0.0277
Mammal (35 g)	0.035
Starling	0.0823
Red-winged blackbird	0.0526
Rock dove (aka pigeon)	0.542
Mammal (1,000 g)	1.000
Mallard	1.082
Ring-necked pheasant	1.135

**G.7.2.1.1.2 Terrestrial—granular application**

Granular pesticide formulations and pesticide-treated seed would pose a unique route of exposure for avian and mammalian species. The pesticide is applied in discrete units, which birds or mammals might ingest accidentally with food items or intentionally as in the case of some bird species that actively seek and pick up gravel or grit to aid digestion or seed as a food source. Granules may also be consumed by wildlife foraging on earthworms, slugs, or other soft-bodied soil organisms to which the granules may adhere.

Terrestrial wildlife RQs for granular formulations or seed treatments would be calculated by dividing the maximum milligrams of a.i. exposed (e.g., EEC) on the surface of an area equal to 1 square foot by the appropriate LD<sub>50</sub> value multiplied by the surrogate's body weight (Table G-3). An adjustment to surface area calculations would be made for broadcast, banded, and in-furrow applications. An adjustment also would be made for applications with and without incorporation of the granules. Without incorporation, it would be assumed that 100 percent of the granules remain on the soil surface available to foraging birds and mammals. Press wheels push granules flat with the soil surface, but the granules are not incorporated into the soil. If granules are incorporated in the soil during band or T-band applications or after broadcast applications, it would be assumed only 15 percent of the applied granules remain available to wildlife. It would be assumed that only 1 percent of the granules are available on the soil surface following in-furrow applications.

EECs for pesticides applied in granular form and as seed treatments would be determined considering potential ingestion rates of avian or mammalian species (e.g., 10-30% body weight/day). This would provide an estimate of maximum exposure that may occur as a result of granule or seed treatment spills such as those that commonly occur at end rows during application and planting. The availability of granules and seed treatments to terrestrial vertebrates would also be considered by calculating the loading per unit area (LD<sub>50</sub>/feet<sup>2</sup>) for comparison to the EPA LOC (EPA 1998b). The T-REX version 1.2.3 (EPA 2005b) contains a submodel that automates Kanaga exposure calculations for granular pesticides and treated seed.

The following formulas would be used to calculate EECs depending upon the type of granular pesticide application:

- In-furrow applications assume a typical value of 1 percent granules, bait, or seed remain unincorporated.

$$mg\ a.i./feet^2 = [(lbs.\ product/acre)(\% a.i.)(453,580\ mg/lbs)(1\% exposed)] / \{[(43,560\ feet\ /acre)/(row\ spacing\ (feet))] / (row\ spacing\ (feet))\}$$

or

$$mg\ a.i./feet^2 = [(lbs\ product/1,000\ foot\ row)(\% a.i.)(1,000\ foot\ row)(453,580\ mg/lb.)(1\% exposed)]$$

$$EEC = [(mg\ a.i./feet^2)(\% of\ pesticide\ biologically\ available)]$$

- Incorporated banded treatments assume that 15 percent of granules, bait, and seeds are unincorporated.

$$\text{mg a.i./feet}^2 = [(\text{lbs. product}/1,000 \text{ row feet})(\% \text{ a.i.})(453,580 \text{ mg/lb.})(1 - \% \text{ incorporated})]/(1,000 \text{ feet})(\text{band width (feet)})$$

$$\text{EEC} = [(\text{mg a.i./feet}^2)(\% \text{ of pesticide biologically available})]$$

- Broadcast treatment without incorporation assumes 100 percent of granules, bait, and seeds are unincorporated.

$$\text{mg a.i./feet}^2 = [(\text{lbs. product}/\text{acre})(\% \text{ a.i.})(453,590 \text{ mg/lb.})]/(43,560 \text{ feet}^2/\text{acre})$$

$$\text{EEC} = [(\text{mg a.i./feet}^2)(\% \text{ of pesticide biologically available})]$$

Where:

- % of pesticide biologically available = 100 percent without species-specific ingestion rates
- Conversion for calculating mg a.i./feet<sup>2</sup> using ounces: 453,580 mg/lb./16 = 28,349 mg/oz.

The following equation would be used to calculate an RQ based on the EEC calculated by one of the above equations. The EEC would be divided by the surrogate LD<sub>50</sub> toxicological endpoint multiplied by the body weight (Table G-3) of the surrogate.

$$\text{RQ} = \text{EEC} / [\text{LD}_{50} (\text{mg/kg}) * \text{body weight (kg)}]$$

As with other risk assessments, an RQ>LOC would be a presumption of unacceptable ecological risk. An RQ<LOC would be a presumption of acceptable risk with only minor, temporary, or localized effects to species.

### **G.7.2.1.2 Aquatic Exposure**

Exposures to aquatic habitats (e.g., wetlands, meadows, ephemeral pools, water delivery ditches) would be evaluated separately for ground-based pesticide treatments of habitats managed for fish and wildlife compared with cropland/facilities maintenance. The primary exposure pathway for aquatic organisms from any ground-based treatments likely would be particle drift during the pesticide application. However, different exposure scenarios would be necessary as a result of contrasting application equipment and techniques as well as pesticides used to control pests on agricultural lands (especially those cultivated by cooperative farmers for economic return from crop yields) and facilities maintenance (e.g., roadsides, parking lots, trails) compared with other managed habitats on the refuge. In addition, pesticide applications may be done <25 feet of the high water mark of aquatic habitats for habitat management treatments, whereas no-spray buffers (≥25 feet) would be used for croplands/facilities maintenance treatments.

#### **G.7.2.1.2.1 Habitat treatments**

For the worst-case exposure scenario to non-target aquatic habitats, EECs (Table G-4) would be derived from Urban and Cook (1986), which assumes an intentional overspray to an entire, non-target water body (1 foot depth) from a treatment <25 feet from the high water mark using the maximum application rate (acid basis). However, use of BMPs for applying pesticides (see Section

G.5.2) would likely minimize/eliminate potential drift to non-target aquatic habitats during actual treatments. If there would be unacceptable (acute or chronic) risk to fish and wildlife with the simulated 100 percent overspray ( $RQ > LOC$ ), then the proposed pesticide use may be disapproved or the PUP may be approved at a lower application rate to minimize/eliminate unacceptable risk to aquatic organisms ( $RQ = LOC$ ).

**Table G-4. Estimated Environmental Concentrations of Pesticides in Aquatic Habitats (1 foot depth) Immediately after Direct Application (Urban and Cook 1986)**

Lbs/acre	EEC (parts per billion (ppb))
0.10	36.7
0.20	73.5
0.25	91.9
0.30	110.2
0.40	147.0
0.50	183.7
0.75	275.6
1.00	367.5
1.25	459.7
1.50	551.6
1.75	643.5
2.00	735.7
2.25	827.6
2.50	919.4
3.00	1,103.5
4.00	1,471.4
5.00	1,839
6.00	2,207
7.00	2,575
8.00	2,943
9.00	3,311
10.00	3,678

#### **G.7.2.1.2.2 Cropland/facilities maintenance treatments**

Field drift studies conducted by the Spray Drift Task Force (SDTF), which is a joint project of several agricultural chemical businesses, were used to develop a generic spray drift database. From this database, the AgDRIFT computer model was created to satisfy EPA pesticide registration spray drift data requirements and as a scientific basis to evaluate off-target movement of pesticides from particle drift and assess potential effects of exposure to wildlife. The SDTF AgDRIFT model version 2.01 (AgDRIFT 2001; SDTF 2003) would be used to derive EECs resulting from drift of pesticides to refuge aquatic resources from ground-based pesticide applications >25 feet from the high water mark. The SDTF AgDRIFT model is publicly available at <http://www.agdrift.com>. At this website, click “AgDRIFT 2.0,” followed by “Download Now,” and follow the instructions to obtain the computer model.

The AgDRIFT model is composed of submodels called tiers. Tier I Ground submodel would be used to assess ground-based applications of pesticides. Tier outputs (EECs) would be calculated with AgDRIFT using the following input variables: maximum application rate (acid basis), low boom (20 inches), fine to medium droplet size, EPA-defined wetland, and a  $\geq 25$ -foot distance (buffer) from treated area to water.

#### **G.7.2.2 Use of Information on Effects of Biological Control Agents, Pesticides, Degradates, and Adjuvants**

NEPA documents regarding biological and other environmental effects of biological control agents, pesticides, degradates, and adjuvants prepared by another Federal agency, where the scope would be relevant to evaluation of effects from pesticide uses on refuge lands, would be reviewed. Possible source agencies for such NEPA documents include the Bureau of Land Management, USFS, National Park Service, USDA-APHIS, and the military services. It might be appropriate to incorporate by reference parts or all of existing document(s). Incorporating by reference ([40 CFR 1502.21](#)) is a technique used to avoid redundancies in analysis. It also would reduce the bulk of a Service NEPA document, which only would identify the documents that are incorporated by reference. In addition, relevant portions would be summarized in the Service NEPA document to the extent necessary to provide the decision maker and public with an understanding of relevance of the referenced material to the current analysis.

In accordance with the requirements set forth in [43 CFR 46.135](#), the Service would specifically incorporate through reference ecological risk assessments prepared by the USFS (<http://www.fs.fed.us/r6/invasiveplant-eis/Risk-Assessments/Herbicides-Analyzed-InvPlant-EIS.htm>) and Bureau of Land Management ([http://www.blm.gov/wo/st/en/prog/more/veg\\_eis.html](http://www.blm.gov/wo/st/en/prog/more/veg_eis.html)). These risk assessments and associated documentation also are available in total with the administrative record for the final environmental impact statement titled *Pacific Northwest Region Invasive Plant Program – Preventing and Managing Invasive Plants* (USFS 2005) and *Vegetation Treatments Using Herbicides on Bureau of Land Management Lands in 17 Western States Programmatic EIS (PEIS)* (Bureau of Land Management 2007). In accordance with [43 CFR 46.120\(d\)](#), use of existing NEPA documents by supplementing, tiering to, incorporating by reference, or adopting previous NEPA environmental analyses would avoid redundancy and unnecessary paperwork.

As a basis for completing chemical profiles for approving or disapproving refuge PUPs, ecological risk assessments for the following herbicide and adjuvant uses prepared by the USFS would be incorporated by reference:

- 2,4-D
- Chlorosulfuron
- Clopyralid
- Dicamba
- Glyphosate
- Imazapic
- Imazapyr
- Metsulfuron methyl
- Picloram
- Sethoxydim
- Sulfometuron methyl
- Triclopyr
- Nonylphenol polyethoxylate (NPE)-based surfactants

As a basis for completing chemical profiles for approving or disapproving refuge PUPs, ecological risk assessments for the following herbicide uses as well as evaluation of risks associated with pesticide degradates and adjuvants prepared by the Bureau of Land Management would be incorporated by reference:

- Bromacil
- Chlorosulfuron
- Diflufenzopyr
- Diquat
- Diuron
- Fluridone
- Imazapic
- Overdrive (diflufenzopyr and dicamba)
- Sulfometuron methyl
- Tebuthiuron
- Pesticide degradates and adjuvants

### **G.7.2.3 Assumptions for Ecological Risk Assessments**

There are a number of assumptions involved with the ecological risk assessment process for terrestrial and aquatic organisms associated with use of the EPA's (2004) process. These assumptions may be risk neutral or may lead to an over- or under-estimation of risk from pesticide exposure depending upon site-specific conditions. The following describes these assumptions, their application to the conditions typically encountered, and whether they may lead to recommendations that are risk neutral, or that underestimate or overestimate ecological risk from potential pesticide exposure.

- Indirect effects would not be evaluated by ecological risk assessments. These effects include the mechanisms of indirect exposure to pesticides: consuming prey items (fish, birds, or

small mammals), reductions in the availability of prey items, and disturbance associated with pesticide application activities.

- Exposure to a pesticide product can be assessed based upon the active ingredient. However, exposure to a chemical mixture (pesticide formulation) may result in effects that are similar or substantially different compared to only the active ingredient. Nontarget organisms may be exposed directly to the pesticide formulation or only various constituents of the formulation as they dissipate and partition in the environment. If toxicological information for both the active ingredient and formulated product are available, then data representing the greatest potential toxicity would be selected for use in the risk assessment process (EPA 2004). As a result, this conservative approach may lead to an overestimation of risk characterization from pesticide exposure.
- Because toxicity tests with listed or candidate species or closely related species are not available, data for surrogate species would be most often used for risk assessments. Specifically, bobwhite quail and mallard duck are the most frequently used surrogates for evaluating potential toxicity to federally listed avian species. Bluegill sunfish, rainbow trout, and fathead minnow are the most common surrogates for evaluating toxicity for freshwater fishes. Sheep's head minnow can be an appropriate surrogate marine species for coastal environments. Rats and mice are the most common surrogates for evaluating toxicity to mammals. Interspecies sensitivity is a major source of uncertainty in pesticide assessments. As a result of this uncertainty, data are selected for the most sensitive species tested within a taxonomic group (birds, fish, and mammals) given the quality of the data is acceptable. If additional toxicity data for more species of organisms in a particular group are available, the selected data would not be limited to the species previously listed as common surrogates.
- The Kanaga nomogram outputs maximum EEC values that may be used to calculate an average daily concentration over a specified interval of time, which is referred to as a time-weighted-average (TWA). The maximum EEC would be selected as the exposure input for both acute and chronic risk assessments in the screening-level evaluations. The initial or maximum EEC derived from the Kanaga nomogram represents the maximum expected instantaneous or acute exposure to a pesticide. Acute toxicity endpoints are determined using a single exposure to a known pesticide concentration typically for 48 to 96 hours. This value is assumed to represent ecological risk from acute exposure to a pesticide. On the other hand, chronic risk to pesticide exposure is a function of pesticide concentration and duration of exposure to the pesticide. An organism's response to chronic pesticide exposure may result from either the concentration of the pesticide or the length of exposure, or some combination of both factors. Standardized tests for chronic toxicity typically involve exposing an organism to several different pesticide concentrations for a specified length of time (days, weeks, months, years, or generations). For example, avian reproduction tests include a 10-week exposure phase. Because a single length of time is used in the test, time response data are usually not available for inclusion in risk assessments. Without time response data it is difficult to determine the concentration that elicits a toxicological response.
- Using maximum EECs for chronic risk estimates may result in an overestimation of risk, particularly for compounds that dissipate rapidly. Conversely, using TWAs for chronic risk estimates may underestimate risk if it is the concentration rather than the duration of exposure that is primarily responsible for the observed adverse effect. The maximum EEC would be used for chronic risk assessments although it may result in an overestimation of risk. TWAs may be used for chronic risk assessments, but they would be applied judiciously considering the potential for underestimation or overestimation of risk. For example, the number of days exposure exceeds an LOC may influence the suitability of a pesticide use.

The greater the number of days the EEC exceeds the LOC, the greater the ecological risk. This is a qualitative assessment, and is subject to reviewers' expertise in ecological risk assessment and tolerance for risk.

- The length of time used to calculate the TWA can have a substantial effect on the exposure estimates, and there is no standard method for determining the appropriate duration for this estimate. The T-REX model assumes a 21-week exposure period, which is equivalent to avian reproductive studies designed to establish a steady-state concentration for bioaccumulative compounds. However, this does not necessarily define the true exposure duration needed to elicit a toxicological response. Pesticides that do not bioaccumulate may achieve a steady-state concentration earlier than 21 weeks. The duration of time for calculating TWAs would require justification and would not exceed the duration of exposure in the chronic toxicity test (approximately 70 days for the standard avian reproduction study). An alternative to using the duration of the chronic toxicity study is to base the TWA on the application interval. In this case, increasing the application interval would suppress both the estimated peak pesticide concentration and the TWA. Another alternative to using TWAs would be to consider the number of days that a chemical is predicted to exceed the LOC.
- Pesticide dissipation is assumed to be first-order in the absence of data suggesting alternative dissipation patterns such as biphasic. Field dissipation data would generally be the most pertinent for assessing exposure in terrestrial species that forage on vegetation. However, these data are often not available and can be misleading, particularly if the compound is prone to "wash-off." Soil half-life is the most common degradation data available. Dissipation or degradation data that would reflect the environmental conditions typical of refuge lands would be used, if available.
- For species found in the water column, it would be assumed that the greatest bioavailable fraction of the pesticide active ingredient in surface waters is freely dissolved in the water column.
- Actual habitat requirements of any particular terrestrial species are not considered, and it is assumed that species exclusively and permanently occupy the treated area, or adjacent areas receiving pesticide at rates commensurate with the treatment rate. This assumption would produce a maximum estimate of exposure for risk characterization. This assumption would likely lead to an overestimation of exposure for species that do not permanently and exclusively occupy the treated area (EPA 2004).
- Exposure through incidental ingestion of pesticide-contaminated soil is not considered in the EPA risk assessment protocols. Research suggests <15 percent of the diet can consist of incidentally ingested soil depending upon species and feeding strategy (Beyer et al. 1994). An assessment of pesticide concentrations in soil compared to food item categories in the Kanaga nomogram indicates incidental soil ingestion would not likely increase dietary exposure to pesticides. Inclusion of soil into the diet would effectively reduce the overall dietary concentration compared to the present assumption that the entire diet consists of a contaminated food source (Fletcher et al. 1994). An exception to this may be soil-applied pesticides in which exposure from incidental ingestion of soil may increase. Potential for pesticide exposure under this assumption may be underestimated for soil-applied pesticides and overestimated for foliar-applied pesticides. The concentration of a pesticide in soil would likely be less than predicted on food items.
- Exposure through inhalation of pesticides is not considered in the EPA risk assessment protocols. Such exposure may occur through three potential sources: spray material in droplet form at time of application, vapor phase with the pesticide volatilizing from treated surfaces, and airborne particulates (soil, vegetative matter, and pesticide dusts). The EPA (1990)

reported exposure from inhaling spray droplets at the time of application is not an appreciable route of exposure for birds. According to research on mallards and bobwhite quail, respirable particle size (particles reaching the lung) in birds is limited to maximum diameter of 2 to 5 microns. The spray droplet spectra covering the majority of pesticide application scenarios indicate that less than 1 percent of the applied material is within the respirable particle size. This route of exposure is further limited because the permissible spray drop size distribution for ground pesticide applications is restricted to American Society of Agricultural Engineers (ASAE) medium or coarser drop size distribution.

- Inhalation of a pesticide in the vapor phase may be another source of exposure for some pesticides under certain conditions. This mechanism of exposure to pesticides occurs post-application, and it would pertain to those pesticides with a high vapor pressure. The EPA is currently evaluating protocols for modeling inhalation exposure from pesticides including near-field and near-ground air concentrations based upon equilibrium and kinetics-based models. Risk characterization for exposure with this mechanism is unavailable.
- The effect from exposure to dust contaminated with the pesticide cannot be assessed generically as partitioning issues related to application site soils and chemical properties of the applied pesticides render the exposure potential from this route highly situation-specific.
- Dermal exposure may occur through three potential sources: direct application of spray to terrestrial wildlife in the treated area or within the drift footprint, incidental contact with contaminated vegetation, or contact with contaminated water or soil. Interception of spray and incidental contact with treated substrates may pose risk to avian wildlife (Driver et al. 1991). However, available research related to wildlife dermal contact with pesticides is extremely limited, with the exception of dermal toxicity values for some mammals used as human surrogates (rats and mice), which are common. The EPA is currently evaluating protocols for modeling dermal exposure. Risk characterization may be underestimated for this route of exposure, particularly with high-risk pesticides such as some organophosphates or carbamate insecticides. If protocols are established by the EPA for assessing dermal exposure to pesticides, they would be considered for incorporation into pesticide assessment protocols.
- Exposure to a pesticide may occur from consuming surface water, dew, or other water on treated surfaces. Water-soluble pesticides have the potential to dissolve in surface runoff, and puddles in a treated area may contain pesticide residues. Similarly, pesticides with lower organic carbon partitioning characteristics and higher solubility in water have a greater potential to dissolve in dew and other water associated with plant surfaces. Estimating the extent to which such pesticide loadings to drinking water occurs is complex and would depend upon the partitioning characteristics of the active ingredient, soil types in the treatment area, and the meteorology of the treatment area. In addition, the use of various water sources by wildlife is highly species-specific. Currently, risk characterization for this exposure mechanism is not available. The EPA is actively developing protocols to quantify drinking water exposure from puddles and dew. If and when protocols are formally established by the EPA for assessing exposure to pesticides through drinking water, these protocols would be incorporated into pesticide risk assessment protocols.
- Risk assessments are based upon the assumption that the entire treatment area would be subject to pesticide application at the rates specified on the label. In most cases, there is potential for uneven application of pesticides through such plausible incidents such as changes in calibration of application equipment, spillage, and localized releases at specific areas in or near the treated field that are associated with mixing and handling and application equipment as well as applicator skill. Inappropriate use of pesticides and the occurrence of

spills represent a potential underestimation of risk. It is likely not an important factor for risk characterization. All pesticide applicators are required to be certified by the state in which they apply pesticides. Certification training includes the safe storage, transport, handling, and mixing of pesticides; equipment calibration; and proper application with annual continuing education.

- The EPA relies on Fletcher et al. (1994) for setting the assumed pesticide residues in wildlife dietary items. The EPA (2004) “believes that these residue assumptions reflect a realistic upper-bound residue estimate, although the degree to which this assumption reflects a specific percentile estimate is difficult to quantify.” Fletcher et al.’s (1994) research suggests that the pesticide active ingredient residue assumptions used by the EPA represent a ninety-fifth percentile estimate. However, research conducted by Pfleeger et al. (1996) indicates EPA residue assumptions for short grass were not exceeded. Baehr and Habig (2000) compared the EPA residue assumptions with distributions of measured pesticide residues for the EPA’s Uptake, Translocation, Accumulation, and Biotransformation (UTAB) database. Overall residue selection levels would tend to overestimate risk characterization. This is particularly evident when wildlife individuals are likely to have selected a variety of food items acquired from multiple locations. Some food items may be contaminated with pesticide residues whereas others are not contaminated. However, it is important to recognize differences in species feeding behavior. Some species may consume whole aboveground plant material, but others preferentially select different plant structures. Also, species may preferentially select a food item although multiple food items may be present. Without species-specific knowledge regarding foraging behavior, characterizing ecological risk other than in general terms is not possible.
- Acute and chronic risk assessments rely on comparisons of wildlife dietary residues with LC<sub>50</sub> or NOEC values expressed as concentrations of pesticides in laboratory feed. These comparisons assume that ingestion of food items in the field occurs at rates commensurate with those in the laboratory. Although the screening assessment process adjusts dry-weight estimates of food intake to reflect the increased mass in fresh-weight wildlife food intake estimates, it does not allow for gross energy and assimilative efficiency differences between wildlife food items and laboratory feed. Differences in assimilative efficiency between laboratory and wild diets suggest that current screening assessment methods are not accounting for a potentially important aspect of food requirements.
- There are several other assumptions that can affect non-target species not considered in the risk assessment process. These include possible additive or synergistic effects from applying two or more pesticides or additives in a single application, co-location of pesticides in the environment, cumulative effects from pesticides with the same mode of action, effects of multiple stressors (e.g., combination of pesticide exposure and adverse abiotic and biotic factors), and behavioral changes induced by exposure to a pesticide. These factors may exist at some level contributing to adverse effects to non-target species, but they are usually characterized in the published literature in only a general manner, limiting their value in the risk assessment process.
- It is assumed that aquatic species exclusively and permanently occupy the water body being assessed. Actual habitat requirements of aquatic species are not considered. With the possible exception of scenarios where pesticides are directly applied to water, it is assumed that no habitat use considerations specific for any species would place the organisms in closer proximity to pesticide use sites. This assumption produces a maximum estimate of exposure or risk characterization. It would likely be realistic for many aquatic species that may be found in aquatic habitats within or in close proximity to treated terrestrial habitats. However,

the spatial distribution of wildlife is usually not random because wildlife distributions are often related to habitat requirements of species. Clumped distributions of wildlife may result in an underestimation or overestimation of risk depending upon where the initial pesticide concentration occurs relative to the species or species habitat.

- For species found in the water column, it would be assumed that the greatest bioavailable fraction of the pesticide active ingredient in surface waters is freely dissolved in the water column. Additional chemical exposure from materials associated with suspended solids or food items is not considered because partitioning onto sediments likely is minimal. Adsorption and bioconcentration occur at lower levels for many newer pesticides compared with older, more persistent bioaccumulative compounds. For pesticides with RQs close to the listed species LOC, the potential for additional exposure from these routes may be a limitation of risk assessments, where potential pesticide exposure or risk may be underestimated.
- Mass transport losses of pesticide from a water body (except for losses by volatilization, degradation, and sediment partitioning) would not be considered for ecological risk assessment. The water body would be assumed to capture all pesticide active ingredients entering as runoff, drift, and adsorbed to eroded soil particles. It would also be assumed that pesticide active ingredient is not lost from the water body by overtopping or flow-through, nor is concentration reduced by dilution. In total, these assumptions would lead to a near maximum possible water-borne concentration. However, this assumption would not account for the potential to concentrate pesticide through evaporative loss. This limitation may have the greatest impact on water bodies with high surface-to-volume ratios such as ephemeral wetlands, where evaporative losses are accentuated and applied pesticides have low rates of degradation and volatilization.
- For acute risk assessments, there would be no averaging time for exposure. An instantaneous peak concentration would be assumed, where instantaneous exposure is sufficient in duration to elicit acute effects comparable to those observed over more protracted exposure periods (typically 48 to 96 hours) tested in the laboratory. In the absence of data regarding time-to-toxic event and analyses and latent responses to instantaneous exposure, risk would likely be overestimated.
- For chronic exposure risk assessments, the averaging times considered for exposure are commensurate with the duration of the invertebrate life cycle or fish early life stage tests (e.g., 21-28 days and 56-60 days, respectively). Response profiles (time to effect and latency of effect) to pesticides likely vary widely with mode of action and species and should be evaluated on a case-by-case basis as available data allow. Nevertheless, because the EPA relies on chronic exposure, and toxicity endpoints based on a finding of no observed effect, the potential for any latent toxicity effects or averaging time assumptions to alter the results of an acceptable chronic risk assessment prediction is limited. The extent to which duration of exposure from water-borne concentrations overestimate or underestimate actual exposure depends on several factors. These include the following: localized meteorological conditions, runoff characteristics of the watershed (e.g., soils, topography), the hydrological characteristics of receiving waters, environmental fate of the pesticide active ingredient, and the method of pesticide application. It should also be understood that chronic effects studies are performed using a method that holds water concentration in a steady state. This method is not likely to reflect conditions associated with pesticide runoff. Pesticide concentrations in the field increase and decrease in surface water on a cycle influenced by rainfall, pesticide use patterns, and degradation rates. As a result of the dependency of this assumption on

several undefined variables, risk associated with chronic exposure may in some situations be overestimated or underestimated.

- The EPA is required by the Food Quality Protection Act to assess the cumulative risks of pesticides that share common mechanisms of toxicity, or act the same way within an organism. Currently, the EPA has identified four groups of pesticides that have a common mechanism of toxicity requiring cumulative risk assessments. These four groups are: the organophosphate insecticides, N-methyl carbamate insecticides, triazine herbicides, and chloroacetanilide herbicides.

### **G.7.3 Pesticide Mixtures and Degradates**

Pesticide products are usually a formulation of several components generally categorized as active ingredients and inert or other ingredients. The term active ingredient is defined by the FIFRA as preventing, destroying, repelling, or mitigating the effects of a pest, or a plant regulator, defoliant, desiccant, or nitrogen stabilizer. In accordance with FIFRA, the active ingredient(s) must be identified by name(s) on the pesticide label along with its relative composition expressed in percentage(s) by weight. In contrast, inert ingredient(s) are not intended to affect a target pest. Their role in the pesticide formulation is to act as a solvent (keep the active ingredient in a liquid phase), an emulsifying or suspending agent (keep the active ingredient from separating out of solution), or a carrier (such as clay in which the active ingredient is impregnated on the clay particle in dry formulations). For example, if isopropyl alcohol is used as a solvent in a pesticide formulation, then it would be considered an inert ingredient. FIFRA only requires that inert ingredients identified as hazardous and associated percent composition, and the total percentage of all inert ingredients, must be declared on a product label. Inert ingredients that are not classified as hazardous are not required to be identified.

The EPA (September 1997) issued Pesticide Regulation Notice 97-6, which encouraged manufacturers, formulators, producers, and registrants of pesticide products to voluntarily substitute the term “other ingredients” for “inert ingredients” in the ingredient statement. This change recognized that all components in a pesticide formulation potentially could elicit or contribute to an adverse effect on non-target organisms and, therefore, are not necessarily inert. Whether referred to as “inerts” or “other ingredients,” these constituents within a pesticide product have the potential to affect species or environmental quality. The USEPA categorizes regulated inert ingredients into the following four lists (EPA 2012):

- List 1 – Inert Ingredients of Toxicological Concern
- List 2 – Potentially Toxic Inert Ingredients
- List 3 – Inerts of Unknown Toxicity
- List 4 – Inerts of Minimal Toxicity

Several of the List 4 compounds are naturally occurring earthen materials (e.g., clay materials, simple salts) that would not elicit toxicological response at applied concentrations. However, some of the inerts (particularly the List 3 compounds and unlisted compounds) may have moderate to high potential toxicity to aquatic species based on MSDS or published data.

Comprehensively assessing potential effects to non-target fish, wildlife, plants, and/or their habitats from pesticide use is a complex task. It would be preferable to assess the cumulative effects from exposure to the active ingredient, its degradates, and inert ingredients as well as other active ingredients in the spray mixture. However, it would only be feasible to conduct deterministic risk

assessments for each component in the spray mixture singly. Limited scientific information is available regarding ecological effects (additive or synergistic) from chemical mixtures that typically rely upon broadly encompassing assumptions. For example, the USFS (2005) found that mixtures of pesticides used in forest management likely would not cause additive or synergistic effects to nontarget species based upon a review of scientific literature regarding toxicological effects and interactions of agricultural chemicals (Agency for Toxic Substances and Disease Registry [ATSDR] 2004). Moreover, information on inert ingredients, adjuvants, and degradates is often limited by the availability of and access to reliable toxicological data for these constituents.

Toxicological information regarding “other ingredients” may be available from sources such as the following:

- Toxicology, Occupational Medicine, and Environmental Series (TOMES) (a proprietary toxicological database including EPA’s Integrated Risk Information System (IRIS), the Hazardous Substance Data Bank, the Registry of Toxic Effects of Chemical Substances [RTECS])
- EPA’s Ecotoxicology (ECOTOX) database, which includes Aquatic Information Retrieval (AQUIRE) (a database containing scientific papers published on the toxic effects of chemicals to aquatic organisms)
- TOXLINE (a literature searching tool)
- MSDSs from pesticide suppliers
- Other sources such as the *Farm Chemicals Handbook*

Because there is a lack of specific inert toxicological data, inert(s) in a pesticide may cause adverse ecological effects. However, inert ingredients typically represent only a small percentage of the pesticide spray mixture, and it would be assumed that negligible effects would be expected to result from inert ingredients.

Although the potential effects of degradates should be considered when selecting a pesticide, it is beyond the scope of this assessment process to consider all possible breakdown chemicals of the various product formulations containing an active ingredient. Degradates may be more or less mobile and more or less hazardous in the environment than their parent pesticides (Battaglin et al. 2003). Differences in environmental behavior (e.g., mobility) and toxicity between parent pesticides and degradates would make assessing potential degradate effects extremely difficult. For example, a less toxic and more mobile, bioaccumulative, or persistent degradate may have potentially greater effects on species and/or degrade environmental quality. The lack of data on the toxicity of degradates for many pesticides represents a source of uncertainty for assessing risk.

An EPA-approved label specifies whether a product can be mixed with one or more pesticides. Without product-specific toxicological data, it would not be possible to quantify the potential effects of these mixtures. In addition, a quantitative analysis could only be conducted if reliable scientific information allowed a determination of whether the joint action of a mixture would be additive, synergistic, or antagonistic. Such information would not likely exist unless the mode of action is common among the chemicals and receptors. Moreover, the composition of and exposure to mixtures would be highly site- and/or time-specific and, therefore, it would be nearly impossible to assess potential effects to species and environmental quality.

To minimize or eliminate potential negative effects associated with applying two or more pesticides as a mixture, the use would be conducted in accordance with the labeling requirements. Labels for

two or more pesticides applied as a mixture should be completely reviewed, and products with the least potential for negative effects would be selected for use on the refuge. This is especially relevant when a mixture would be applied in a manner that may already have the potential for an effect(s) associated with an individual pesticide. Use of a tank mix under these conditions would increase the level of uncertainty in terms of risk to species or potential to degrade environmental quality.

Adjuvants generally function to enhance or prolong the activity of pesticide. For terrestrial herbicides, adjuvants aid in the absorption into plant tissue. Adjuvant is a broad term that generally applies to surfactants, selected oils, anti-foaming agents, buffering compounds, drift control agents, compatibility agents, stickers, and spreaders. Adjuvants are not under the same registration requirements as pesticides, and the EPA does not register or approve the labeling of spray adjuvants. Individual pesticide labels identify types of adjuvants approved for use with it. In general, adjuvants compose a relatively small portion of the volume of pesticides applied. Selection of adjuvants with limited toxicity and low volumes would be recommended to reduce the potential for the adjuvant to influence the toxicity of the pesticide.

#### **G.7.4 Determining Effects to Soil and Water Quality**

The approval process for pesticide uses would consider potential to degrade water quality on and off refuge lands. A pesticide can only affect water quality through movement away from the treatment site. After application, pesticide mobilization can be characterized by one or more of the following (Kerle et al. 1996):

- Attach (sorb) to soil, vegetation, or other surfaces and remain at or near the treated area;
- Attach to soil and move off-site through erosion from runoff or wind;
- Dissolve in water that can be subjected to runoff or leaching.

As an initial screening tool, selected chemical characteristics and rating criteria for a pesticide can be evaluated to assess potential to enter ground and/or surface waters. These would include the following: persistence, sorption coefficient ( $K_{oc}$ ), groundwater ubiquity score (GUS), and solubility.

Persistence, which is expressed as half-life ( $t_{1/2}$ ), represents the length of time required for 50 percent of the deposited pesticide to degrade (completely or partially). Persistence in the soil can be categorized as the following: nonpersistent <30 days, moderately persistent = 30 to 100 days, and persistent >100 days (Kerle et al. 1996). Half-life data are usually available for aquatic and terrestrial environments.

Another measure of pesticide persistence is dissipation time ( $DT_{50}$ ). It represents the time required for 50 percent of the deposited pesticide to degrade and move from a treated site, whereas half-life describes the rate for degradation only. As with half-life, units of dissipation time are usually expressed in days. Field or foliar dissipation times are the preferred data for use to estimate pesticide concentrations in the environment. However, soil half-lives are the most common persistence data cited in published literature. If field or foliar dissipation data are not available, soil half-life data may be used. The average or representative half-life value of most important degradation mechanism would be selected for quantitative analysis for both terrestrial and aquatic environments.

Mobility of a pesticide is a function of how strongly it is adsorbed to soil particles and organic matter, its solubility in water, and its persistence in the environment. Pesticides strongly adsorbed to soil particles, relatively insoluble in water, and not environmentally persistent would be less likely to

move across the soil surface into surface waters or to leach through the soil profile and contaminate groundwater. Conversely, pesticides that are not strongly adsorbed to soil particles, are highly water soluble, and are persistent in the environment would have greater potential to move from the application site (off-site movement).

The degree of pesticide adsorption to soil particles and organic matter (Kerle et al. 1996) is expressed as the soil adsorption coefficient. The  $K_{oc}$  is measured as micrograms of pesticide per gram of soil ( $\mu\text{g/g}$ ), which can range from near zero to the thousands. Pesticides with higher  $K_{oc}$  values are strongly sorbed to soil and, therefore, would be less subject to movement.

Water solubility describes the amount of pesticide that will dissolve in a known quantity of water. The water solubility of a pesticide is expressed as milligrams of pesticide dissolved in a liter of water ( $\text{mg/L}$ ) or ppm. As pesticide solubility increases, there would be greater potential for off-site movement.

The GUS is a quantitative screening tool to estimate a pesticide's potential to move in the environment. It uses soil persistence and adsorption coefficients in the following formula.

$$\text{GUS} = \log_{10}(t^{1/2}) \times [4 - \log_{10}(K_{oc})]$$

The potential pesticide movement rating would be based upon its GUS value. Pesticides with a GUS  $<0.1$  would be considered to have an extremely low potential to move toward groundwater. Values of 1.0 to 2.0 would have low potential, 2.0 to 3.0 would have moderate potential, 3.0 to 4.0 would have high potential, and  $>4.0$  would have a very high potential to move toward groundwater.

GUS, water solubility, half-life, and  $K_{oc}$  values are available for selected pesticides from the Oregon State University (OSU) Extension Pesticide Properties Database at <http://npic.orst.edu/ppdmove.htm>. Many of the values in this database were derived from the Soil Conservation Service/Agricultural Research Service/Cooperative Extension Service (SCS/ARS/CES) Pesticide Properties Database for Environmental Decision Making (Wauchope et al. 1992).

Soil properties influence the fate of pesticides in the environment. The following six properties are mostly likely to affect pesticide degradation and the potential for pesticides to move off-site by leaching (vertical movement through the soil) or runoff (lateral movement across the soil surface).

- Permeability is the rate of water movement vertically through the soil. It is affected by soil texture and structure. Coarse-textured soils (e.g., high sand content) have a larger pore size and are generally more permeable than fine-textured soils (i.e., high clay content). The more permeable soils would have a greater potential for pesticides to move vertically down through the soil profile. Soil permeability rates (inches/hour) are usually available in county soil survey reports.
- Soil texture describes the relative percentage of sand, silt, and clay. In general, greater clay content with smaller pore size would lower the likelihood and rate that water would move through the soil profile. Clay also serves to adsorb (bind) pesticides to soil particles. Soils with high clay content would adsorb more pesticide than soils with relatively low clay content. In contrast, sandy soils with coarser texture and lower water-holding capacity would have a greater potential for water to leach through them.
- Soil structure describes soil aggregation. Soils with a well-developed soil structure have looser, more aggregated structures that would be less likely to be compacted. Both

characteristics would allow for less restricted flow of water through the soil profile, resulting in greater infiltration.

- Organic matter would be the single most important factor affecting pesticide adsorption in soils. Many pesticides are adsorbed to organic matter, which would reduce their rate of downward movement through the soil profile. Also, soils high in organic matter would tend to hold more water, which may make less water available for leaching.
- Soil moisture affects how fast water would move through the soil. If soils are already wet or saturated before rainfall or irrigation, excess moisture would result in runoff rather than infiltrate into the soil profile. Soil moisture also would influence microbial and chemical activity in soil, which effects pesticide degradation.
- Soil pH influences chemical reactions that occur in the soil, which in turn determines whether a pesticide would degrade, the rate of degradation, and, in some instances, which degradation products are produced.

Based upon the aforementioned properties, soils most vulnerable to groundwater contamination would be sandy soils with low organic matter. In contrast, the least vulnerable soils would be well-drained clayey soils with high organic matter. Consequently, pesticides with the lowest potential for movement in conjunction with appropriate BMPs (see below) would be used in an IPM framework to treat pests while minimizing effects to non-target biota and protecting environmental quality.

Along with soil properties, the potential for a pesticide to affect water quality through runoff and leaching would consider site-specific environmental and abiotic conditions including rainfall, water table conditions, and topography (Huddleston 1996).

- Water is necessary to separate pesticides from soil. This can occur in two basic ways. Pesticides that are soluble move easily with runoff water. Pesticide-laden soil particles can be dislodged and transported from the application site in runoff. The concentration of pesticides in the surface runoff would be greatest for the first runoff event following treatment. The rainfall intensity and route of water infiltration into soil, to a large extent, determine pesticide concentrations and losses in surface runoff. The timing of the rainfall after application also would have an effect. Rainfall interacts with pesticides at a shallow soil depth (¼ to ½ inch), which is called the mixing zone (Baker and Miller 1999). The pesticide/water mixture in the mixing zone would tend to leach down into the soil or runoff depending upon how quickly the soil surface becomes saturated and how rapidly water can infiltrate into the soil. Leaching would decrease the amount of pesticide available near the soil surface (mixing zone) to runoff during the initial rainfall event following application and subsequent rainfall events.
- Terrain slope would affect the potential for surface runoff and the intensity of runoff. Steeper slopes would have greater potential for runoff following a rainfall event. In contrast, soils that are relatively flat would have little potential for runoff, except during intense rainfall events. In addition, soils in lower areas would be more susceptible to leaching as a result of receiving excessive water from surrounding higher elevations.
- Depth to groundwater would be an important factor affecting the potential for pesticides to leach into groundwater. If the distance from the soil surface to the top of the water table is shallow, pesticides would have less distance to travel to reach groundwater. Shallower water tables that persist for longer periods would be more likely to experience groundwater contamination. Soil survey reports are available for individual counties. These reports provide data in tabular format regarding the water table depths and the months during which

they persist. In some situations, a hard pan exists above the water table that would prevent pesticide contamination from leaching.

### **G.7.5 Determining Effects to Air Quality**

Pesticides may volatilize from soil and plant surfaces and move from the treated area into the atmosphere. The potential for a pesticide to volatilize is determined by the pesticide's vapor pressure, which would be affected by temperature, sorption, soil moisture, and the pesticide's water solubility. Vapor pressure is often expressed in mm Hg. To make these numbers easier to compare, vapor pressure may be expressed in exponent form ( $I \times 10^{-7}$ ), where I represents a vapor pressure index. In general, pesticides with  $I < 10$  would have a low potential to volatilize, whereas pesticides with  $I > 1,000$  would have a high potential to volatilize (OSU 1996). Vapor pressure values for pesticides are usually available in the pesticide product MSDS or the USDA Agricultural Research Service (ARS) pesticide database.

### **G.7.6 Preparing a Chemical Profile**

The following instructions would be used by Service personnel to complete chemical profiles for pesticides. Specifically, profiles would be prepared for pesticide active ingredients (e.g., glyphosate, imazapic) that would be contained in one or more trade name products that are registered and labeled with the EPA. All information fields under each category (e.g., toxicological endpoints, environmental fate) would be completed for a chemical profile. If no information is available for a specific field, then "No data is available in references" would be recorded in the profile. Available scientific information would be used to complete chemical profiles. Each entry of scientific information would be shown with applicable references.

Completed chemical profiles would provide a structured decision-making process using quantitative assessment/screening tools with threshold values (where appropriate) that would be used to evaluate potential biological and other environmental effects to refuge resources. For ecological risk assessments presented in these profiles, the "worst-case scenario" would be evaluated to determine whether a pesticide could be approved for use considering the maximum single application rate specified on pesticide labels for habitat management and croplands/facilities maintenance treatments pertaining to refuges. Where the worst-case scenario likely would only result in minor, temporary, and localized effects to listed and non-listed species with appropriate BMPs (see Section G.5), the proposed pesticide's use in a PUP would have a scientific basis for approval under any application rate specified on the label that is at or below rates evaluated in a chemical profile. In some cases, the chemical profile would include a lower application rate than the maximum labeled rate in order to protect refuge resources. As necessary, chemical profiles would be periodically updated with new scientific information or as pesticides with the same active ingredient are proposed for use on the refuge in PUPs.

Throughout this section, threshold values (to prevent or minimize potential biological and environmental effects) would be clearly identified for specific information presented in a completed chemical profile. Comparison with these threshold values provides an explicit scientific basis to approve or disapprove PUPs for habitat management and cropland/facilities maintenance on refuge lands. In general, PUPs would be approved for pesticides with chemical profiles where there would be no exceedances of threshold values. However, BMPs are identified for some screening tools that would minimize/eliminate potential effects (exceedance of the threshold value) as a basis for approving PUPs.

**Date:** Service personnel would record the date when the chemical profile is completed or updated. Chemical profiles (e.g., currently approved pesticide use patterns) would be periodically reviewed and updated as necessary. The most recent review date would be recorded on a profile to document when it was last updated.

**Trade Name(s):** Service personnel would accurately and completely record the trade name(s) from the pesticide label, which includes a suffix that describes the formulation (e.g., WP, DG, EC, L, SP, I, II or 64). The suffix often distinguishes a specific product from among several pesticides with the same active ingredient. Service personnel would record a trade name for each pesticide product with the same active ingredient.

**Common chemical name(s):** Service personnel would record the common name(s) listed on the pesticide label or MSDS for an active ingredient. The common name of a pesticide is listed as the active ingredient on the title page of the product label immediately following the trade name, and the MSDS Section 2: Composition/Information on Ingredients. A chemical profile is completed for each active ingredient.

**Pesticide Type:** Service personnel would record the type of pesticide for an active ingredient as one of the following: herbicide, desiccant, fungicide, fumigant, growth regulator, insecticide, piscicide, or rodenticide.

**EPA Registration Number(s):** The EPA Reg. No. appears on the title page of the label and MSDS Section 1: Chemical Product and Company Description. It is not the EPA Establishment Number, which is usually located near it. Service personnel would record the EPA Reg. No. for each trade name product with an active ingredient based upon PUPs.

**Pesticide Class:** Service personnel would list the general chemical class for the pesticide (active ingredient). For example, malathion is an organophosphate and carbaryl is a carbamate.

**CAS (Chemical Abstract Service) Number:** This number is often located in the second section (Composition/Information on Ingredients) of the MSDS. The MSDS table listing components usually contains this number immediately prior to or following the percent composition.

**Other Ingredients:** From the most recent MSDS for the proposed pesticide product(s), Service personnel would include any chemicals in the pesticide formulation that are not listed as active ingredients but are described as toxic or hazardous, or are regulated under the Superfund Amendments and Reauthorization Act (SARA), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Toxic Substances Control Act (TSCA), OSHA, State Right-to-Know, or other listed authorities. These are usually found in MSDS sections titled “Hazardous Identifications,” “Exposure Control/Personal Protection,” and “Regulatory Information.” If concentrations of other ingredients are available for any compounds identified as toxic or hazardous, then Service personnel would record this information in the chemical profile by trade name. MSDSs may be obtained from the manufacturer, manufacturer’s website or from an online database maintained by Crop Data Management Systems, Inc. (see list below).

### **G.7.6.1 Toxicological Endpoints**

Toxicological endpoint data would be collected for acute and chronic tests with mammals, birds, and fish. Data would be recorded for species available in the scientific literature. If no data are found for

a particular taxonomic group, then “No data available is references” would be recorded as the data entry. Throughout the chemical profile, references (including toxicological endpoint data) would be cited using parentheses (#) following the recorded data.

**Mammalian LD<sub>50</sub>:** For test species in the scientific literature, Service personnel would record available data for oral lethal dose (LD<sub>50</sub>) in mg/kg-bw (body weight) or ppm-bw. The most common test species in scientific literature are the rat and mouse. The lowest LD<sub>50</sub> value found for a rat would be used as a toxicological endpoint for dose-based RQ calculations to assess acute risk to mammals (see Table G-1 in Section G.7.2).

**Mammalian LC<sub>50</sub>:** For test species in the scientific literature, Service personnel would record available data for dietary lethal concentration (LC<sub>50</sub>) as reported (e.g., mg/kg-diet or ppm-diet). The most common test species in scientific literature are the rat and mouse. The lowest LC<sub>50</sub> value found for a rat would be used as a toxicological endpoint for diet-based RQ calculations to assess acute risk (see Table G-1 in Section G.7.2).

**Mammalian Reproduction:** For test species listed in the scientific literature, Service personnel would record the test results (e.g., Lowest Observed Effect Concentration [LOEC], Lowest Observed Effect Level [LOEL], No Observed Adverse Effect Level [NOAEL], NOAEC) in mg/kg-bw or mg/kg-diet for reproductive test procedure(s) (e.g., generational studies [preferred], fertility, newborn weight). The most common test species available in scientific literature are rats and mice. The lowest NOEC, NOAEC, LOEL, or NOAEL test results found for a rat would be used as a toxicological endpoint for RQ calculations to assess chronic risk (see Table G-1 in Section G.7.2).

**Avian LD<sub>50</sub>:** For test species available in the scientific literature, Service personnel would record values for oral lethal dose (LD<sub>50</sub>) in mg/kg-bw or ppm-bw. The most common test species available in scientific literature are the bobwhite quail and mallard. The lowest LD<sub>50</sub> value found for an avian species would be used as a toxicological endpoint for dose-based RQ calculations to assess acute risk (see Table G-1 in Section G.7.2).

**Avian LC<sub>50</sub>:** For test species available in the scientific literature, Service personnel would record values for dietary lethal concentration (LC<sub>50</sub>) as reported (e.g., mg/kg-diet or ppm-diet). The most common test species available in scientific literature are the bobwhite quail and mallard. The lowest LC<sub>50</sub> value found for an avian species would be used as a toxicological endpoint for dietary-based RQ calculations to assess acute risk (see Table G-1 in Section G.7.2).

**Avian Reproduction:** For test species available in the scientific literature, Service personnel would record test results (e.g., LOEC, LOEL, NOAEC, NOAEL) in mg/kg-bw or mg/kg-diet consumed for reproductive test procedure(s) (e.g., early life cycle, reproductive). The most common test species available in scientific literature are the bobwhite quail and mallard. The lowest NOEC, NOAEC, LOEL, or NOAEL test results found for an avian species would be used as a toxicological endpoint for RQ calculations to assess chronic risk (see Table G-1 in Section G.7.2).

**Fish LC<sub>50</sub>:** For test freshwater or marine species listed in the scientific literature, Service personnel would record a LC<sub>50</sub> in ppm or mg/L. The most common test species available in the scientific literature are the bluegill, rainbow trout, and fathead minnow (marine). Test results for many game species may also be available. The lowest LC<sub>50</sub> value found for a freshwater fish species would be used as a toxicological endpoint for RQ calculations to assess acute risk (see Table G-1 in Section G.7.2).

**Fish Early Life Stage/Life Cycle:** For test freshwater or marine species available in the scientific literature, Service personnel would record test results (e.g., LOEC, NOAEL, NOAEC, lowest observed adverse effect concentration [LOAEC]) in ppm for test procedure(s) (e.g., early life cycle, life cycle). The most common test species available in the scientific literature are bluegill, rainbow trout, and fathead minnow. Test results for other game species may also be available. The lowest test value found for a fish species (preferably freshwater) would be used as a toxicological endpoint for RQ calculations to assess chronic risk (see Table G-1 in Section G.7.2).

**Other:** For test invertebrate and nonvascular and vascular plant species available in the scientific literature, Service personnel would record LC<sub>50</sub>, LD<sub>50</sub>, LOEC, LOEL, NOAEC, NOAEL, or EC<sub>50</sub> (environmental concentration) values in ppm or mg/L. The most common test invertebrate species available in scientific literature is the honey bee. Green algae and pondweed are frequently available test species for aquatic non-vascular and vascular plants, respectively.

**Ecological Incident Reports:** After a site has been treated with pesticide(s), wildlife may be exposed to these chemical(s). When exposure is high relative to the toxicity of the pesticides, wildlife may be killed or visibly harmed (incapacitated). Such events are called ecological incidents. The EPA maintains a database (Ecological Incident Information System) of ecological incidents. This database stores information extracted from incident reports submitted by various Federal and state agencies and non-government organizations. Information included in an incident report is date and location of the incident, type and magnitude of effects observed in various species, use(s) of pesticides known or suspected of contributing to the incident, and results of any chemical residue and cholinesterase activity analyses conducted during the investigation.

Incident reports can play an important role in evaluating the effects of pesticides by supplementing quantitative risk assessments. All incident reports for pesticide(s) with the active ingredient and associated information would be recorded.

### **G.7.6.2 Environmental Fate**

**Water Solubility:** Service personnel would record values for water solubility ( $S_w$ ), which describes the amount of pesticide that dissolves in a known quantity of water.  $S_w$  is expressed as mg/L (ppm). Pesticide  $S_w$  values would be categorized as one of the following: insoluble <0.1 ppm, moderately soluble = 100 to 1,000 ppm, highly soluble >10,000 ppm (U.S. Geological Survey 2000). As pesticide  $S_w$  increases, there would be greater potential to degrade water quality through runoff and leaching.

$S_w$  would be used to evaluate potential for bioaccumulation in aquatic species (see Octanol-Water Partition Coefficient ( $K_{ow}$ ) below).

**Soil Mobility:** Service personnel would record available values for soil adsorption coefficient ( $K_{oc}$  [ $\mu\text{g/g}$ ]). It provides a measure of a chemical's mobility and leaching potential in soil.  $K_{oc}$  values are directly proportional to organic content, clay content, and surface area of the soil.  $K_{oc}$  data for a pesticide may be available for a variety of soil types (e.g., clay, loam, sand).

$K_{oc}$  values would be used in evaluating the potential to degrade groundwater by leaching (see Potential to Move to Groundwater below).

**Soil Persistence:** Service personnel would record values for soil half-life, which represents the length of time (days) required for 50 percent of the deposited pesticide to degrade (completely or partially) in the soil. Based upon the half-life value, soil persistence would be categorized as one of the following: non-persistent <30 days, moderately persistent = 30 to 100 days, and persistent >100 days (Kerle et al. 1996).

*Threshold for approving PUPs:*

If soil half-life  $\leq 100$  days, then a PUP would be approved without additional BMPs to protect water quality.

If soil half-life >100 days, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the “Specific Best Management Practices (BMPs)” section to minimize potential surface runoff and leaching that can degrade water quality:

- *Do not exceed one application per site per year.*
- *Do not use on coarse-textured soils where the groundwater table is <10 feet and average annual precipitation >12 inches.*
- *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

Along with  $K_{oc}$ , soil half-life values would be used in evaluating the potential to degrade groundwater by leaching (see Potential to Move to Groundwater below).

**Soil Dissipation:** Field dissipation time would be the preferred data for use to estimate pesticide concentrations in the environment because it is based upon field studies, unlike soil half-life, which is derived in a laboratory. However, soil half-life is the most common persistence data available in the published literature. If field dissipation data are not available, soil half-life data would be used in a chemical profile. The average or representative half-life value of most important degradation mechanism would be selected for quantitative analysis for both terrestrial and aquatic environments.

Based upon the  $DT_{50}$  value, environmental persistence in the soil also would be categorized as one of the following: non-persistent <30 days, moderately persistent = 30 to 100 days, and persistent >100 days.

*Threshold for approving PUPs:*

If soil  $DT_{50} \leq 100$  days, then a PUP would be approved without additional BMPs to protect water quality.

If soil  $DT_{50} > 100$  days, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the “Specific Best Management Practices (BMPs)” section to minimize potential surface runoff and leaching that can degrade water quality:

- *Do not exceed one application per site per year.*
- *Do not use on coarse-textured soils where the groundwater table is <10 feet and average annual precipitation >12 inches.*

- *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

Along with  $K_{oc}$ , soil  $DT_{50}$  values (preferred over soil half-life) would be used in evaluating the potential to degrade groundwater by leaching (see Potential to Move to Groundwater below), if available.

**Aquatic Persistence:** Service personnel would record values for aquatic half-life, which represents the length of time required for 50 percent of the deposited pesticide to degrade (completely or partially) in water. Based upon the aquatic half-life value, aquatic persistence would be categorized as one of the following: nonpersistent <30 days, moderately persistent = 30 to 100 days, and persistent >100 days (Kerle et al. 1996).

*Threshold for approving PUPs:*

If aquatic half-life  $\leq 100$  days, then a PUP would be approved without additional BMPs to protect water quality.

If aquatic half-life >100 days, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the “Specific Best Management Practices (BMPs)” section to minimize potential surface runoff and leaching that can degrade water quality:

- *Do not exceed one application per site per year.*
- *Do not use on coarse-textured soils where the groundwater table is <10 feet and average annual precipitation >12 inches.*
- *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

**Aquatic Dissipation:** Dissipation time ( $DT_{50}$ ) represents the time required for 50 percent of the deposited pesticide to degrade or move (dissipate), whereas, aquatic half-life describes the rate for degradation only. As with aquatic half-life, units of dissipation time are usually expressed in days. Based upon the  $DT_{50}$  value, environmental persistence in aquatic habitats also would be categorized as one of the following: non-persistent <30 days, moderately persistent = 30 to 100 days, and persistent >100 days.

*Threshold for approving PUPs:*

If aquatic  $DT_{50} \leq 100$  days, then a PUP would be approved without additional BMPs to protect water quality.

If aquatic  $DT_{50} > 100$  days, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the “Specific Best Management Practices (BMPs)” section to minimize potential surface runoff and leaching that can degrade water quality:

- *Do not exceed one application per site per year.*
- *Do not use on coarse-textured soils where the groundwater table is <10 feet and average annual precipitation >12 inches.*

- *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

**Potential to Move to Groundwater:**  $GUS = \log_{10}(\text{soil } t_{1/2}) \times [4 - \log_{10}(K_{oc})]$ . If a  $DT_{50}$  value is available, it would be used rather than a  $t_{1/2}$  value to calculate a GUS score. Based upon the GUS value, the potential to move toward groundwater would be recorded as one of the following categories: extremely low potential <1.0, low potential 1.0 to 2.0, moderate potential 2.0 to 3.0, high potential 3.0 to 4.0, and very high potential >4.0.

*Threshold for approving PUPs:*

If  $GUS \leq 4.0$ , then a PUP would be approved without additional BMPs to protect water quality.

If  $GUS > 4.0$ , then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the “Specific Best Management Practices (BMPs)” section to minimize potential surface runoff and leaching that can degrade water quality:

- *Do not exceed one application per site per year.*
- *Do not use on coarse-textured soils where the groundwater table is <10 feet and average annual precipitation >12 inches.*
- *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

*Threshold for approving PUPs:*

If  $I \leq 1,000$ , then a PUP would be approved without additional BMPs to minimize drift and protect air quality.

If  $I > 1,000$ , then a PUP would only be approved with additional BMPs specifically to minimize drift and protect air quality. One or more BMPs such as the following would be included in the “Specific Best Management Practices (BMPs)” section to reduce volatilization and potential to drift and degrade air quality:

- *Do not treat when wind velocities are <2 or >10 mph with existing or potential inversion conditions.*
- *Apply large-diameter droplets possible for spray treatments.*
- *Avoid spraying when air temperatures >85°F.*
- *Use the lowest spray height possible above target canopy.*
- *Where identified on the pesticide label, soil should incorporate pesticide as soon as possible during or after application.*

**Octanol-Water Partition Coefficient ( $K_{ow}$ ):** The octanol-water partition coefficient ( $K_{ow}$ ) is the concentration of a pesticide in octanol and water at equilibrium at a specific temperature. Because octanol is an organic solvent, it is considered a surrogate for natural organic matter. Therefore,  $K_{ow}$  would be used to assess potential for a pesticide to bioaccumulate in tissues of aquatic species (e.g., fish). If  $K_{ow} > 1,000$  or  $S_w < 1$  mg/L and soil  $t_{1/2} > 30$  days, then there would be high potential for a pesticide to bioaccumulate in aquatic species such as fish (U.S. Geological Survey 2000).

*Threshold for approving PUPs:*

If the potential for a pesticide to bioaccumulate is not high in aquatic species, then the PUP would be approved.

If there is a high potential to bioaccumulate in aquatic species ( $K_{ow} > 1,000$  or  $S_w < 1$  mg/L and soil  $t_{1/2} > 30$  days), then the PUP would not be approved, except under unusual circumstances where approval would only be granted by the Washington Office.

**Bioaccumulation/Bioconcentration:** Bioaccumulation is the physiological process where pesticide concentrations in tissue increase in biota because they are taken and stored at a faster rate than they are metabolized or excreted. The potential for bioaccumulation would be evaluated through bioaccumulation factors (BAFs) or bioconcentration factors (BCFs). Based upon BAF or BCF values, the potential to bioaccumulate would be recorded as one of the following: low = 0 to 300, moderate = 300 to 1,000, or high  $> 1,000$  (Calabrese and Baldwin 1993).

*Threshold for approving PUPs:*

If BAF or BCF  $\leq 1,000$ , then a PUP would be approved without additional BMPs.

If BAF or BCF  $> 1,000$ , then a PUP would not be approved, except under unusual circumstances where approval would only be granted by the Washington Office.

***Worst-Case Ecological Risk Assessment***

**Maximum Application Rates (acid equivalent [ae]):** Service personnel would record the highest application rate of an active ingredient (ae basis) for habitat management and cropland/facilities maintenance treatments in this data field of a chemical profile. These rates can be found in Table CP.1 under the column heading “Max Product Rate – Single Application (lbs/acre – AI on acid equiv basis).” This table would be prepared for a chemical profile from information specified in labels for trade name products identified in PUPs. If these data are not available in pesticide labels, then write “NS” for “not specified on label” in this table.

**EECs:** An estimated EEC represents potential exposure to fish and wildlife (birds and mammals) from using a pesticide. EECs would be derived by Service personnel using an EPA screening-level approach (EPA 2004). For each maximum application rate (see previous paragraph), Service personnel would record two EEC values in a chemical profile; these would represent the worst-case terrestrial and aquatic exposures for habitat management and croplands/facilities maintenance treatments. For terrestrial and aquatic EEC calculations, see the description for data entry under Presumption of Unacceptable Risk/Risk Quotients, the next field in a chemical profile.

**Presumption of Unacceptable Risk/Risk Quotients:** Service personnel would calculate and record acute and chronic RQs for birds, mammals, and fish using the provided tabular formats for habitat management and/or cropland/facilities maintenance treatments. RQs recorded in a chemical profile would represent the worst-case assessment for ecological risk. See Section G.7.2 for a discussion regarding the calculations of RQs.

For aquatic assessments associated with habitat management treatments, RQ calculations would be based upon selected acute and chronic toxicological endpoints for fish, and the EEC would be

derived from Urban and Cook (1986) assuming 100 percent overspray to an entire 1-foot-deep water body using the maximum application rate (ae basis [see above]).

For aquatic assessments associated with cropland/facilities maintenance treatments, RQ calculations would be done by Service personnel based upon selected acute and chronic toxicological endpoints for fish, and an EEC would be derived from the aquatic assessment in AgDRIFT model version 2.01 under Tier I ground-based application with the following input variables: max application rate (ae basis [see above]), low boom (20 inches), fine to medium/coarse droplet size, 20 swaths, EPA-defined wetland, and 25-foot distance (buffer) from treated area to water.

See Section G.7.2.1.2 for more details regarding the calculation of EECs for aquatic habitats for habitat management and cropland/facilities maintenance treatments.

For terrestrial avian and mammalian assessments, RQ calculations would be done by Service personnel based upon dietary exposure, where the “short grass” food item category would represent the worst-case scenario. For terrestrial spray applications associated with habitat management and cropland/facilities maintenance treatments, exposure (EECs and RQs) would be determined using the Kanaga nomogram method through the EPA’s T-REX version 1.2.3. T-REX input variables would include the following: max application rate (ae basis [see above]) and pesticide half-life (days) in soil to estimate the initial, maximum pesticide residue concentration on general food items for terrestrial vertebrate species in short (<20 cm tall) grass.

For granular pesticide formulations and pesticide-treated seed with a unique route of exposure for terrestrial avian and mammalian wildlife, see Section G.7.2.1.1.2 for the procedure that would be used to calculate RQs.

All calculated RQs in both tables would be compared with LOCs established by the EPA (see Table G-2 in Section G.7.2). If a calculated RQ exceeds an established LOC value (in brackets inside the table), then there would be a potential for an acute or chronic effect (unacceptable risk) to federally listed (threatened or endangered) species and non-listed species. See Section G.7.2 for detailed descriptions of acute and chronic RQ calculations and comparison to LOCs to assess risk.

*Threshold for approving PUPs:*

If  $RQs \leq LOCs$ , then a PUP would be approved without additional BMPs.

If  $RQs > LOCs$ , then a PUP would only be approved with additional BMPs specifically to minimize exposure (ecological risk) to bird, mammal, and/or fish species. One or more BMPs such as the following would be included in the “Specific Best Management Practices (BMPs)” section to reduce potential risk to nonlisted or listed species:

- *Lower application rate and/or fewer number of applications so  $RQs \leq LOCs$ .*
- *For aquatic assessments (fish) associated with cropland/facilities maintenance, increase the buffer distance beyond 25 feet so  $RQs \leq LOCs$ .*

**Justification for Use:** Service personnel would describe the reason for using the pesticide based on control of specific pests or groups of pests. In most cases, the pesticide label would provide the appropriate information regarding control of pests to describe in the section.

**Specific Best Management Practices (BMPs):** Service personnel would record specific BMPs necessary to minimize or eliminate potential effects to non-target species and/or degradation of environmental quality from drift, surface runoff, or leaching. These BMPs would be based upon scientific information documented in previous data fields of a chemical profile. Where necessary and feasible, these specific practices would be included in PUPs as a basis for approval.

If there are no specific BMPs that are appropriate, then Service personnel would describe why the potential effects to refuge resources and/or degradation of environmental quality are outweighed by the overall resource benefit(s) from the proposed pesticide use in the BMP section of the PUP. See Section G.5 of this document for a complete list of BMPs associated with mixing and applying pesticides appropriate for all PUPs with ground-based treatments that would be additive to any necessary, chemical-specific BMPs.

**References:** Service personnel would record scientific resources used to provide data/information for a chemical profile. They would use the number sequence to uniquely reference data in a chemical profile.

The following online data resources are readily available for toxicological endpoint and environmental fate data for pesticides:

1. California Product/Label Database. Department of Pesticide Regulation, California Environmental Protection Agency. (<http://www.cdpr.ca.gov/docs/label/labelque.htm#regprods>)
2. ECOTOX database. Office of Pesticide Programs, EPA, Washington, D.C. (<http://cfpub.epa.gov/ecotox/>)
3. EXTOTOXNET Pesticide Information Profiles. Cooperative effort of University of California-Davis, Oregon State University, Michigan State University, Cornell University, and University of Idaho through Oregon State University, Corvallis, Oregon. (<http://extotoxnet.orst.edu/pips/ghindex.html>)
4. Food and Agriculture Organization (FAO) specifications and evaluations for plant protection products. Pesticide Management Unit, Plant Protection Services, FAO, United Nations. (<http://www.fao.org/WAICENT/FAOINFO/AGRICULT/AGP/AGPP/Pesticid/>)
5. Human health and ecological risk assessments. Pesticide Management and Coordination, Forest Health Protection, USFS, USDA. (<http://www.fs.fed.us/foresthealth/pesticide/risk.htm>)
6. Pesticide Chemical Fact Sheets. Clemson University Pesticide Information Center. (<http://entweb.clemson.edu/pesticid/Document/Labels/factshee.htm>)
7. Pesticide Fact Sheets. Published by Information Ventures, Inc. for Bureau of Land Management, Bonneville Power Administration, U.S. Department of Energy, and USFS, USDA. (<http://infoventures.com/e-hlth/pesticide/pest-fac.html>)
8. Pesticide fact sheets. National Pesticide Information Center. (<http://npic.orst.edu/npicfact.htm>)
9. Pesticide fate database. EPA, Washington, D.C. (<http://cfpub.epa.gov/pfate/home.cfm>).

10. Pesticide product labels and MSDSs. Crop Data Management Systems, Inc. (<http://www.cdms.net/pfa/LUpdateMsg.asp>) or multiple websites maintained by agricultural companies.
11. Registered Pesticide Products (Oregon database). Oregon Department of Agriculture. ([http://www.oda.state.or.us/dbs/pest\\_products/search.lasso](http://www.oda.state.or.us/dbs/pest_products/search.lasso))
12. Regulatory notes. Pest Management Regulatory Agency, Health Canada, Ontario, Canada. (<http://www.hc-sc.gc.ca/pmra-arla/>)
13. Reptile and amphibian toxicology literature. Canadian Wildlife Service, Environment Canada, Ontario, Canada. ([http://www.cws-scf.ec.gc.ca/nwrc-cnrf/ratl/index\\_e.cfm](http://www.cws-scf.ec.gc.ca/nwrc-cnrf/ratl/index_e.cfm))
14. Specific Chemical Fact Sheet—New Active Ingredients, Biopesticide Fact Sheet and Registration Fact Sheet. EPA, Washington, D.C. ([http://www.epa.gov/pesticides/factsheets/chemical\\_fs.htm](http://www.epa.gov/pesticides/factsheets/chemical_fs.htm))
15. Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas. The Invasive Species Initiative. The Nature Conservancy. (<http://tnsweeds.ucdavis.edu/handbook.html>)
16. Wildlife contaminants online. U.S. Geological Survey, Department of Interior, Washington, D.C. (<http://www.pwrc.usgs.gov/contaminants-online/>)
17. One-liner database. 2000. EPA Office of Pesticide Programs, Washington, D.C.

### Chemical Profile

<b>Date:</b>			
<b>Trade Name(s):</b>		<b>Common Chemical Name(s):</b>	
<b>Pesticide Type:</b>		<b>EPA Registration Number:</b>	
<b>Pesticide Class:</b>		<b>CAS Number:</b>	
<b>Other Ingredients:</b>			

### Toxicological Endpoints

<b>Mammalian LD<sub>50</sub>:</b>	
<b>Mammalian LC<sub>50</sub>:</b>	
<b>Mammalian Reproduction:</b>	
<b>Avian LD<sub>50</sub>:</b>	
<b>Avian LC<sub>50</sub>:</b>	
<b>Avian Reproduction:</b>	
<b>Fish LC<sub>50</sub>:</b>	
<b>Fish ELS/Life Cycle:</b>	
<b>Other:</b>	

### Ecological Incident Reports

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### Environmental Fate

<b>Water solubility (S<sub>w</sub>):</b>	
<b>Soil Mobility (K<sub>oc</sub>):</b>	
<b>Soil Persistence (t<sub>1/2</sub>):</b>	
<b>Soil Dissipation (DT<sub>50</sub>):</b>	
<b>Aquatic Persistence (t<sub>1/2</sub>):</b>	
<b>Aquatic Dissipation (DT<sub>50</sub>):</b>	
<b>Potential to Move to Groundwater (GUS score):</b>	
<b>Volatilization (mm Hg):</b>	
<b>Octanol-Water Partition Coefficient (K<sub>ow</sub>):</b>	
<b>Bioaccumulation/Biocentration:</b>	<b>BAF:</b> <b>BCF:</b>

### Worst Case Ecological Risk Assessment

<b>Max Application Rate (ai lbs/acre – ae basis)</b>	<b>Habitat Management:</b> <b>Croplands/Facilities Maintenance:</b>
<b>EECs</b>	<b>Terrestrial (Habitat Management):</b> <b>Terrestrial (Croplands/Facilities Maintenance):</b> <b>Aquatic (Habitat Management):</b> <b>Aquatic (Croplands/Facilities Maintenance):</b>

### Habitat Management Treatments:

Presumption of Unacceptable Risk		Risk Quotient (RQ)	
		Listed (T&E) Species	Non-listed Species
Acute	Birds	[0.1]	[0.5]
	Mammals	[0.1]	[0.5]
	Fish	[0.05]	[0.5]
Chronic	Birds	[1]	[1]

	Mammals	[1]	[1]
	Fish	[1]	[1]

Cropland/Facilities Maintenance Treatments:

Presumption of Unacceptable Risk		Risk Quotient (RQ)	
		Listed (T&E) Species	Non-listed Species
Acute	Birds	[0.1]	[0.5]
	Mammals	[0.1]	[0.5]
	Fish	[0.05]	[0.5]
Chronic	Birds	[1]	[1]
	Mammals	[1]	[1]
	Fish	[1]	[1]

**Justification for Use:  
Specific Best Management  
Practices (BMPs):  
References:**


**Table CP.1 Pesticide Name**

Trade Name <sup>a</sup>	Treatment Type <sup>b</sup>	Max Product Rate – Single Application (lbs/acre or gal/acre)	Max Product Rate - Single Application (lbs/acre - AI on acid equiv basis)	Max Number of Applications Per Season	Max Product Rate Per Season (lbs/acre/season or gal/acre/season)	Minimum Time Between Applications (Days)

<sup>a</sup> From each label for a pesticide identified in PUPs, Service personnel would record application information associated with possible/known uses on Service lands.

<sup>b</sup> Treatment type: H – habitat management or CF – cropland/facilities maintenance. If a pesticide is labeled for both types of treatments (uses), then record separate data for H and CF applications.

## G.8. References

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