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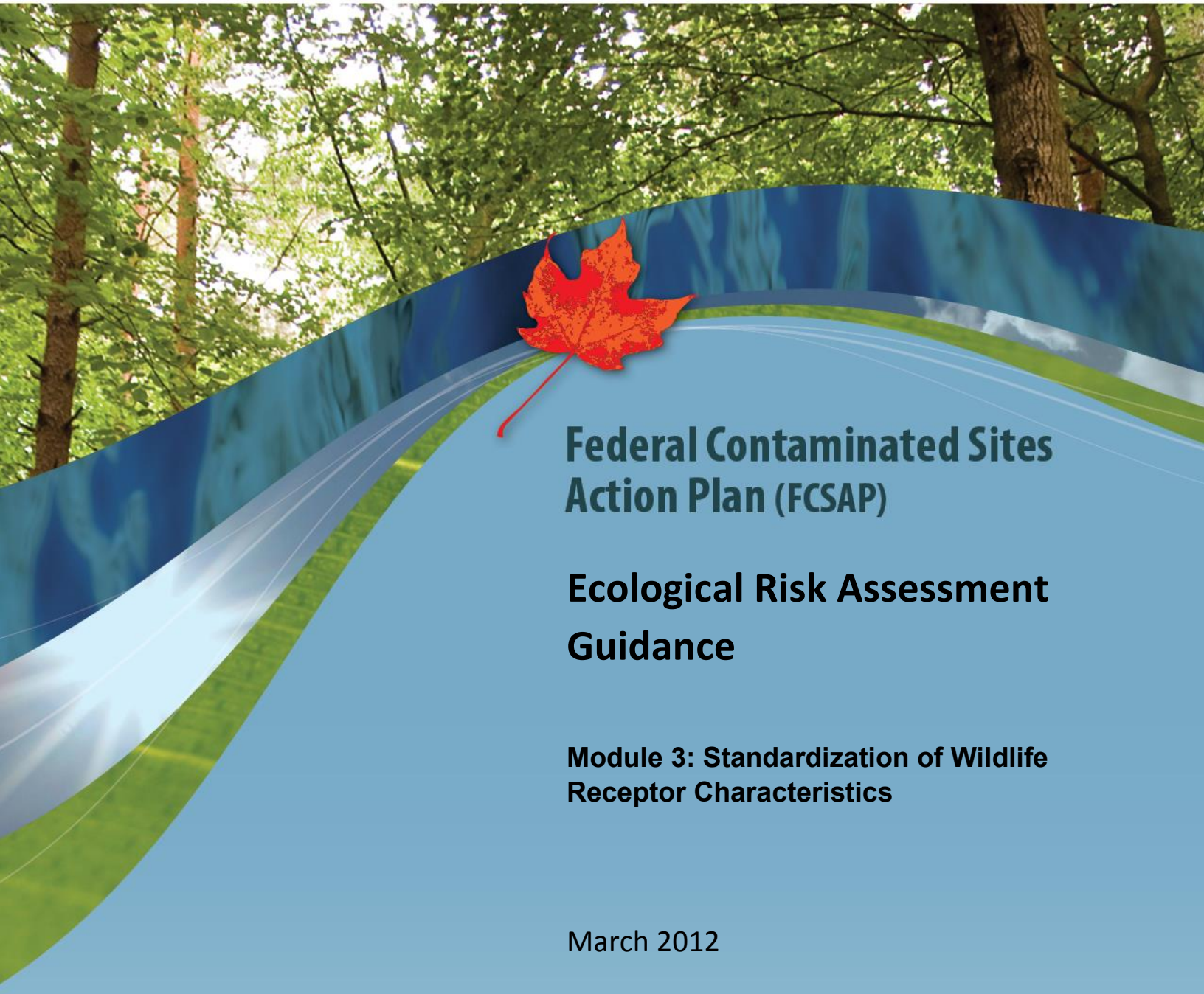

Federal Contaminated Sites Action Plan (FCSAP)

Ecological Risk Assessment Guidance

Module 3: Standardization of Wildlife Receptor Characteristics

March 2012

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Federal Contaminated Sites Action Plan (FCSAP): Ecological Risk Assessment Guidance
Module 3: Standardization of Wildlife Receptor Characteristics

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1. BACKGROUND

The Federal Contaminated Sites Action Plan (FCSAP) was developed to support federal departments, agencies and consolidated crown corporations to reduce the risks to human health and the environment, as well as to reduce the financial liabilities associated with federal contaminated sites. Under FCSAP, ecological risk assessments (ERAs) are commonly used as a site management tool at federal contaminated sites. The FCSAP Ecological Risk Assessment Focus Group is developing guidance for ERA supplemental to the existing CCME guidance (1996, 1997). The FCSAP ERA guidance consists of a comprehensive main ERA guidance document (Environment Canada [EC] 2012) and several specific technical guidance modules.

This document is a technical guidance module on standardization of wildlife receptor characteristics used to quantify contaminant exposure via oral intake (see Section 3.3.3 of the main guidance document – EC 2012). In this document, wildlife refers to birds and mammals, as well as reptiles and amphibians. This module identifies 27 wildlife species commonly used in ERAs throughout Canada which use both terrestrial and aquatic environments, and provides information on specific receptor characteristics that can be applied in ERAs on federal contaminated sites. Providing standardized receptor characteristics for ERAs to federal custodians and their consultants is intended to improve national consistency in the management of federal contaminated sites.

> ***Important Information:***
>
> This module is **not** intended to standardize the process of *selection* of receptors in ERA. Rather, it should be used as a resource *after* the appropriate receptors of concern (ROCs) have already been selected. **In all cases, the selection of ROCs in the problem formulation phase of the ERA should be based on site-specific considerations.** In addition, while some receptor characteristics could be expected to vary little among sites (e.g., adult body weight), others may vary considerably among sites (e.g., diet and foraging range size). For these latter characteristics, the information provided in this module should be viewed as a default that, depending on the ERA, may need to be tailored on a site-specific basis. For sites where precision in estimates of wildlife risks is important for guiding risk management decisions, dietary composition and foraging range should be developed on a site-specific basis.

1.1. Receptor Characteristics in ERA

In ERA, a receptor of concern (ROC)[1] can be any non-human individual, population, community, habitat or ecosystem that is potentially exposed to contaminants of concern (COCs). COCs are

[1] The term Valued Ecosystem Component (VEC) has the same or similar meaning, but is not generally used by ERA practitioners.

those contaminants that have been selected for evaluation in the ERA[2]. The level of biological organization at which an ROC is defined varies. In the case of lower trophic levels, the community is often identified as the ROC (e.g., invertebrate community, grassland community). In the case of higher trophic levels, the ROC is usually defined at the species level (individual organism or population – e.g., mink, eagle). In the latter case, a species may be selected for direct assessment of that species (i.e., assuming that the species chosen is of particular interest to risk managers) or for use as a representative (or surrogate) for similar organisms. For wildlife receptors, the focus of this Technical Module, a surrogate ROC can be used in the ERA to represent risks to a type of receptor with particular characteristics (e.g., a shrew may be used as a surrogate ROC for insectivorous mammal). In most cases, the receptor types are selected on the basis of functional feeding groups (e.g., small omnivorous mammals, piscivorous birds) rather than on taxonomic linkages.

In selecting a specific surrogate ROC, the risk assessor considers the degree to which the ROC may be assumed to be representative and/or protective of other similar receptors on the basis of contaminant sensitivity and similarities in characteristics such as diet and foraging range (see Section 2.2.5 of the main guidance document – EC 2012). More than one surrogate ROC may be selected, particularly where a particular ROC has a higher relative sensitivity to the COCs (see Section 2.2.5.1 of the main guidance document – EC 2012) or is rare or endangered, or has some similar status (e.g., consult the *Species at Risk Act* (*SARA*) and provincial lists). Once the surrogate wildlife ROCs are chosen, receptor-specific characteristics such as body weight, feeding behaviour, ingestion rates (food, water and soil/sediment), and habitat range are used to estimate the total (i.e., multi-media) dose for each COC (see Section 3 of the main guidance document – EC 2012). The total dose estimate is then compared to a Toxicity Reference Value (TRV; see Technical Module 2 on Selection or Development of Site-Specific Toxicity Reference Values) or to dose-response data when characterizing risks (see Section 5.3.2 of the main guidance document – EC 2012).

1.2. Scope of Module

This module provides standardized receptor characteristics for wildlife species (as defined in **Section 1** and the glossary) commonly used in ERAs throughout Canada, which use both aquatic and terrestrial environments; these characteristics are used to quantify COC exposure via oral intake.

In contrast to wildlife ROCs, other receptor groups, particularly lower trophic levels (e.g., plants, soil invertebrates), are usually assessed by evaluating the concentration of contaminants in external exposure media (e.g., water, soil, sediment), rather than total dietary dose, thus details of receptor characteristics are often not relevant for estimating exposure for these lower trophic levels. While there may be exceptions (e.g., an ERA where a particular plant community is an

[2] In some jurisdictions, terms such as COPC (Contaminants of Potential Concern) or PCOC (Potential Contaminant of Concern) refer to the initial list of substances considered, whereas the term Contaminants of Concern (COC) is used to refer to the final list after the selection process conducted as part of the problem formulation. In other jurisdictions the term COC is not used at all and the final list is referred to as the list of COPCs. In this guidance document, the term COC refers to the final list of substances retained for the risk assessment at the end of problem formulation.

important receptor), cases where detailed receptor characteristics for these lower trophic level organisms are important would be rare, and in those cases the receptor characteristics should probably be defined on a site-specific basis. These lower trophic level receptor groups are not addressed in this document.

> ***US EPA Wildlife Exposure Handbook (1993):***
>
> This document is intended to provide standard values for wildlife receptors across Canada, and as such, should be consulted prior to the US EPA Wildlife Exposure Handbook (1993). However, these two resources should be considered complementary as: (1) this document references US EPA (1993) allometric equations or receptor-specific information where no Canadian information was found; and (2) the US EPA (1993) main document and appendices contain information not provided herein.

In the past, most ERAs addressing "wildlife" have focused only on birds and mammals. Amphibians and reptiles were rarely assessed for COC exposure *via* oral intake due to a general lack of toxicological data. While there are still broad gaps and uncertainties, there is a growing database of toxicological information specific to amphibians and reptiles (Sparling et al. 2010). Consequently, these taxa are also included in this Technical Module.[3] The objective of this module is to provide default standard values for wildlife receptor characteristics for use by the ERA practitioner, particularly for preliminary assessments where habitat information may not yet be available. However, since many wildlife species can exist in a variety of habitats, some specific characteristics such as diet and foraging range may vary substantially from habitat to habitat (and across Canada), as well as seasonally (see **Section 2.1.9** for a discussion of the seasonal aspects of receptor-specific characteristics relevant to exposure estimation). Therefore, it may be important for the ERA practitioner to get site-specific information for some receptor characteristics, depending on the needs of a specific ERA. To recognize this variability in receptor characteristics, ranges of values for some characteristics are provided where appropriate, along with a default standard value. The ERA practitioner should always provide appropriate rationale when choosing the values of the specific characteristics (regardless of whether default or other values are chosen).

1.3. Receptor Characteristics Covered in this Module

A number of receptor-specific characteristics have the potential to affect the degree to which ROCs are exposed to the contaminants of potential concern (COCs) on the site (see Section 2.2.5 of the main guidance document – EC 2012). The characteristics covered in this module include the following:

- Habitat type (e.g,. forest, river, ocean);
- Foraging range;
- Body weight (BW);

[3] TRVs for amphibians and reptiles are limited; however, total dose estimates can be evaluated along spatial gradients or compared between on-site and reference conditions.

- Receptor type (i.e., feeding guild, such as carnivore, herbivore, or omnivore) and foraging behaviour (e.g., hunting, grazing);
- Food type and dietary proportions;
- Feeding rate (amount of food typically consumed per defined time);
- Rate of drinking water ingestion (amount of water typically consumed per defined time); and
- Rate of incidental soil/sediment ingestion (amount of soil/sediment typically consumed per defined time).

As noted in **Section 1.2**, the focus of this module is on receptor characteristics relevant for determining exposure *via* oral intake, which is the only exposure route addressed for wildlife ROCs in the majority of ERAs. Characteristics or behaviours that may be important for quantifying other potential exposure routes (e.g., dermal absorption or inhalation) are discussed in **Section 2.1.9**, but have not been included in the receptor-specific tables (**Appendix A**). Additionally, contaminant bioavailability (although specific to contaminant type rather than receptor), is also discussed below (**Section 2.1.9**) since it is an important parameter for estimating total dose.

Receptor characteristics provided in this Technical Module apply to adult organisms – considerations relevant to juvenile life stages are discussed in **Section 2.1**.

1.4. Receptors Covered in this Module

The wildlife receptors included in this module were selected based on input obtained from: (1) ERA practitioners across Canada (from private practice), including practitioners with experience conducting risk assessments in the northern territories; and (2) information obtained from the Centre d'expertise en analyse environnementale Quebec (CEAEQ) regarding their list of wildlife receptors (Paramètres d'exposition chez les mammifères, oiseaux, CEAEQ 2006a, 2006b).

In many cases, mammalian and avian receptor species chosen by different practitioners were the same. In other cases, different species of the same receptor group were chosen. Where there was little agreement among consultants on the particular species (e.g., for shrews, mice, hawks and falcons), a species with: (1) the widest distribution across Canada; and (2) presence in a wide diversity of habitats was chosen. The primary intent of receptor selection was not necessarily to obtain receptors from each feeding guild and habitat type, but rather to identify the receptors most commonly used. Nevertheless, receptors were chosen to fill as many feeding guilds (e.g., omnivore, carnivore, herbivore) as possible, to encompass a variety of terrestrial and aquatic habitats, and to ensure relevance to most ERAs. Importantly, as noted in **Section 1.2**, one amphibian and one reptile species were included to facilitate the use of these receptors at federal sites, as appropriate. The aquatic and terrestrial receptors chosen for this module are categorized into types according to most relevant feeding guild (**Tables 1 and 2)**.

Table 1. Selected wildlife ROCs for aquatic ecosystems

Aquatic Receptor Group	Aquatic Receptor Type	Surrogate ROCs	
		Marine	**Freshwater**
Mammals	Herbivore		muskrat; moose
	Insectivore		
	Piscivore/Carnivore	river otter	American mink, river otter
	Omnivore		
Birds	Herbivore	mallard duck	mallard duck
	Insectivore/Invertivore	spotted sandpipers, lesser scaup	spotted sandpipers, lesser scaup
	Piscivore/Carnivore	bald eagle, great-blue heron, common loon	common merganser, bald eagle, great-blue heron, common loon
	Omnivore	mallard duck	mallard duck

Table 2. Selected wildlife ROCs for terrestrial ecosystems

Terrestrial Receptor Group	Terrestrial Receptor Type	Surrogate ROCs
		Terrestrial
Mammals	Herbivore	meadow vole, white-tailed deer, snowshoe hare
	Insectivore	common shrew
	Carnivore	red fox, short-tailed weasel
	Omnivore	black bear, deer mouse
Birds	Herbivore	ruffed grouse, spruce grouse
	Insectivore	barn swallow
	Carnivore	red-tailed hawk, peregrine falcon
	Omnivore	American robin
Amphibians	Carnivore	wood frog
Reptiles	Carnivore	common garter snake

2. GUIDANCE

This section describes each receptor characteristic and introduces the receptor-specific tables (**Appendix A**). Detailed guidance on how each of the receptor characteristics is used in ERA is provided in Section 3 of the main guidance document (EC 2012).

Information on ROCs was obtained from a thorough review of existing literature, including in-house reference guides, on-line journals, government reports, articles and academic dissertations. Where available, information from Canadian studies was used to provide information on preferred habitat, foraging range size, diet and body weight. For foraging range, the minimum and maximum ranges encountered in the literature were included. The minimum foraging range, which could represent range in the breeding or wintering seasons, was also highlighted in order to be as conservative as possible. For body weight, the minimum and maximum weights were given, while the average weight was most often provided in the literature as being representative of most individuals. Diet proportions were based on a careful review of relevant literature and professional judgment. Ingestion rates were based on either allometric scaling or species-specific estimates. Literature on species-specific food ingestion rates for wildlife was preferred where details regarding age and gender of the animals were provided.

2.1. Review of Receptor-Specific Characteristics

As the majority of ERAs use adult organisms, the receptor characteristics provided in the receptor-specific tables and discussed below are for adult ROCs. In some instances, an assessment of juveniles (and hence juvenile-specific characteristics) may be appropriate, particularly when available TRVs are based solely on juvenile endpoints such as growth. However, receptor characteristics may vary greatly between juveniles and adults (and among adults) of the same species (e.g., body weight, diet) and exposure to COCs may be quite different. Receptor-specific characteristics for juveniles are not provided in this module (some information on juveniles, such as body weight, is provided in CEAEQ 2006a & 2006b, US EPA 1993 and OSWER 2005, Attachment 4-3, Table 20).

Additionally, many of the receptor characteristics discussed below vary seasonally (see **Section 2.1.9**), and by size, reproductive status and habitat. Although default numbers are provided for receptor characteristics where appropriate, ranges are also provided for situations where the default value may need to be adjusted.

2.1.1. Habitat Type

Information regarding habitat types is useful when identifying appropriate ROCs for a site, and will provide an indication of probable diet for the ROCs under consideration. Additionally, site use patterns by receptors will vary according to available habitat types (i.e., preferred habitat will be subject to the highest use). The configuration of high-use habitat types relative to the pattern of contamination will affect ROC exposure and may determine whether a ROC spends more time on-site or off-site, depending on the relative suitability of the habitat (see Section 3.4 of the main document for a discussion on spatially explicit exposure models). The ASTM-International Standard Guide for Estimating Wildlife Exposure Using Measures of Habitat Quality (Designation E2385-11) provides a useful discussion on when habitat modifications of exposure

estimates would reduce uncertainty (particularly where both habitat and contaminant distribution are heterogeneous), and may be more useful than modifications based solely on foraging range.

2.1.2. Foraging Range

The term "foraging range" is used in this module preferentially to the term "home range". In many cases, these two terms can be synonymous; however, foraging range is specific to the area typically explored by an animal while it is feeding (ASTM E2385-11), while the home range would typically also include activities such as denning. In the case of migratory birds, the home range can be extensive (spanning continents), while the foraging range is specific to local seasonal habitat (i.e., for breeding). For this module, the foraging range was considered more relevant to oral dose calculations than home range.

The foraging range of each receptor is usually used in ERA relative to the size of the site (or relevant portion of the site) under assessment. The ratio of site size to foraging range is often used as a modifying factor to total dose calculations. In some cases, a conservative screening assessment may assume that a receptor spends all of its time on-site, but more realistic assessments should apportion exposure between on-site and the surrounding 'off-site' areas, and may also include modifications of exposure estimates based on relative quality of habitat (**Section 2.1.1**, above and Section 3.4 of the main document), where warranted.[4]

Estimation of off-site contributions should be based on data (or a well-informed decision) rather than on a default assumption that off-site contributions are negligible. This is particularly important for large mammals or other receptors which may spend only a very small portion of time foraging on a site.

The default foraging range provided for each ROC is a conservative estimate based on an up-to-date literature review. However, foraging ranges can vary in size for a number of reasons, such as habitat quality in the general area, seasonal availability of foods, gender and rearing of young. Ranges are provided where site-specific considerations are important (e.g., if habitat quality is low, range size may be larger)[5].

Although some wildlife (birds in particular) are migratory and may spend only a few months or weeks using a site before leaving for wintering or breeding grounds, migratory receptors should be considered as ROCs in many cases (see Section 2.2.5 of the main guidance document – EC 2012). Exposure estimation for migratory species requires careful consideration of foraging range (see Section 2.1.9 below). In all cases, rationale (based on best professional judgment) for the selection of a foraging range should be provided.

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[4] Where ROCs may have a large foraging range compared to small areas of high COC concentrations, acute exposure (and thus TRVs based on acute exposure) may be relevant.

[5] The ERA practitioner will need to exercise best professional judgement when choosing a home range size, depending on the specific needs of the risk assessment.

2.1.3. Body Weight

Body weight values are usually used in allometric equations[6] to determine ingestion rates. In the receptor-specific tables, body weight data were derived from up-to-date literature on each species (as recommended in the main guidance document – EC 2012). The US EPA Wildlife Exposure Factors Handbook (US EPA 1993) also has body weight values for a variety of species, which can be used as a default for ROCs not considered in this module.

2.1.4. Feeding Guild and Foraging Behaviour

General information on feeding guild and foraging behaviour is useful when selecting ROCs for an ERA. Wildlife belonging to different feeding guilds (e.g., omnivore, carnivore, piscivore) may have different exposure to COCs as different dietary items may contain higher or lower COC concentrations. Additionally, foraging behaviour may influence the ROC's exposure to contaminated soil or sediment. For example, a dabbling duck such as a mallard forages near the sediment/water interface and is more exposed to sediment-related contamination than a piscivorous waterfowl such as the common loon.

2.1.5. Food Types and Dietary Proportions

Most receptors consume more than one type of food. Although a conservative screening assessment may use the most contaminated food type to calculate total dose from food, more realistic assessments should consider dietary proportions for any receptor that consumes more than one type of food. Dietary proportions provided in receptor-specific tables were based on an up-to-date literature review; as mentioned earlier, these should often be modified based on site-specific considerations. For many receptors there is seasonal variation in diet (see **Section 2.1.9** below).

2.1.6. Ingestion Rate for Food

Ingestion rates for food are typically characterized as mg or kg/kg body weight/day. Food ingestion rates can vary by size and gender, and by seasonal changes in ambient temperature, activity levels, reproductive activities, and the type of diet consumed. Additionally, captive animals may have higher or lower ingestion rates than free-living animals, depending on the diet provided. However, detailed information on changes in food ingestion rates based on the above factors is not readily available. Typically, the most commonly used resources for food ingestion rates in ERA include US EPA (1993) and Sample et al. (1996). Where possible, species-specific ingestion rates were provided[7] otherwise values derived from the allometric equations provided by the US EPA (1993; equations derived from Nagy 1987) have been included in the receptor-specific tables as a default. Some species-specific ingestion rates for food are on a wet weight

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[6] Allometric equations are considered acceptable for use in calculating wildlife food and water ingestion rates (as used by the US EPA [1993]). In contrast, allometric scaling of TRVs is generally not considered good practice (see Allard et al. 2010 and also Technical Module 2 on Selection or Development of Site-Specific Toxicity Reference Values).

[7] An exhaustive literature search was not conducted, but searches were conducted in Biosis Previews, JSTOR (www.jstor.org), and using the search engine Google Scholar®.

basis (but not all), while allometric equations are on a dry weight basis[8] (see footnote 4 regarding appropriate use of allometric scaling). The US EPA (1993; Tables 4-1 and 4-2) provides the water composition of some plant and animal wildlife foods, which could be used as an initial default where site-specific values are unavailable for conversion between wet and dry weights.

2.1.7. Ingestion Rate for Water

Ingestion rates for water are typically characterized as L/kg body weight/day and are used in total dose calculations. Water ingestion rates can vary by body weight, physiological adaptations, diet, temperature and activity levels (US EPA 1993). Similar to the lack of recent literature for wildlife food ingestion rates, recently published studies quantifying wildlife water ingestion rates were not identified. Therefore, values derived from the allometric equations provided by the US EPA (1993; equations derived from Calder and Braun 1983) have been included in the receptor-specific tables as a default (see footnote 4 regarding the appropriate use of allometric scaling).

2.1.8. Incidental Ingestion Rates for Soil and Sediment

Mammals and birds may incidentally ingest COCs in soil or sediment ingestion (e.g., during grooming, when consuming soil-covered plant roots or when dabbling for invertebrates). Information on this factor is typically lacking, but some soil ingestion rates are provided in US EPA (1993) and Beyer et al. (1994). The soil ingestion rates are provided as a percentage of soil in the diet on a dry weight basis. As these rates are based on scat analyses, they include soil ingested along with food, as well as soil incidentally ingested during grooming or digging.[9] If for a certain receptor a soil or sediment ingestion rate is not provided in Appendix A and other reliable estimates are not available a default rate of 2% soil in the diet on a dry weight basis may be assumed for most receptors.

2.1.9. Seasonal Aspects of Receptor-Specific Characteristics Relevant to Exposure Estimation

Many wildlife characteristics relevant to exposure estimation (e.g., body weight, foraging range, food type and dietary proportions) may vary substantially from season to season. The values chosen for these characteristics have the potential to substantially alter the outcome of an ERA.

When considering values for receptor-specific characteristics used for exposure estimation, it is relevant to consider both: (1) the time scale over which the characteristic varies; and (2) the toxicological basis of the TRV used for each COC. Importantly, exposure estimates should not be modified by assigning a proportion of the year for which a ROC occupies a site (e.g., receptors

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[8] Wet weight food ingestion rates must be paired with wet weight contaminant concentrations, while dry weight food ingestion rates must be paired with dry weight contaminant concentrations. Alternatively, dry or wet weight food ingestion values can be converted using literature-based or site-specific specific moisture content of the food types ingested by the ROC.

[9] If food tissue items collected for risk assessment purposes are unwashed (see Section 3.3.3 of the main guidance document), then there is some double-counting of ingested soil volumes.

which migrate or hibernate). Below we specifically consider migration, hibernation[10] and food types and dietary proportions, as they relate to exposure estimation and TRV derivation.

Migration - When a migratory species is chosen as a ROC for a site, the exposure to COCs may be less than for non-migratory wildlife, depending on the length of time the ROC is present on-site. However, as a default, migration should not be used to dilute assumed exposure unless the ERA practitioner knows that the effects endpoints (e.g., TRVs) for a particular COC occur on a very long timescale. Most studies of chronic effects are on shorter timeframes than 6 months, and most available TRVs are derived as intake per unit body weight per day. Therefore, in most cases, there is no basis for diluting exposure based on migratory patterns.

Hibernation/torpor – As with migratory species, a wildlife receptor that hibernates (e.g., frog) or goes into torpor (e.g., bear) may have lower exposure to COCs, depending on the length of time spent in hibernation and whether it wakes to feed periodically. However, as with migration, hibernation should not be used to dilute assumed exposure, for the same reasons – unless effects are known to occur only over very long time frames, it should be assumed that a ROC may receive harmful exposure during its active season.

Food types and Dietary Proportions – Many wildlife species have a seasonal component to their diet. Some foods (such as berries or spawning salmon) are only available seasonally. In general, dietary proportions which reflect an average diet over the course of the year and include seasonal items (such as those presented in the receptor-specific tables in Appendix A) are appropriate for assessing risks. However, a season-specific diet assessment may be appropriate when: (1) there are considerable seasonal variations in diet; (2) COC concentrations in dietary items also vary considerably; and (3) effects may occur over a relatively short time scale (e.g., a few weeks to months). In such a case, it may be important for the ERA practitioner to refine seasonal estimates not only for the diet items but also for other receptor-specific characteristics, such as the seasonal foraging range[11].

2.1.10. Other Factors Relevant to Exposure Estimation

There are other factors that may affect total dose but that are often primarily contaminant-specific (but also highly dependent on the receptor). Three such factors include dose from dermal exposure, dose from inhalation exposure, and bioavailability of COCs in the gut of wildlife.

Dermal exposure (direct contact with soil and sediment) of wildlife should be considered when relevant, for COCs that can be absorbed readily through this pathway. Dermal exposure can also be a relevant exposure pathway for amphibians and reptiles. Detailed guidance on how to assess dermal exposure is limited (SAB-CS 2008, Suter 1996). Approaches for this pathway should be taken on a site-specific basis with appropriate rationale and consultation (see Section 2.2.6 of the main guidance document – EC 2012).

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[10] Hibernation and migration have not been included in the module as receptor-specific characteristics (**Section 2.1**), but given the potential implications to exposure estimation, have been included here for discussion.

[11] Although in most cases a chronic TRV would apply (most studies of chronic effects are on shorter timeframes than 6 months), the use of an acute TRV should be considered where a dietary component is very time-limited.

Inhalation exposure through wind-blown dust or inhalation of vapours can be a relevant pathway for some mammals, birds, reptiles and amphibians. In practice, this pathway has not been commonly assessed, but may be required in some jurisdictions in future, and should be considered where the conceptual model indicates potential widespread exposure. For example, a site with high concentrations of volatile compounds and good small mammal habitat may warrant consideration of vapour inhalation. Inhalation toxicity data are currently lacking for most contaminants, but some jurisdictions are developing guidance and screening values for soil and vapour. In addition, because small mammals generally construct their burrows to allow for air flow, characterizing exposure may be challenging (see Section 2.2.6 of the main guidance document – EC 2012). Detailed guidance on how to assess inhalation exposure to wildlife is limited. Approaches for this pathway should be taken on a site-specific basis with appropriate rationale and consultation.

Finally, total dose estimates can be adjusted to account for incomplete uptake or absorption of COCs in the gut of wildlife (i.e., incomplete bioavailability). Logically, most TRVs are developed from studies conducted using readily bioavailable forms of contaminant (e.g., soluble metal salts). Unless accounted for, the degree to which the COC form found at the site is less bioavailable than the form used in the TRV development will translate directly into over-estimated risks. On the human health side, physiologically-based extraction procedures (PBET; e.g., Ruby et al. 1996) have been developed and refined (Ruby et al. 1999, Nico et al., 2006) over the past 15 years that help to quantify bioaccessibility (i.e., the degree to which a substance in soil/sediment is released into solution and available for absorption) of specific COCs (certain metals only). While similar efforts have been attempted to support ERA, particularly in characterizing bioaccessibility of mining-related contamination, standard procedures and protocols have yet to be developed. Given the large uncertainties associated with this issue, incorporation of realistic bioaccessibility estimates should be conducted where defensible. That said, in the absence of specific quantitative information regarding site-specific bioaccessibility, risk assessors should assume that 100% of the COC is available (see Section 3.3.3 of the main guidance document – EC 2012).

2.2. Receptor-Specific Tables

Tables of receptor-specific characteristics for each of the 27 species identified (**Tables 1 and 2)** are provided in **Appendix A.** The tables include each of the specific characteristics, a default value and a range of values where appropriate, and a written commentary with references. In some cases, particularly for reptiles and amphibians, information was unavailable or scarce for some of the characteristics; this was identified in the tables. References for each receptor are provided after each receptor-specific table, it is recommended that consultants review the literature to ensure project relevance.

- Estimates in the receptor-specific tables for body weight and ingestion rates are presented as follows:
    - An average body weight is provided as a default; ranges for males and females are provided as appropriate/available. Body weights are presented in grams (g) or kilograms (kg) as appropriate depending on the weight of the animal. Average body weights were rounded to the first decimal place; or in the case of heavier wildlife (i.e., bear, moose and deer), to the nearest kilogram.

  - Food ingestion rates are provided in kg food (either dry weight or wet weight based on the source) per kg body weight per day. No attempt was made to standardize these rates to either dry or wet weight; conversions should be made on a site specific basis based on the moisture content of the diet of the ROC (see Section 2.1.6). Food ingestion rates were rounded to two decimal places.
  - Water ingestion rates are provided in liters (L) per kg body weight per day and were rounded to two decimal places.

- The default foraging range provided for each ROC is a conservative estimate (smallest area) based on an up-to-date literature review. Ranges are provided where site-specific considerations are important (e.g., if habitat quality is low, range size may be larger). Foraging range is presented in square kilometers (km) /meters (m) as well as hectares, depending on the receptor. For some receptors which forage along the water, linear foraging range was also provided (in km or m). Foraging ranges were rounded to the first or second decimal place, as appropriate depending on the range size and reporting unit (or to the nearest whole number where ranges were large).
  - For migratory birds which do not winter in Canada (spotted sandpiper and barn swallow), the breeding season range size was provided.
  - For migratory birds which may both breed and winter in Canada (mallard, lesser scaup, common merganser, bald eagle, great blue heron, common loon, peregrine falcon and American robin), the breeding season range size was selected as the default (smallest range size).
  - For resident birds (red-tailed hawk, ruffed grouse and spruce grouse), the foraging range is inclusive of the breeding and non-breeding seasons.
- For the purposes of risk assessment, feeding guilds assigned to ROCs in the receptor-specific tables are based on the majority of the diet. For example, although the muskrat diet is 20% carnivorous, the muskrat was classified as a herbivore due to an 80% herbivorous diet. Depending upon the potential for contamination of different food items and the nature of assumptions in the ERA, the practitioner may choose to focus on the majority dietary component.

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APPENDIX A

RECEPTOR-SPECIFIC TABLES

Muskrat (*Ondatra zibethicus*)

Characteristic	Determination	Notes (With References)
General Habitat Type	Wetland	(Nagorsen 2005; Banfield 1974)
Specific Habitat Type	Permanent wetland that is deep enough not to freeze solid in winter and contains cattails, bulrushes and/or sedges (Nagorsen 2005).	
Foraging Range Size (All Seasons)	Area: **300 m^2** (302 - 7900 m^2) Linear: **250 m** (250 - 400 m)	Area: Range is variable depending on food availability (Banfield 1974; Proulx and Gilbert 1983; Caley 1987). Linear: (Brooks 1985)
Body Weight	Avg: **1.0 kg**	(Banfield 1974; Nagorsen 2005)
Foraging Guild	Herbivore	(Banfield 1974; Eder and Pattie 2001; Nagorsen 2005)
Foraging Behavior	Grazing; rarely hunting	(Nagorsen 2005; Banfield 1974)
Diet Proportions		
Aquatic Vegetation	80%	Stems, leaves, shoots, roots and tubers of aquatic plants such as cattails, bulrushes, pondweeds, water lilies and horsetails are the most common food species for muskrats in North America (Errington 1941; Takos 1947; Lacki et al. 1990). In some areas where cattail is plentiful, it may represent up to 80% of muskrat diet (Proulx and Gilbert 1983). In some habitat types, muskrat will eat animal matter including turtles, mussels, clams, crayfish, snails, fish and small birds (Convey et al. 1989; Neves and Odom 1989; Eder and Pattie 2001; Nagorsen 2005).
Aquatic Invertebrates	15%	
Other (Fish, Small Mammals/Birds, Salamanders, Earthworms)	5%	
Food Ingestion Rate	0.07 kg dry food/kg wet BW/day	(Campbell and MacArthur 1996).[12][13]
Water Ingestion Rate	0. 10 L/kg wet BW/day	This is based on the allometric equation (Calder and Braun 1983 in US EPA 1993) for total water intake for all mammals (L/day; $(0.099*BW^{0.90})$ divided by BW. The average BW provided in this table was used for these calculations.

[12] This food ingestion rate is based on captured muskrats (both males and females, all age classes) fed a natural diet with body weights ranging from 0.8 to 1 kg.

[13] The species-specific food ingestion rates for the muskrat (0.34 and 0.26 g/g day) provided by the US EPA (1993) is based on captive animals fed corn and greens, with no mention of age or gender.

Characteristic	Determination	Notes (With References)
Incidental Soil or Sediment Ingestion Rate	None identified	Refer to Section 2.1.8.

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Moose (*Alces alces*)

Characteristic	Determination	Notes (With References)
General Habitat Type	Forest, Wetland	(Banfield 1974)
Specific Habitat Type	Disturbed and open forests	Boreal, northern and subalpine forests. Common in recently disturbed habitats where there is a mix of young and old forest stands as well as diverse browse species (Shackleton 1999).
Foraging Range Size (All Seasons)	Area: **4.6 km^2** (4.6 - 262 km^2)	Habitat sizes for the moose vary considerably with geographic location and method of calculation (Doerr 1983; Cederlund and Okarma 1988; Leptich and Gilbert 1989; Cederlund and Sand 1994; Stenhouse et al. 1994; Demarchi 2003).
Body Weight	Avg: **400 kg** Male: 453 kg Female: 350 kg	(Banfield 1974)
Foraging Guild	Herbivore	(Banfield 1974; Eder and Pattie 2001)
Foraging Behavior	Browsers	(Banfield 1974; Eder and Pattie 2001)
Diet Proportions		
Shrubs/Trees	80%	Moose are generalist herbivores that feed on herbaceous plants (including aquatic), leaves and new growth of shrubs and trees in summer and twigs of woody vegetation during winter (Banfield 1974). Up to 80% of the moose diet is woody matter consisting of shrubs, twigs and branches (Eder and Pattie 2001). The remaining 20% consists of aquatic vegetation that is eaten because of its high sodium content (Fraser et al. 1980). In winter, the most commonly consumed plant species is willow, but twigs of trembling aspen, saskatoon, birch and red-osier dogwood are also eaten in great quantities (Weixelman et al. 1998; Shackleton 1999). Conifers such as spruce and pine will not sustain moose, although some types of fir and yew are eaten readily (Cushwa and Coady 1976; Allen et al. 1987). In summer, moose are attracted to weedy lakes, marshes and sluggish streams where they feed on aquatic vegetation such as horsetail, bur-reed and pondweed (Nietfeld et al. 1985; MacCracken and Viereck 1990; Shackleton 1999).
Aquatic Plants	20%	

Characteristic	Determination	Notes (With References)
Food Ingestion Rate	0.02kg dry food/kg wet BW/day	(Renecker and Hudson 1985)[14]
Water Ingestion Rate	0.05 L/kg wet BW/day	This is based on the allometric equation (Calder and Braun 1983 in US EPA 1993) for total water intake for all mammals (L/day; ($0.099*BW^{0.90}$) divided by BW. The average BW provided in this table was used for these calculations.
Incidental Soil or Sediment Ingestion Rate	<2% of dry food ingestion rate	(Beyer et al.1994)

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Northern River Otter (*Lontra canadensis*)

Characteristic	Determination	Notes (With References)
General Habitat Type	Shoreline, Waterways	(Eder and Pattie 2001; Banfield 1974)
Specific Habitat Type	In and along the wooded shores of lakes and coastlines (Eder and Pattie 2001; Banfield 1974).	
Foraging Range Size (All Seasons)	Linear: **3.5 km** (3.5 - 30 km) Area: **9 km^2** (9 - 231 km^2)	Generally females have a smaller linear foraging range, compared to the larger linear foraging range of males. Research suggests polluted areas cause foraging range size to increase (Toweill and Tabor 1982; Baker 1983; Shirley et al. 1988; Reid 1994; Bowyer et al. 1995; Hatler et al. 2008).
Body Weight	Avg: **7.5 kg** Male: 7.7 kg Female: 7.3 kg	(Lariviere and Walton 1998)
Foraging Guild	Carnivore	(Eder and Pattie 2001; Banfield 1974)
Foraging Behavior	Hunting	(Eder and Pattie 2001; Banfield 1974)
Diet Proportions		
Fish	80%	River otters are opportunistic foragers, feeding on aquatic animals, particularly fish, frogs, crayfish, turtles, insects, and sometimes birds and small mammals (Knudson and Hale 1968; Toweill and Tabor 1982; Hatler et al. 2008). In particular, otters target slow-moving, mid-sized fish species (Guertin et al. 2010). In the Great Lakes Region, diet studies determined that fish occurred in 80-100% of stomachs analyzed and that crayfish, an important secondary food group, were present in 30-60% of stomachs analyzed (Knudson and Hale 1968).
Aquatic Invertebrates	15%	
Small Mammals/Birds	5%	
Food Ingestion Rate	0.03 kg dry food/kg BW/day	(Davis et al. 1992)[15].

[15]Ingestion rate is based on male river otters (taken from an otter farm). Otters were fed a formulated feed consisting of fish, poultry, liver, eggs and fortified mink cereal.

Characteristic	Determination	Notes (With References)
Water Ingestion Rate	0.08 L/kg wet BW/day	This is based on the allometric equation (Calder and Braun 1983 in US EPA 1993) for total water intake for all mammals (L/day; $(0.099*BW^{0.90})$ divided by BW. The average BW provided in this table was used for these calculations.
Incidental Soil or Sediment Ingestion Rate	None identified	Refer to Section 2.1.8.

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American Mink (*Mustela vison*)

Characteristic	Determination	Notes (With References)
General Habitat Type	Shoreline, Waterways	(Eder and Pattie 2001; Banfield 1974)
Specific Habitat Type	Stream banks, lakeshores, forest edges, large swamps and tidal flats (Banfield 1974). Coastline and wet zones in brush lands, mountains and grasslands (Eder and Pattie 2001).	
Foraging Range Size (All Seasons)	Linear: **0.4 km** (0.4 - 11 km) Area: **0.06 km^2** (0.06 – 16.3 km^2)	Smallest foraging range size determined from adult females and largest range size determined from adult males (Ritcey and Edwards 1956; Eagle and Whitman 1987; Niemimaa 1995; Stevens et al. 1997; Hatler et al. 2008).
Body Weight	Avg: **820 g** Male: 570 g Female: 1060 g	(McCabe 1949)
Foraging Guild	Carnivore	(Eder and Pattie 2001; Banfield 1974)
Foraging Behavior	Hunting	(Eder and Pattie 2001; Banfield 1974)
Diet Proportions		
Fish	30%	The American mink diet consists of invertebrates, amphibians, fish, waterfowl and their eggs, mice, voles, rabbits, snakes and aquatic invertebrates (Chapman and Feldhammer 1982; Maser 1998; Eder and Pattie 2001; Hatler et al. 2008). On Vancouver Island, mink forage primarily in the intertidal zone where crustaceans and fish are preferred, and mammals and insects are supplemental (Hatler 1976). Scat analysis results show seasonal diet differences with increased presence of crabs from April to July (Hatler 1976). The incidence of crabs, fish, and birds and other foods found in fecal analysis were respectively 85-90%, 60-70% and less then 20% (Hatler 1976). A recent study by Kiseleva (2009) in Russia investigated stomach contents of 345 American mink from brook, small river and large river habitats. On average, diet composition consisted of 11 to 24% small mammals, 2 to 30% fish, 19 to 26% insects, 2 to 11% amphibians and
Crustaceans	25%	
Small Mammals/Birds	25%	
Amphibians	10%	
Insects	10%	

Characteristic	Determination	Notes (With References)
		reptiles, and minor amounts of bird and mollusk remains. Results from Racey and Euler (1993) were also used to determine diet proportions.
Food Ingestion Rate	0.14 kg wet food/kg wet BW/day	This rate is based on the average of two ingestion rates (0.12 and 0.16 g/g/ day) for farm raised adults, both sexes as reported in the US EPA (1993)[16].
Water Ingestion Rate	0.03 L/kg wet BW/day	This rate is based on an adult farm raised female (in US EPA 1993) in g/g day (assumes water density of 1 g/ml).
Incidental Soil or Sediment Ingestion Rate	None identified	Refer to Section 2.1.8.

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Meadow Vole (*Microtus pennsylvanicus*)

Characteristic	Determination	Notes (With References)
General Habitat Type	Grassy and open forest habitat	(Banfield 1974; Eder and Pattie 2001)
Specific Habitat Type	Grasslands, pastures, marshy areas, open woodlands, taiga and mountain meadow (Eder and Pattie 2001). Often associated with wet areas such as lakes, streams, dykes, sloughs and ditches (Nagorsen 2005).	
Foraging Range Size (All Seasons)	Area: **69 m^2** (69 – 3,480 m^2)	Females generally have a smaller foraging range than males and range is variable based on season, population density and research method (Madison 1980; Sullivan and Hogue 1987; Pugh and Ostfeld 1998).
Body Weight	Avg: **34.9 g**	(Nagorsen 2005)
Foraging Guild	Herbivore	(Nagorsen 2005)
Foraging Behavior	Grazing	(Nagorsen 2005)
Diet Proportions		
Berries/Seeds	60%	Primary food sources are the stems, leaves and seed heads of grasses and sedges, bark and some insects (Thompson 1965; Maser and Strom 1970; Lindroth and Batzli 1984). For a winter food supply, meadow voles make caches of leaves, roots, rhizomes, bulbs, bark and corms in runways under the snow (van Zyll de Jong 1983). The inner bark of trees, shrubs and conifer seedlings are also eaten (Bucyanayandi et al. 1990; Nagorsen 2005).
Grasses	30%	
Mushrooms	10%	
Food Ingestion Rate	0.33 kg wet food/kg wet BW/day	This rate is based on an average of two values reported in US EPA (1993; 0.325 g/g day), with no information on age and gender of the animals.[17].
Water Ingestion Rate	0.21 L/kg wet BW/day	This rate is based on a 0.21 g/g day water ingestion rate for adult meadow voles (both sexes) and assumes a water density of 1g/ml (US EPA 1993)
Incidental Soil or Sediment Ingestion Rate	2.4 % of dry food ingestion rate	Based on US EPA 1993[18]

[17] Ingestion rate is based on Ogdev et al. 1950.

[18] Species-specific information in US EPA (1993) on soil or sediment ingestion rates are taken from Beyer et al. (1994) which was in press at the time of EPA publication.

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White-tailed Deer (*Odocoileus virginianus*)

Characteristic	Determination	Notes (With References)
General Habitat Type	Forest	(Eder and Pattie 2001)
Specific Habitat Type	Woodlands, meadows, valleys, stream courses and rolling country (Eder and Pattie 2001).	
Foraging Range Size (Minimum is for Winter Season)	Area: **30 ha** (30 - 2435 ha)	Adult females have smaller foraging ranges relative to adult males, and average foraging range in winter is generally significantly smaller than in summer (Tierson et al. 1985; Lesage et al. 2000). Average home (foraging) ranges have varied from 129 ha (winter) to 2435 ha (summer) in Quebec (Lesage et al. 2000), 135 ha (winter) and 225 ha (summer) in the Adirondacks, New York (Tierson et al. 1985), 370 ha (winter) to 277 ha (summer) in New Brunswick (Drolet 1976), 178 ha (winter) in Wisconsin (Larson et al. 1978), and 30 ha (winter) to 75 ha (summer) in Minnesota (Mooty et al. 1987).
Body Weight	Avg: **75 kg** Male: 91 kg Female: 60 kg	(Banfield 1977)
Foraging Guild	Herbivore	(Banfield 1974)
Foraging Behavior	Browsers	(Banfield 1974)
Diet Proportions		
Trees (Buds/Twigs)	35%	The diet of the white-tailed deer is seasonally variable. In the winter, buds and twigs of shrubs are important, in the fall, fruit and mushrooms make up a significant part of the diet, while in the summer, grasses and herbaceous plants are preferred (Banfield 1974; Skinner and Telfer 1974; Hesselton and Hesselton 1982; Crawford 1982). In eastern Canada, white cedar is a major component of the diet, with red maple, red-osier dogwood, mountain-ash, sumac, trembling aspen, ground hemlock, balsam fir and basswood trees also preferred (Banfield 1974). Plants eaten include asters, goldenrod, hawkweed, mayflower, ferns, leaves, water plants and mushrooms (Banfield 1974; Skinner and Telfer 1974).
Herbaceous Plants	20%	
Leaves	15%	
Fruits	10%	
Mushrooms	10%	
Grasses	9%	
Lichens	1%	

Characteristic	Determination	Notes (With References)
Food Ingestion Rate	0.03 kg dry food/kg wet BW/day	This is based on the allometric equation (Nagy 1987 in US EPA 1993) for total dry food intake for herbivorous mammals (g/day;$(0.577*BW^{0.727})$ divided by the BW. The average BW provided in this table was used for these calculations.
Water Ingestion Rate	0.06 L/kg wet BW/day	This is based on the allometric equation (Calder and Braun 1983 in US EPA 1993) for total water intake for all mammals (L/day; $(0.099*BW^{0.90})$ divided by BW. The average BW provided in this table was used for these calculations.
Incidental Soil or Sediment Ingestion Rate	<2.0% of dry food ingestion rate	Beyer et al. 1994

White-tailed Deer References

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Snowshoe Hare (*Lepus americanus*)

Characteristic	Determination	Notes (With References)
General Habitat Type	Forest	(Eder and Pattie 2001)
Specific Habitat Type	Habitat types of particularly high suitability include conifer-dominated habitats, deciduous riparian forests, birch-willow scrub, subalpine parkland and shrub fens/carrs (Dolbeer and Clark 1975; McTaggart-Cowan and Guiguet 1978; Buehler and Keith 1982; Stevens and Lofts 1988).	
Foraging Range Size (All Seasons)	Area: **1.6 ha** (1.6 -10.2 ha)	Foraging range size varies with season and population cycle (Nagorsen 2005; O'Farrell 1965).
Body Weight	Avg: **1.3 kg** (0. 9 – 1.9 kg)	(Nagorsen 2005)
Foraging Guild	Herbivore	(Nagorsen 2005; Banfield 1974)
Foraging Behavior	Grazing	(Nagorsen 2005)
Diet Proportions		
Shrubs	60%	Summer diet consists of grasses, sedges and forbs, while winter diet consists of stems and branches of woody plants, especially the more digestible terminal branches (Wolff 1978; Nagorsen 2005). Favorite winter foods in western Canada and Alaska include spruce needles, and the bark and twigs of trembling aspen, paper birch, willow, alder, spruce, blueberries and soopalallie (or buffaloberry) (*Shepherdia canadensis*) (Banfield 1974; Wolff 1978; Smith et al. 1988). In spring, blueberries, lowbush cranberry (*Vaccinium vitis-idaea*), fireweed (*Epilobium angustifolium*) and horsetail made up 47% of hare diet in Alaska (Wolff 1978). Summer diet in Alaska was primarily the leaves of birch, willow, rose and other deciduous shrubs (Wolff 1978). In Ontario, pine were most heavily browsed by snowshoe hare, but many other species were also eaten including aspen, alder, hazelnut, elderberry, willow and saskatoon (de Vos 1964). Snowshoe hare occasionally exhibits cannibalistic tendencies in winter (Banfield 1974).
Grasses	30%	
Berries	10%	

Characteristic	Determination	Notes (With References)
Food Ingestion Rate	0.06 kg dry food/kg wet BW/day	(Walski and Mautz 1977)[19]
Water Ingestion Rate	0.10 L/kg wet BW/day	This is based on the allometric equation (Calder and Braun 1983 in US EPA 1993) for total water intake for all mammals (L/day; ($0.099*BW^{0.90}$) divided by BW. The average BW provided in this table was used for these calculations.
Incidental Soil or Sediment Ingestion Rate	6.3% of dry dietary ingestion rate	The jackrabbit has been estimated to have 6.3 % soil in diet (dry weight) (US EPA 1993).

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Common (Masked) Shrew (*Sorex cinereus*)

Characteristic	Determination	Notes (With References)
General Habitat Type	Damp Forest	(Nagorsen 1996; Eder and Pattie 2001)
Specific Habitat Type	Associated with coniferous or deciduous moist, cool forests as well as tall grass habitats and brushy riparian areas (Nagorsen 1996; Eder and Pattie 2001) with abundant rocks, stumps, and ferns (Merritt 1987).	
Foraging Range Size (All Seasons)	Area: **0.6 ha**	Average foraging range size (Nagorsen 1996)
Body Weight	Avg: **4.1 g** (2.5g - 8.0g)	(Nagorsen 1996)
Foraging Guild	Insectivore	(Nagorsen 1996; Eder and Pattie 2001)
Foraging Behavior	Hunting	(Nagorsen 1996)
Diet Proportions		
Insects and Larvae	65%	During the summer, the common shrew feeds primarily on insects including larvae of moths and beetles, caterpillars, centipedes, millipedes, spiders, slugs, snails, earthworms, and plant material (Bellocq et al. 1994; McCay and Storm 1997; Lee 2001). Up to 50% of the diet can consist of ants and insect larvae (Lee 2001). Common shrews will also consume mice and amphibians, and occasionally carrion (Nagorsen 1996; Eder and Pattie 2001). In winter, the common shrew's diet is mostly insect eggs and pupae (Merritt 1987). Diet proportions were also determined using Bellocq et al. (1992) and Hamilton (1930).
Slugs, Snails and Earthworms	30%	
Other (Amphibians, Small Mammals, Vegetation)	5%	
Food Ingestion Rate	0.34 kg dry food/kg wet BW/day	This is based on the allometric equation (Nagy 1987 in US EPA 1993) for total dry food intake for rodents (g/day;$(0.621*BW^{0.564})$ divided by the BW. The average BW provided in this table was used for these calculations.
Water Ingestion Rate	0.17 L/kg wet BW/day	This is based on the allometric equation (Calder and Braun 1983 in US EPA 1993) for total water intake for all mammals (L/day; $(0.099*BW^{0.90})$ divided by BW. The average BW provided in this table was used for these calculations.
Incidental Soil or Sediment Ingestion Rate	None identified	Refer to Section 2.1.8.

Common (Masked) Shrew References

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Ermine or Short-tailed Weasel (*Mustela erminea*)

Characteristic	Determination	Notes (With References)
General Habitat Type	Forest	(Eder and Pattie 2001)
Specific Habitat Type	Diverse habitat types used. Coniferous or mixed forests and streamside woodlands. Alpine tundra, rock slides and talus slopes during the summer (Eder and Pattie 2001).	
Foraging Range Size (All Seasons)	Area: **1.0 ha** (1.0 - 87.4 ha)	On average, females have smaller foraging range sizes then males. Habitat size is seasonally variable and range estimates vary between studies (Simms 1979; Robitaille and Raymond 1995; Hatler et al. 2008).
Body Weight	Avg :**89.0 g** Male: 118.3 g Female: 59.5g	(Raymond and Bergeron 1986)
Foraging Guild	Carnivore	(Eder and Pattie 2001)
Foraging Behavior	Hunting	(Eder and Pattie 2001)
Diet Proportions		
Small Mammals	50%	Almost entirely carnivorous, the short-tailed weasel eats most animals it can catch. Diet includes mice, voles, shrews, chipmunks, pocket gophers, pikas, rabbits, bird eggs and nestlings, amphibians and insects (Northcott 1971; Erlinge 1981; Eder and Pattie 2001; Edwards and Forbes 2003). Analysis of short-tailed weasel droppings in New Zealand determined that rats and mice made of 77% of the volume of feces, while lagomorphs (rabbits, hares and pikas) contributed 12%, and birds 3% (Murphy and Bradfield 1992). After a decline in rat populations, birds became the largest contributor to the diet making up 42% of feces volume (Murphy and Bradfield 1992).
Birds	25%	
Lagomorphs (Rabbits)	20%	
Other (Amphibians, Insects, Bird Eggs)	5%	
Food Ingestion Rate	0.11 kg dry food/kg wet BW/day	This is based on the allometric equation (Nagy 1987 in US EPA 1993) for total dry food intake for all mammals (g/day;$(0.235*BW^{0.822})$ divided by BW. The average BW provided in this table was used for these calculations.

Characteristic	Determination	Notes (With References)
Water Ingestion Rate	0.13 L/kg wet BW/day	This is based on the allometric equation (Calder and Braun 1983 in US EPA 1993) for total water intake for all mammals (L/day; $(0.099*BW^{0.90})$ divided by BW. The average BW provided in this table was used for these calculations.
Incidental Soil or Sediment Ingestion Rate	None identified	Refer to Section 2.1.8.

Ermine or Short-tailed Weasel References

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Red Fox (*Vulpes vulpes*)

Characteristic	Determination	Notes (With References)
General Habitat Type	Open Country	(Eder and Pattie 2001)
Specific Habitat Type	Agricultural areas, lakeshores, river valleys, natural forest clearings and alpine and arctic tundra (Eder and Pattie 2001). Typically avoids dense forest (Banfield 1974).	
Foraging Range Size (All Seasons)	Area: **2.8 km^2** (2.8 - 34.2 km^2)	Variable depending on geographic location and season (Lemieux 1989). Widely different range sizes between reports. Juveniles have smaller rangers then adults, and adults with young have reduced range sizes (Jones and Theberge 1982; Banfield 1974).
Body Weight	Avg: **3.8 kg** Male: 4.1 kg Female: 3.4 kg	(Voigt 1987; Banfield 1977)
Foraging Guild	Omnivore	(Banfield 1974; Eder and Pattie 2001)
Foraging Behavior	Hunting	(Eder and Pattie 2001)
Diet Proportions		
Small Mammals	40%	The red fox is omnivorous and primarily consumes small rodents, rabbits and birds during the winter, and fruits, berries, bird eggs, small mammals and nesting birds in the summer (Jones and Theberge 1982; Sargeant et al. 1984; Eder and Pattie 2001; Banfield 1974). Diet studies comparing summer and winter feeding habits found a 10% increase (by volume) in the presence of fruits in the feces of red foxes during the summer season (Fortin 1995). Diet proportions were also determined in consultation with Banfield (1974).
Invertebrates	25%	
Birds	20%	
Fruits and Plant Material	15%	
Food Ingestion Rate	0.09 kg wet food/kg wet BW/day	This rate is based on an average of three ingestion rates for adults in captivity as reported in US EPA (1993)[20].
Water Ingestion Rate	0.09 L/kg wet BW/day	This is based on the allometric equation (Calder and Braun 1983 in US EPA 1993) for total water intake for all mammals (L/day; (0.099*BW$^{0.90}$) divided by BW. The average BW provided in this table was used for these calculations.

[20] The rates reported in US EPA (1993) are based on Sargeant (1978)

Characteristic	Determination	Notes (With References)
Incidental Soil or Sediment Ingestion Rate	2.8% of dry food ingestion rate	US EPA (1993)

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Black Bear (*Ursus americanus*)

Characteristic	Determination	Notes (With References)
General Habitat Type	Forest	(Eder and Pattie 2001)
Specific Habitat Type	Deciduous or coniferous forests, swamps, and berry patches (Banfield 1974).	
Foraging Range Size (All Seasons)	Area: **3 km^2** (3 – 1147 $km^{2)}$	Range is extremely variable and dependent on season, gender and habitat. Females typically have smaller ranges then males. The smallest range estimate was determined from adult males between the end of July and end of October. The largest range was determined from adult males between the end of April and beginning of July (Samson and Huot 1994; Boileau at al.1994; Nilsen et al. 1995; Leblanc and Huot 2000).
Body Weight	Avg: **68 kg** Male (June-July): 90 kg Female (June-July): 46 kg	Seasonally variable. During hibernation, black bears lose 20-40% of body weight (Eder and Pattie 2001).
Foraging Guild	Omnivore	(Eder and Pattie, 2001; Banfield, 1974)
Foraging Behavior	Hunting/Grazing	
Diet Proportions		
Berries/Seeds	50%	Black bears are omnivorous and utilize seasonally and locally abundant food. The bulk of their diet is vegetation and includes leaves, flowering parts, roots, bulbs, berries, nuts, fruits of grasses, forbs, shrubs and trees (Fish and Wildlife Branch 1980). Black bears will also kill small mammals, fish and young ungulates in addition to eating carrion and insects (Banfield 1974; Fish and Wildlife Branch 1980; Graber and White 1983; Bull et al. 2001). An analysis of 621 black bear scats in northeastern Oregon found the mean estimated volume of food items to be 35% grasses, 24% insects, 16% fruit, 11% soil and wood, 10% animal remains and 4% leaves and stems (Bull et al. 2001). Of scats collected in July, 98% contained insects including
Grasses and Leaves	30%	
Carrion	10%	
Fish	5%	
Other (Insects, Small Mammals)	5%	

Characteristic	Determination	Notes (With References)
		primarily ants and some yellowjackets (*Vespula* sp.)(Bull et al. 2001). In spring, black bears forage for succulent vegetation in wet meadows, riparian inclusions, skunk cabbage swamps, avalanche chutes, and burns (McDonald and Fuller 2005; Stevens and Lofts 1988). During this period, they feed mainly on poplar catkins, spruce needles, newly emerging grasses and sedges, insects, ants, tree buds and carrion resulting from winter losses (Banfield 1974; Kolenosky and Strathearn 1987; Raine and Kansas 1990).
Food Ingestion Rate	0.03 kg dry food/kg wet BW/day	This is based on the allometric equation (Nagy 1987 in US EPA 1993) for total dry food intake for all mammals (g/day;$(0.235*BW^{0.822})$ divided by BW. The average BW provided in this table was used for these calculations.
Water Ingestion Rate	0.06 L/kg wet BW/day	This is based on the allometric equation (Calder and Braun 1983 in US EPA 1993) for total water intake for all mammals (L/day; $(0.099*BW^{0.90})$ divided by BW. The average BW provided in this table was used for these calculations.
Incidental Soil or Sediment Ingestion Rate	None identified	Refer to Section 2.1.8.

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Deer Mouse (*Peromyscus maniculatus*)

Characteristic	Determination	Notes (With References)
General Habitat Type	Variable habitats	(Banfield 1974)
Specific Habitat Type	Broad tolerance of diverse habitats. Forested, shrub-steppe, arid grassland, rocky alpine habitats, grassy areas, human dwellings and caves (Banfield 1974; Sullivan et al. 2000).	
Foraging Range Size (All Seasons)	Area: **120 m^2** (120 – 4000 m^2)	Foraging range is variable based on food availability (Teferi and Millar 1993; Bowman et al. 1999). Increased food abundance will decrease range (Nagorsen 2005). In British Columbia, females have a smaller range limited to ~2500 m^2, while males range can extend to ~4000 m^2 (Taitt 1981).
Body Weight	Avg: **21.7 g** (15.0 – 41.8g)	(Nagorsen 2005)
Foraging Guild	Omnivore	(Eder and Pattie 2001)
Foraging Behavior	Grazer/hunter	(Eder and Pattie 2001)
Diet Proportions		
Ground Insects	45%	The deer mouse is omnivorous, feeding on seeds of trees, shrubs and grasses, a wide range of invertebrates, and occasionally fungi (Nagorsen 2005). A study by Wolff et al. (1985) presented the results of dissected stomach content from seventy (70) deer mice captured from the Mountain Lake Biological Station in southwestern Virginia. Although diet varied seasonally, the overall averages for deer mouse stomach contents were as follows: 47.1% arthropods, 2.4% lepidopteran (moth and butterfly) larvae, 10.2% adult lepidopterans, 15.1% fruit, 8.6% green vegetation, 4.3% fungi, 10.2% nuts and seeds, and 2.0% unknown.
Berries/seeds	30%	
Grasses	15%	
Mushroom	5%	
Earthworms	5%	
Food Ingestion Rate	0.27 kg wet food/kg wet BW/day	This rate is based on an average of 6 food ingestion rates for adults, both sexes in US EPA 1993 in g/g day (wet weight).
Water Ingestion Rate	0.19 L/kg wet BW/day	This rate is based on a 0.19 g/g day water ingestion rate for adult deer mice (both sexes) and assumes a water density of 1g/ml)
Incidental Soil or Sediment Ingestion Rate	<2.0 % of dry food ingestion rate	Based on white-footed mouse (US EPA 1993; Beyer et al., 1994)

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Mallard (*Anas platyrhynchos*)

Characteristic	Determination	Notes (With References)
General Habitat Type	Wetlands	(Godfrey 1986)
Specific Habitat Type	Very adaptable. Preferred habitats include ponds, lakes, marshes, river bends, bays ditches and city ponds. Prefers freshwater but frequents saltwater in the winter (Godfrey 1986).	
Foraging Range Size (Minimum is for Breeding Season)	Area: **9.2 ha** (9.2 – 240 ha)	The mallard is migratory but may breed and overwinter in Canada. Habitat size is highly dependent upon location. Smaller range sizes are found in prairie pothole habitats (~9 ha) and larger range sizes are found in northern Minnesota forests (~240 ha) (Gilmer at al. 1975; Titman 1983; Dwyer at al. 1979).
Body Weight	Avg: **1.2 kg** Male: 1.1 kg (0.5 -1.7 kgg) Female: 1.2 kg (0.7 -1.7 kg)	(Bellrose 1976)
Foraging Guild	Omnivore	(Drillling et al. 2002)
Foraging Behavior	Dabbling	(Ehrlich et al. 1988)
Diet Proportions		
Aquatic Plants	50%	Mallards are dabbling ducks; therefore, they do not dive underwater for food, but feed at or just below the surface. Most of the mallard diet is made up of plant material, such as wetland plants, seeds and grains (Palmer 1976; Hughes and Young 1982; Delnicki and Reinecke 1986; Gruenhagen and Fredrickson 1990). In southwestern British Columbia, diet analysis, by percent dry weight of food in the esophagus, determined that individuals ate 30.5% leaves and roots, 13% potatoes, and the remainder seeds (Lovvorn and Baldwin 1996). In winter, green vegetation such as weeds, grass and sedge seeds increased to 52% and potatoes remained constant at 13% (Hirst and Easthope 1981). Laying females were found to eat more animal food (72%) when compared to males (38%) and non-laying
Aquatic Invertebrates	40%	
Berries/Seeds	5%	
Other (Ground Insects, Flying Insects, Fish)	5%	

Characteristic	Determination	Notes (With References)
		females (37%) (Swanson et al. 1985). Mallards in other areas have also been observed eating insects and other invertebrates (Ehrlich et al. 1988; Gruenhagen and Fredrickson 1990; Drilling et al. 2002).
Food Ingestion Rate	0.05 kg dry food/kg wet BW/day	This is based on the allometric equation (Nagy 1987 in US EPA 1993) for total dry food intake for all birds (g/day;$(0.648*BW^{0.651})$ divided by BW. The average BW provided in this table was used for these calculations.
Water Ingestion Rate	0.06 L/kg wet BW/day	This is based on the allometric equation (Calder and Braun 1983 in US EPA 1993) for total water intake for all birds (L/day; $(0.059*BW^{0.67})$ divided by BW. The average BW provided in this table was used for these calculations.
Incidental Soil or Sediment Ingestion Rate	2.0 -3.3% of dry food ingestion rate	Beyer et al. 1994, US EPA 1993

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Spotted Sandpiper (*Actitis macularia*)

Characteristic	Determination	Notes (With References)
General Habitat Type	Shoreline	(Godfrey 1986)
Specific Habitat Type	The sandy, rocky or muddy shores of interior lakes, ponds and streams as well as coastal salt water. Prefers relatively open areas (Godfrey 1986).	
Foraging Range Size (Minimum is for Breeding Season)	Area: **0.08 ha** (0.08 - 1.2 ha)	The spotted sandpiper is migratory and does not overwinter in Canada. Breeding range for spotted sandpiper is generally quite small (Miller and Miller 1948; Hays 1972; Oring and Knudson 1972; Oring et al. 1991; Oring et al. 1997).
Body Weight	Avg: **37.5 g** Males: 36.9 g (30.0 - 46.0 g) Females: 38.0 g (no range given)	Season and location dependent (Irving 1960).
Foraging Guild	Insectivore	(Oring et al. 1997)
Foraging Behavior	Ground Cleans	(Ehrlich et al. 1988)
Diet Proportions		
Ground Insects	50 %	The spotted sandpiper forages principally for terrestrial and aquatic invertebrates but their diet can also include fish (Oring et al. 1997). Primary prey items include flies, grasshoppers, crickets, beetles, caterpillars, worms, mollusks and crustaceans, and spiders (Nelson 1939; Cramp and Simmons 1983; Ehrlich et al. 1988). Several studies have determined that midges and mayflies are a major food source for spotted sandpipers (Maxson and Oring 1980; Lank et al. 1985). Ehrlich et al. (1988) noted that spotted sandpipers can deftly catch flying insects and that invertebrates are also picked off the water's surface.
Aquatic Invertebrates	30%	
Flying Insects	10%	
Aquatic Plants	5%	
Other (Amphibians, Fish)	5%	
Food Ingestion Rate	0.18 kg dry food/kg wet BW/day	This is based on the allometric equation (Nagy 1987 in US EPA 1993) for total dry food intake for all birds (g/day;$(0.648*BW^{0.651})$ divided by BW. The average BW provided in this table was used for these calculations. [21]

[21] The US EPA (1993) species specific value for spotted sandiper is based on juveniles

Characteristic	Determination	Notes (With References)
Water Ingestion Rate	0.17 L/kg wet BW/day	This is based on the allometric equation (Calder and Braun 1983 in US EPA 1993) for total water intake for all birds (L/day; ($0.059*BW^{0.67}$) divided by BW. The average BW provided in this table was used for these calculations.
Incidental Soil or Sediment Ingestion Rate	None identified	Refer to Section 2.1.8.

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Lesser Scaup (*Aythya affinis*)

Characteristic	Determination	Notes (With References)
General Habitat Type	Marine and Freshwater	(Godfrey 1986; Campbell et al. 1990)
Specific Habitat Type	Interior lakes and ponds, low islands and moist sedge meadows. During migration found in coastal bays, estuaries, rivers and large lakes (Godfrey 1986).	
Foraging Range Size (Minimum is for Breeding Season)	Area: **0.1 km^2** (0.1 -17.1 km^2)	The lesser scaup is migratory but may breed and overwinter in Canada. Foraging range in winter is quite large (Herring and Collazo 2005). References for summer range were not found, but range is likely much smaller than in winter. A range of approximately 10 ha, similar to mallard, was considered to be reasonable.
Body Weight	Avg: **707 g** Male: 745 g Female: 669 g	Mass variable based on season (Moore 1991).
Foraging Guild	Insectivore	(Austin et al. 1998)
Foraging Behavior	Surface Dives	(Ehrlich et al. 1988)
Diet Proportions		
Insects	45%	Diet is variable based on season location and reproductive stage (Afton et al. 1991). The primary foods consumed are insects, crustaceans (amphipods) and mollusks, while seeds and portions of aquatic plants are a significant component in some areas (Dirschl 1969; Austin et al. 1998; Lindeman and Clark 1999; Strand 2005). In Manitoba, diet studies determined that before periods of rapid follicular growth the percent occurrence of insects, amphipods, leeches and seeds were respectively (50.2%), (28.9%), (17.4%) and (3.1%) (Afton et al.1991).
Leeches	25%	
Amphipods	20%	
Aquatic plants and seeds	10%	
Food Ingestion Rate	0.07 kg dry food/kg wet BW/day	This is based on the allometric equation (Nagy 1987 in US EPA 1993) for total dry food intake for all birds (g/day;(0.648*$BW^{0.651}$) divided by BW. The average BW provided in this table was used for these calculations.

Characteristic	Determination	Notes (With References)
Water Ingestion Rate	0.07 L/kg wet BW/day	This is based on the allometric equation (Calder and Braun 1983 in US EPA 1993) for total water intake for all birds (L/day; $(0.059*BW^{0.67})$ divided by BW. The average BW provided in this table was used for these calculations.
Incidental Soil or Sediment Ingestion Rate	None identified	Refer to Section 2.1.8.

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Common Merganser (*Mergus merganser*)

Characteristic	Determination	Notes (With References)
General Habitat Type	Freshwater	(Godfrey 1986)
Specific Habitat Type	Lakes and rivers in or near woodlands during summer. In winter, they are found in rivers and open water lakes. Less often observed in salt water (Godfrey 1986).	
Foraging Range Size (Minimum is for Breeding Season)	Area: **0.04 km^2** (0.04 - 13.9 km^2) Linear: **0.7 km** (0.7 - 2.5 km)	The common merganser is migratory but may breed and overwinter in Canada. Habitat size is variable based on season, location and habitat suitability. Area Estimates - (Ross 1987; Cadman et al. 1987; Erskine 1987). Linear estimates - (Wood 1986).
Body Weight	Avg: **1.5 kg** Male:1.7 kg (1.3-2.2 kg) Female: 1.3 kg (0.9-1.8 kg)	Variable by gender and season (Erskine 1972; Cramp and Simmons 1977).
Foraging Guild	Piscivore	(Ehrlich et al. 1988)
Foraging Behavior	Surface Dives	(Ehrlich et al. 1988)
Diet Proportions		
Fish	90%	Common mergansers primarily consume fish; however, they also occasionally eat aquatic invertebrates (e.g., mollusks, crustaceans and worms), frogs, small mammals, birds and plants (Palmer 1976; Ehrlich et al. 1988; Del Hoyo et al. 1992; Mallory and Metz 1999). Diet studies from stomach analyses of 48 common mergansers in interior British Columbia during the summer found that the following fish species were consumed (% in diet): sculpin and chub (each 23.6%), shiner (13.7%), sucker (9.8%) and crayfish (5.9%) (Munro and Clemens 1932). Downy young eat mostly aquatic invertebrates but switch to fish when they are about 12 days old (White 1957).
Aquatic Invertebrates	8%	
Aquatic Plants	2%	
Food Ingestion Rate	0.05 kg dry food/kg wet BW/day	This is based on the allometric equation (Nagy 1987 in US EPA 1993) for total dry food intake for all birds (g/day;(0.648*BW$^{0.651}$) divided by BW. The average BW provided in this table was used for these calculations.

Characteristic	Determination	Notes (With References)
Water Ingestion Rate	0.05 L/kg wet BW/day	This is based on the allometric equation (Calder and Braun 1983 in US EPA 1993) for total water intake for all birds (L/day; ($0.059*BW^{0.67}$) divided by BW. The average BW provided in this table was used for these calculations.
Incidental Soil or Sediment Ingestion Rate	None identified	Refer to Section 2.1.8.

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Bald Eagle (*Haliaeetus leucocephalus*)

Characteristic	Determination	Notes (With References)
General Habitat Type	Near Water	(Godfrey 1986)
Specific Habitat Type	In the areas adjacent to large rivers, lakes and coastline (Godfrey 1986).	
Foraging Range Size (Minimum is for Breeding Season)	Area: **2.1 km^2** (2.1 – 21.6 km^2)	The bald eagle is migratory but may breed and overwinter in Canada. Variable based on habitat, food availability and season (Frenzel 1984; Gerrard et al. 1992; Garrett et al. 1993; Watson 2002).
Body Weight	Avg: **4.7 kg** Male: 4.1 kg (3.7 – 4.9 kg) Females: 5.4 kg (4.6 – 6.4 kg)	(Imler and Kalmbach 1955)
Foraging Guild	Piscivore	(Ehrlich et al. 1988)
Foraging Behavior	Hunting (High patrol and swoops)	(Ehrlich et al. 1988)
Diet Proportions		
Fish	65%	The bald eagle is an opportunistic forager and scavenger that preferentially eats fish but also consumes a variety of mammalian, avian, and reptilian prey (Todd et al. 1982; Ehrlich et al. 1988; Buehler 2000; Watson 2002). Stalmaster (1987) also concluded that fish are preferred throughout range but consumption is variable based on location and seasonal availability. After a review of 20 different diet composition studies, Stalmaster (1987) determined the average bald eagle diet to be composed of 56% fish, 28% birds, 14% mammals and 2% other. In prey remains collected from eagle nests in western Washington, Knight et al. (1990) found 49 bird species, eight mammal species and 14 invertebrate species with 55% of remains being birds; however, based on direct observation, 92% of delivered prey items were fish. Watson (2002) studied bald eagles in four different aquatic habitats and determined that those living on freshwater lakes consumed the highest amount of fish (84%) and had the smallest home range size (210 ha) compared those in marine, bay or river habitats.
Small Mammals	20%	
Birds	15%	

Characteristic	Determination	Notes (With References)
Food Ingestion Rate	0.12 kg wet food/kg wet BW/day	This rate is based on 0.12 g/g day ingestion rate for adults, both sexes (US EPA 1993)
Water Ingestion Rate	0.04 L/kg wet BW/day	This is based on the allometric equation (Calder and Braun 1983 in US EPA 1993) for total water intake for all birds (L/day; $(0.059*BW^{0.67})$ divided by BW. The average BW provided in this table was used for these calculations.
Incidental Soil or Sediment Ingestion Rate	None identified	Refer to Section 2.1.8.

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Great Blue Heron (*Ardea herodias*)

Characteristic	Determination	Notes (With References)
General Habitat Type	Marine and Freshwater	(Godfrey 1986)
Specific Habitat Type	Open fresh or saltwater at the edges of streams, river sloughs, lakes, ponds, ditches, mudflats and marshes (Godfrey 1986).	
Foraging Range Size (Minimum is for Breeding Season)	Area: **16.6 km^2** (16.6 – 2827 km^2)	The great blue heron is migratory but may breed and overwinter in Canada. Little information is available on foraging home range. References indicate that great blue herons forage between 2.3 km and 30 km linear distance away from heronries (Parris 1979; Dowd and Flake 1985; Butler 1991; Vennesland and Butler 2011)
Body Weight	Avg: **2.3 kg** Male: 2.5 kg Female: 2.1 kg	(Simpson 1984)
Foraging Guild	Piscivore	(Ehrlich et al. 1988)
Foraging Behavior	Stalk and Strike	(Ehrlich et al. 1988)
Diet Proportions		
Fish	65%	The diet of the great blue heron consists principally of fish; however, small mammals, amphibians, invertebrates, birds and crustaceans are also taken when they are available (Palmer 1962; Kushlan 1978; Peifer 1979; Verbeek and Butler 1989; Butler 1991). Small fish such as gunnels, sculpins, flounders, sticklebacks and shiner perch are the primary foods of breeding herons in British Columbia (Harfenist et al. 1995; Butler 1997). Herons also eat marine invertebrates such as mud shrimp, isopods and crabs (Verbeek and Butler 1989). Butler (1991) suggested foraging preference is based on individual ability with juveniles learning hunting skills in grasslands, adult females focusing on intertidal beaches, and males favoring riverbanks. Some research suggests that voles may be important in the diet of nestlings (Collazo 1979; Butler 1991) and for wintering birds (Butler 1997).
Small Mammals	25%	
Aquatic Invertebrates	10%	

Characteristic	Determination	Notes (With References)
Food Ingestion Rate	0.18 kg wet food/kg wet BW/day	This rate is based on 0.18 g/g day ingestion rate for adults, both sexes (US EPA 1993).[22]
Water Ingestion Rate	0.04 L/kg wet BW/day	This is based on the allometric equation (Calder and Braun 1983 in US EPA 1993) for total water intake for all birds (L/day; $(0.059*BW^{0.67})$ divided by BW. The average BW provided in this table was used for these calculations.
Incidental Soil or Sediment Ingestion Rate	None identified	Refer to Section 2.1.8.

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Common Loon (*Gavia immer*)

Characteristic	Determination	Notes (With References)
General Habitat Type	Marine and fresh water	(Godfrey 1986)
Specific Habitat Type	Lakes and rivers during the summer; seacoasts and large lakes in the winter (Godfrey 1986).	
Foraging Range Size (Minimum is for Breeding Season)	Area: **4.4 ha** (4.4 – 59.0 ha)	The common loon is migratory but may breed and overwinter in Canada. Foraging range is highly variable based on territory quality, prey and nest site availability (Zimmer 1979; Miller and Dring 1988; Evers et al. 2000; Evers 2001; Evers et al. 2010)
Body Weight	Avg: **5.3 kg** Male: 6.0 kg (5.5 – 6.4 kg) Female: 4.7 kg (4.3 – 5.0 kg)	(Evers et al. 2010)
Foraging Guild	Piscivore	(Ehrlich et al. 1988)
Foraging Behavior	Surface Dives	(Ehrlich et al. 1988)
Diet Proportions		
Fish	90%	Loons are opportunistic predators that primarily consume fish (Barr 1996). Perch are known to be a common component of the diet and are preferentially consumed relative to salmonids perhaps because salmonids are more difficult to capture (Evers et al. 2004). Aquatic invertebrates, such as crayfish, make up a significant secondary component of the diet, especially when fish are difficult to capture due to poor water visibility (Barr 1973). In some cases, aquatic invertebrates made up over 30% percent of the common loon diet (Barr 1973).
Aquatic Invertebrates	10%	
Food Ingestion Rate	0.19 kg wet food/kg wet BW/day	(Barr 1996)[23].

[23] Based on a pair of hand-reared birds (male and female, with young) fed a diet of fish and an average body weight of 5 kg.

Characteristic	Determination	Notes (With References)
Water Ingestion Rate	0.03 L/kg wet BW/day	This is based on the allometric equation (Calder and Braun 1983 in US EPA 1993) for total water intake for all birds (L/day; ($0.059*BW^{0.67}$) divided by BW. The average BW provided in this table was used for these calculations.
Incidental Soil or Sediment Ingestion Rate	None identified	Refer to Section 2.1.8.

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Ruffed Grouse (*Bonasa umbellus*)

Characteristic	Determination	Notes (With References)
General Habitat Type	Forest	(Godfrey 1986)
Specific Habitat Type	Second growth and mixed woodlands. Forest and stream edges, openings and alder or willow bordered ravines (Godfrey 1986).	
Foraging Range Size (All Seasons)	Area: **1.0 ha** (1.0 – 180 ha)	The ruffed grouse is a resident species. Foraging ranges are quite variable between studies (Thompson and Fritzell 1989). Seasonally variable with summer ranges smaller then winter ranges (Bump et al. 1947; Archibald 1975; Godfrey 1975; Epperson 1988; Maxson 1989; Scott et al. 1998).
Body Weight	Avg: **552 g** Males: 604 g Females: 500 g	(Rusch et al. 2000)
Foraging Guild	Omnivore	(Ehrlich et al. 1988)
Foraging Behavior	Foliage Browsing	(Ehrlich et al. 1988)
Diet Proportions		
Leaves (Shrubs/Trees)	55%	Twigs and buds, particularly of trembling aspen are important food for ruffed grouse (Svoboda and Gullion 1972; Jakubas and Gullion 1991). A number of other plant species as well as fruits also make up part of ruffed grouse diet in some regions (Stafford and Dimmick 1979; Rusch et al. 2000). Insects and invertebrates are believed to be an important food source for chicks and are also eaten by adults (Bump et al. 1947; Ehrlich et al. 1988).
Berries	30%	
Insects and Invertebrates	15%	
Food Ingestion Rate	0.06 kg dry food/kg wet BW/day	(Guglielmo and Karasov 1995)[24]

[24] Based on captured ruffed grouse (males and females, adults and juveniles) fed a natural diet. Grouse were fed a series of diets (Series 1 in Table 2 of the Guglielmo and Karasov (1995), those included in this study were diets where grouse did not have significant weight loss (aspen flower buds, hazel catkins and mixed wild browse). Although juveniles were included, body weight listed are similar to those presented in the module table.

Characteristic	Determination	Notes (With References)
Water Ingestion Rate	0.07 L/kg wet BW/day	This is based on the allometric equation (Calder and Braun 1983 in US EPA 1993) for total water intake for all birds (L/day; ($0.059*BW^{0.67}$) divided by BW. The average BW provided in this table was used for these calculations.
Incidental Soil or Sediment Ingestion Rate	None identified	Refer to Section 2.1.8.

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Spruce Grouse (*Dendragapus canadensis*)

Characteristic	Determination	Notes (With References)
General Habitat Type	Forest	(Godfrey 1986)
Specific Habitat Type	Coniferous and mixed wood forests, muskeg, forest edges and openings (Godfrey 1986).	
Foraging Range Size (All Seasons)	Area: **3.0 ha** (3 – 24 ha)	The spruce grouse is a resident species and is generally sedentary with discrete territories and overlapping but restricted ranges, generally never more than a few hectares (Ellison 1971; Herzog and Boag 1977; Robinson 1980; Lattner 1982; Campbell et al. 1990; Boag and Schroeder 1992).
Body Weight	Avg: **~600 g**	Variable depending on location and season (Boag and Schroeder 1992). Throughout the year, males generally weigh more then females with the exception of the prelaying and laying stage (April and May) when females are heavier then males (Ellison and Weeden 1979; Boag and Schroeder 1992).
Foraging Guild	Herbivore	(Ehrlich et al. 1988)
Foraging Behavior	Foliage Browse	(Ehrlich et al. 1988)
Diet Proportions		
Conifer Needles and Buds	65%	Throughout the majority of its range, the spruce grouse eats pine needles (*Pinus banksiana* or *Pinus contorta*) as the main component of its diet (Crichton 1963; Pendergast and Boag 1970; Naylor and Bendell 1989). In the absence of pine needles, spruce needles (*Picea glauca or Picea mariana*) are consumed. In periods without snow, the freshly growing tips, leaves, flowers and fruits of blueberries are a significant secondary component of the diet (Boag and Schroeder 1992). Spruce grouse are also known to occasionally eat insects and especially grasshoppers (Ehrlich et al. 1988) while fungi are believed to be an important component of the diet for chicks (DeFranceschi and Boag 1991).
Berries	30%	
Other (Insects, Fungi)	5%	
Food Ingestion Rate	0.07 kg dry food/kg wet BW/day	This is based on the allometric equation (Nagy 1987 in US EPA 1993) for total dry food intake for all birds (g/day;$(0.648*BW^{0.651})$ divided by BW. The average BW provided in this table was used for these calculations.

Characteristic	Determination	Notes (With References)
Water Ingestion Rate	0.07 L/kg wet BW/day	This is based on the allometric equation (Calder and Braun 1983 in US EPA 1993) for total water intake for all birds (L/day; $(0.059*BW^{0.67})$ divided by BW. The average BW provided in this table was used for these calculations.
Incidental Soil or Sediment Ingestion Rate	None identified	Refer to Section 2.1.8.

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Barn Swallow (*Hirundo rustica*)

Characteristic	Determination	Notes (With References)
General Habitat Type	Open areas	(Campbell et al. 1997)
Specific Habitat Type	Urban backyards of rural farmyards, farmlands, roadsides, weedy fields, neat water such as lakes, marshes, streams, estuaries, sloughs and meadows, orchards and vineyards (Campbell et al. 1997).	
Foraging Range Size (Breeding Season)	Area: **0.8 km^2** (0.8 - 4.5 km^2)	The barn swallow is migratory and does not overwinter in Canada. Foraging distance between 0.5 km and 1.2 km linear distance from nest site (Møller 1987; Samuel 1971).
Body Weight	Avg: **18.7 g** Males: 18.1 g Females: 19.2 g	(Brown and Brown 1999)
Foraging Guild	Insectivore	(Ehrlich et al. 1988)
Foraging Behavior	Aerial Foraging	(Ehrlich et al. 1988)
Diet Proportions		
Insects	99%	Barn swallows are almost exclusively insectivorous, hawking insects (e.g., flies, moths, butterflies, dragonflies, and beetles) during flight over open land and water habitats (Brown and Brown 1999). In an analysis of 467 barn swallow stomachs from across North America, Beal (1918) revealed 99.8% animal matter. Many of the insects hawked aerially may have had an aquatic life stage. Berries and seeds have also been reported as being used occasionally (Ehrlich et al. 1988).
Seeds/berries	1%	
Food Ingestion Rate	0.26 kg dry food/kg wet BW/day	This is based on the allometric equation (Nagy 1987 in US EPA 1993) for total dry food intake for passerine birds (g/day;(0.398*BW$^{0.850}$) divided by BW. The average BW provided in this table was used for these calculations.
Water Ingestion Rate	0.22 L/kg wet BW/day	This is based on the allometric equation (Calder and Braun 1983 in US EPA 1993) for total water intake for all birds (L/day; (0.059*BW$^{0.67}$) divided by BW. The average BW provided in this table was used for these calculations.
Incidental Soil or Sediment Ingestion Rate	None identified	Refer to Section 2.1.8.

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Red-tailed Hawk (*Buteo jamaicensis*)

Characteristic	Determination	Notes (With References)
General Habitat Type	Forest and open habitats	(Godfrey 1986)
Specific Habitat Type	Woodland and open country including pastures, fields and shrub-dominated areas. Usually near trees during nesting season (Godfrey 1986).	
Foraging Range Size (Minimum is for Winter Season)	Area: **0.2 km^2** (0.2 - 50 km^2)	The red-tailed hawk is a resident species. Foraging range is variable and based on season, habitat, food availability and human disturbance. Foraging range is significantly lower in winter than in summer in most studies (Fitch et al. 1946; Orions and Kuhlman 1956; Austing 1964; Shelton 1971; Gates 1972; Misztal 1974; Lowe 1978; Peterson 1979; Bildstein 1987; Preston and Beane 2009).
Body Weight	Avg: **1.1 kg** Males: 1.0 kg Females: 1.2 kg	Measured during the breading season (Palmer 1988).
Foraging Guild	Carnivore	(Ehrlich et al. 1988)
Foraging Behavior	Hunting (High Patrol; Swoops)	(Ehrlich et al. 1988)
Diet Proportions		
Rodents	85%	In Alberta, Luttich et al. (1970) found that 66% of the diet of red-tailed hawks consisted of small mammals including hares, ground-squirrels and voles. Waterfowl (i.e., approximately 18% of the diet) were also taken on a regular basis (Luttich et al. 1970). Generally, more than 80% of a red-tailed hawks diet consists of rodents, with amphibians, snakes, birds and fish taken to a lesser extent (Gates 1972; Adamcik et al. 1979; Stinson 1980; Ehrlich et al. 1988; Janes 1984; Preston and Beane 2009).
Birds	10%	
Amphibians and Reptiles	5%	
Food Ingestion Rate	0.10 kg wet food/kg wet BW/day	This rate is based on an average (0.099g/g per day) of 3 values (adult male and female in winter, adult male in summer) for adults, both sexes (US EPA 1993).[25]

[25] Sample et al. (1996) reports a food ingestion rate of 0.109 kg wet food/day for the red-tailed hawk (derived from an updated version of Craighead and Craighead 1969; the 1956 version was used by the US EPA). Using the body weight in this table, this would convert to a rate of 0.097 kg/kg wet BW/day, which is very similar to the ingestion rate calculated using US EPA 1993 values.

Characteristic	Determination	Notes (With References)
Water Ingestion Rate	0.06 L/kg wet BW/day	This is based on the allometric equation (Calder and Braun 1983 in US EPA 1993) for total water intake for all birds (L/day; $(0.059*BW^{0.67})$ divided by BW. The average BW provided in this table was used for these calculations.
Incidental Soil or Sediment Ingestion Rate	None identified	Refer to Section 2.1.8.

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Peregrine Falcon (*Falco peregrinus*)

Characteristic	Determination	Notes (With References)
General Habitat Type	Open habitats	(Ehrlich et al. 1988; Godfrey 1986)
Specific Habitat Type	Tundra, savannah, marshes and seacoasts to high mountains and open forests (Ehrlich et al. 1988; Godfrey 1986).	
Foraging Range Size (Minimum is for Breeding Season)	Area: **16.0 km^2** (16 - 1,508 km^2) Linear: **1.2 km** (1.2 – 80 km) coastline or river	The peregrine falcon is migratory but may breed and overwinter in Canada. Range is variable depending on prey availability (Mearns 1985). Believed to largely forage within 5 km of breeding sites or within a 78.5 km^2 area (Beebe 1960; Nelson 1973; Nelson 1977; Enderson and Kirven 1983; White et al. 2002). Smallest range was determined in the Canadian Arctic and Greenland (Fyfe 1969; Bromley 1988; Court et al. 1988; Folk and Moller 1988; Mattox and Seegar 1988; Swem and Ambrose 1994) while the largest was determined in Colorado (Enderson and Craig 1997). Linear range estimates were determined in consultation with Brooks 1926; White 1975; Ambrose at al. 1988; Enderson et al 1995; Mesta 1999; White et al. 2002).
Body Weight (g)	Avg: **814.5 g** Male: 652 g (590 -810 g) Female: 977g (760 – 1194 g)	Considerably variable between geographic regions and throughout the year. Breeding season weights of *anatum* species given (Court et al. 1988).
Foraging Guild	Carnivore	(Ehrlich et al. 1988)
Foraging Behavior	Hunting (Aerial Pursuit)	(Ehrlich et al. 1988)
Diet Proportions		
Birds	85%	Dietary composition is greatly variable depending on location, habitat and season, and even between different birds (White et al. 2002). A comprehensive review of diet studies determined that birds are the most common prey species (Sherrod 1978; Hunter et al. 1988; Paine et al. 1990; White et al. 2002). Based on frequency of occurrence, birds are consumed between 77% and 99% of the time with secondary
Mammals	10%	
Other (Fish, Insects)	5%	

Characteristic	Determination	Notes (With References)
		prey sources including mammals and rarely amphibians, fish and insects (Sherrod 1978). In North America, 429 different species of birds have been recorded as prey, while 10 bat species and 13 other mammals were reported (White et al. 2002). A study by Bradley and Oliphant (1991) found unusually high proportions of small mammal prey in the diet of Arctic falcons during years of high small mammal abundance.
Food Ingestion Rate	0.06 kg dry food/kg wet BW/day	This is based on the allometric equation (Nagy 1987 in US EPA 1993) for total dry food intake for all birds (g/day;$(0.648*BW^{0.651})$ divided by BW. The average BW provided in this table was used for these calculations.
Water Ingestion Rate	0.06 L/kg wet BW/day	This is based on the allometric equation (Calder and Braun 1983 in US EPA 1993) for total water intake for all birds (L/day; $(0.059*BW^{0.67})$ divided by BW. The average BW provided in this table was used for these calculations.
Incidental Soil or Sediment Ingestion Rate	None identified	Refer to Section 2.1.8.

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American Robin (*Turdus migratorius*)

Characteristic	Determination	Notes (With References)
General Habitat Type	Open habitat; generalist	(Godfrey 1986)
Specific Habitat Type	Forest edges, woodlands, gardens, parks, country farmland, open fields, second growth forests and riparian areas. Less common in heavily forested areas (Ehrlich et al. 1988; Godfrey 1986).	
Foraging Range Size (Minimum is for Breeding Season)	Area: **0. 7 ha** (0. 7 - 28.3 ha)	The American robin is migratory but may breed and overwinter in Canada. Small foraging range size found in deciduous forest habitats (Weatherhead and McRae 1990). Knupp at al. (1977) found that American Robins use undefended feeding grounds up to 300 meters away from nesting site (28.3 ha range).
Body Weight	Avg: **79 g** Male: 77.4 g Female: 80.6 g	(Wheelright 1986)
Foraging Guild	Omnivore	(Campbell et al.1997)
Foraging Behavior	Ground Clean	(Ehrlich et al. 1988)
Diet Proportions		
Fruit	60%	Earthworms are one of the most important food sources in many areas (Campbell et al. 1997), but fruit, berries and invertebrates can also be important, particularly during the migratory and winter periods (Beal 1915; Wheelwright 1986; Ehrlich et al. 1988; Sallabanks and James 1999). During the period before reproduction, insects make up a significant component of the diet, and insects are also fed to young. (Martin et al. 1951; Ehrlich et al. 1988).
Invertebrates	40%	
Food Ingestion Rate	1.21 kg wet food/kg wet BW/day	This rate is based on the average of two ingestion rates (0.89 and 1.52 g/g day) as reported in US EPA (1993) for both genders, adults and juveniles (juvenile body weights were less than 5% different than adults).[26]

[26] The US EPA 1993 reports food ingestion rates (0.89 and 1.52 g/g day) from Skorupa and Hothem 1985 and Hazelton et al. 1984.

Characteristic	Determination	Notes (With References)
Water Ingestion Rate	0.14 L/kg wet BW/day	This is based on the allometric equation (Calder and Braun 1983 in US EPA 1993) for total water intake for all birds (L/day; ($0.059*BW^{0.67}$) divided by BW. The average BW provided in this table was used for these calculations.
Incidental Soil or Sediment Ingestion Rate	4% of dry food ingestion rate	This is based on a calculation by Sample and Suter (1994) for the American robin using the following assumptions: (1) assumed that soil consumption is proportional to earthworm consumption; (2) used sediment ingestion values for the American woodcock (10.4% soil ingestion, diet is 99% earthworms); and (3) assumed the robin consumes 40% earthworms.[27]

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[27]= (40/(99/10.4))

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Wood Frog (*Lithobates sylvatica*)

Characteristic	Determination	Notes (With References)
General Habitat Type	Wet habitats	(Matsuda et al. 2006; Corkran and Thoms 1996)
Specific Habitat Type	Forests, fields, muskegs, marshes, wet meadows, moist woodlands and brush (Matsuda et al. 2006; Corkran and Thoms 1996).	
Foraging Range Size (All Seasons)	Area: **25 ha**	(Baldwin et al. 2006)
Body Weight	Avg: **8 g**	Encyclopedia Britannica
Foraging Guild	Carnivore	(Muths et al. 2005)
Foraging Behavior	Hunting	(Muths et al. 2005)
Diet Proportions		
Insects and Spiders	70%	Diet studies in Alberta determined that adult and juvenile wood frogs are carnivorous with their diet dominated by arthropods such as insects and spiders (Moore and Stickland 1955). Secondary diet components include snails and slugs and the occasional earthworm (Moore and Stickland 1955). Tadpoles are opportunistic and omnivorous feeding on algae, bacteria and single cell organisms, but will also eat amphibian eggs and hatchlings of American toad (*Bufo americanus*), gray tree frog (*Hyla chrysocelis*), pickerel frog (*Rana palustris*) and spotted salamander (*Ambystoma maculata*) (Petranka and Thomas 1995).
Snails and Slugs	25%	
Earthworms	5%	
Food Ingestion Rate	None identified	
Water Ingestion Rate	None identified	Water ingestion rates were not identified for the wood frog. The water balance of amphibians is complex, as they absorb water through their skin as well as extract water from their food (US EPA 1993). Nearly all amphibians rely on the skin for rehydration and are not known to drink water through the mouth (Wells 2007).
Incidental Soil or Sediment Ingestion Rate	None identified	Refer to Section 2.1.8.

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Common Gartersnake (*Thamnophis sirtalis*)

Characteristic	Determination	Notes (With References)
General Habitat Type	Generally near aquatic habitats	(St. John 2002; Matsuda et al. 2006)
Specific Habitat Type	Habitat ranges from forest, fields and prairies and is often found near water in moist forests and meadows, vegetated riparian zones of creeks, rivers, lakes and marshes (St. John 2002; Matsuda et al. 2006).	
Foraging Range Size (All Seasons)	Avg: **1 ha**	Carpenter (1952) estimated the home range to be approximately 2 acres (~ 1 ha) in size.
Body Weight	Avg: **90 g**	(Whittier and Crews 1990)
Foraging Guild	Carnivore	(Matsuda et al. 2006)
Foraging Behavior	Hunting	(Matsuda et al. 2006)
Diet Proportions		
Amphibians	60%	Prey of common gartersnake is variable and habitat dependent, but generally includes amphibians, earthworms, small mammals and birds, freshwater fishes and leeches (White and Kolb 1974; Kephart and Arnold 1982; Gregory and Nelson 1991; Matsuda et al. 2006). Diet studies conducted in Michigan determined that common gartersnakes consumed approximately 75% amphibians, 20% earthworms and trace amounts of mammals, fish and caterpillars (Carpenter 1952). St. John (2002) noted that adult common gartersnakes prefer fish and amphibians, while juveniles primarily ate earthworms.
Ground Insects/ Earthworms	30%	
Fish	6%	
Other (Birds, Small Mammals)	4%	
Food Ingestion Rate	0.03 kg wet food/kg wet BW/day	(Bessler et al. 2010)[28].
Water Ingestion Rate	None identified	
Incidental Soil or Sediment Ingestion Rate	None identified	Refer to Section 2.1.8.

[28] This ingestion rate is based on a "moderate normal feeding schedule" of 5 meals per month which ranged from 12 to 19% of the snakes body weight. For the purposes of this module, the intakes for each meal over the course of the month were summed and divided by 30 days (one month). Snakes in this study were wild caught and approximately 50 g in body weight.

Common Gartersnake References

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List of Acronyms

BW	Body Weight
CCME	Canadian Council of Ministers of the Environment
CEAEQ	Centre d'expertise en analyse environnementale Quebec
COC	Contaminant of Concern
ERA	Ecological Risk Assessment
FCSAP	Federal Contaminated Sites Action Plan
PBET	Physiologically-Based Extraction Procedures
ROC	Receptor of Concern
SAB	Science Advisory Board
SARA	Species at Risk Act
TRV	Toxicity Reference Value
US EPA	US Environmental Protection Agency
VEC	Valued Ecosystem Component

Glossary

Best professional judgement – The thorough application of critical judgement in professional practice, in which an experiential, reflective, self-corrective, and purposeful thinking process is applied to consider knowledge, context, evidence, methods, conceptualizations, and criteria. BPJ is a means by which a practitioner can incorporate a diverse range of information without articulating a mechanical process for processing the information.

Contaminants of Concern (COCs) – Contaminants that have been selected for evaluation in the ERA, usually based on a completed problem formulation. The process used to select COCs is not covered in this module.

Ecological Risk Assessment (ERA) – The process by which responses of natural organisms to human-induced environmental alteration is evaluated. ERA entails the application of a formal framework, analytical process, or model to estimate the effects of human actions on a natural resource and to interpret the significance of those effects in light of the uncertainties identified in each study component.

Exposure pathways – The routes of exposure from environmental media (soil, water, air or sediment) to the receptors of concern.

Feeding guild – A group of organisms that use the same ecological resource in a similar way for feeding (e.g., insectivores, granivores, detritivores, carnivores); or, a group of species that overlap significantly in their niche requirements.

Foraging range– The geographic area typically explored by an organism when feeding.

Home range – The geographic area to which an organism normally confines its activity.

Practitioner – The primary investigator in an ecological risk assessment responsible for the design, implementation, and interpretation of results. The practitioner, who may be a consultant, interacts with the responsible party for the site (client), the regulators, and other interested parties.

Receptor of Concern (ROC) – Any non-human individual organism, species, population, community, habitat or ecosystem that is potentially exposed to contaminants of potential concern and that is considered in the ERA.

Surrogate ROC – an ROC that is representative of a receptor type (e.g., a shrew may be used as a surrogate ROC for insectivorous mammal). More than one surrogate ROC may be used to represent a particular receptor type.

Threshold – Dividing line (in units of exposure concentration or dose) between a zone of potential response and a zone of negligible response. Thresholds may be estimated using theory, data, or a combination of both. In nature, thresholds generally do not occur as precise or static entities, due to the variations among individuals and environmental factors that influence responses. Therefore, a threshold is usually expressed as a best estimate considered protective of most of the population, and often includes a margin of safety in the derivation.

Toxicity Reference Value (TRV) – An exposure concentration or dose that is not expected to cause an unacceptable level of effect in receptor(s) exposed to the contaminant of potential concern. A TRV is a specific type of *threshold*, as defined above.

Value ecosystem component (VEC) – for purposes of ERA, this term should be considered synonymous with receptor of concern (ROC). The term VEC originates in environmental assessment literature rather than early ERA literature. Either term can be used by practitioners, but ROC is used exclusively in this guidance document.

Wildlife – In the context of ERA, the term is generally applied to birds and mammals, and sometimes defined to include reptiles and amphibians. Generally it excludes fish and invertebrates.

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Additional information can be obtained at:

Environment Canada
Inquiry Centre
10 Wellington Street, 23rd Floor
Gatineau QC K1A 0H3
Telephone: 1-800-668-6767 (in Canada only) or 819-997-2800
Fax: 819-994-1412
TTY: 819-994-0736
Email: enviroinfo@ec.gc.ca