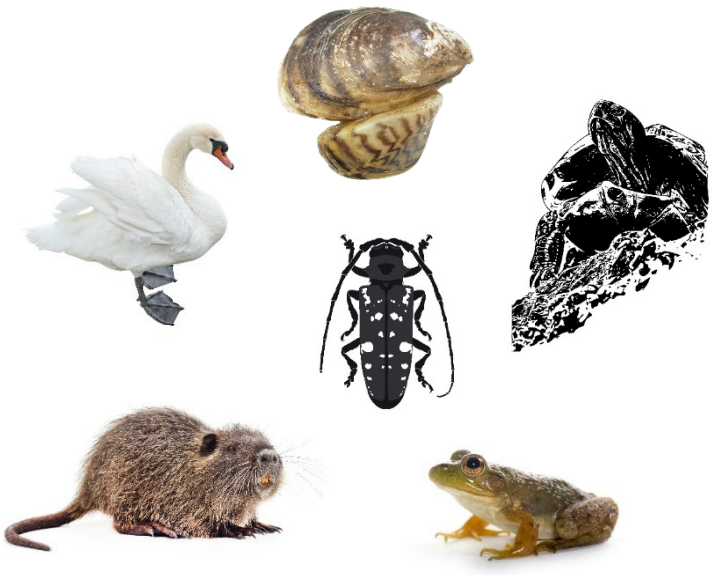

CITY OF PORTLAND

2022 Audit of 2010 Invasive Animal Assessment

Contents

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Executive Summary

The City of Portland conducted an assessment in 2010 to identify invasive terrestrial and aquatic animal species present and established, present but not established, and likely to invade the city within the next decade. In 2021, the City of Portland contracted with Creative Resource Strategies, LLC, to conduct an audit of the 2010 assessment to document lessons learned and outcomes of previous recommendations. Since the 2010 assessment, invasive species protocols have been developed in other locales, and minimum standards have been established for characterizing risk.

City staff and state agency representatives reviewed the 2010 City of Portland invasive animal list and edited the list to reflect new and emerging information.

In 2010, it was documented that 25 invasive animal species were present and established: one amphibian, eight birds, one aquatic invertebrate, two terrestrial invertebrates, 11 mammals, and two reptiles; in addition, seven invasive animal species were present, but not yet established: two birds, three terrestrial invertebrates, and two reptiles. The 2022 review of the 2010 assessment resulted in experts stating that the following species were likely not established in 2010: chukars, monk parakeets, ring-necked pheasants, and peafowl, noting that sightings of chukars and ring-necked pheasants were likely rare sightings attributed to occasional releases of pen-reared birds, disputing monk parakeets were not established in 2010, and noting that peafowl are a domestic species, not an invasive species (ODFW, pers. comm.). These four species were excluded from any further analysis in the 2022 audit and are recommended to be removed from the City of Portland invasive animal list.

Of the 22 invasive animal species experts predicted in 2010 were likely to invade in the next 5-10 years (six aquatic invertebrates, 15 terrestrial invertebrates, and one mammal), one (5%) is present and established (Chinese mystery snail) and two (9%) are present[1], but not yet established (virile crayfish and emerald ash borer). A total of 19 of the 22 species, or 87% of the invasive animal species that were predicted to invade, were not detected during the 10-year period.

The status of recommendations, which reflects the efforts of City staff as well as partners made in 2010, was described as "completed and supported", "partially completed", or "not completed". Of the 21 total actions, a total of 12, or 58% were not completed, 2, or 10% were partially completed, and 7, or 34%, were completed.

A total of 13 recommendations was made to advance 2010 recommendations as well as implement new actions based on emerging protocols and minimum standards:

A. Create two City working groups (one consisting of land managers and botanists and another consisting of wildlife biologists) to develop strategies that protect Portland metropolitan area natural assets from invasive species. Encourage the 4 County Cooperative Weed

[1] These species are present nearby, but have not yet been detected in the City of Portland.

Management Area to expand their role and incorporate all taxa to assist the City and the region in the detection of new invasives.

B. Consider and incorporate climate change stressors in potential strategies to inform a risk assessment of animal invasive species. Identify the causes, types, and effects of uncertainties when determining risk potential for invasive species. Incorporate management feasibility (i.e., risk management assessment) with the scale of impact for each species to enhance the cost-effectiveness of species prioritization.

C. Use a thorough, rigorous process and standardized protocols in the development of animal invasive species prioritization and strategies to obtain the necessary buy-in, support, and resources to address these species.

D. Develop measurable performance metrics to track progress implementing animal invasive species strategies.

E. Establish a robust monitoring and inventory program to inform progress made implementing animal invasive species strategies.

F. Use a combination of decision support tools at a variety of scales (local, regional, national, international) to inform priorities and actions.

G. Establish tiered priorities for animal invasive species to help direct more resources to the highest priority species.

H. Base management actions on management feasibility in addition to risk assessment.

I. Consider stakeholder perceptions when developing a management framework for addressing animal invasive species. Consider available knowledge and information from indigenous peoples to inform decisions.

J. Use a three-step process to inform decision making: invasion risk analysis, feasibility analysis, and priority setting (Figure 1).

K. Focus on pathways of introduction for taxa as well as individual species, to use limited resources efficiently.

L. Consider modifications to Title 13 to incorporate invasive animal strategies into City code.

M. Separate the lists of City of Portland aquatic and terrestrial invasive species because their presence affects different habitat types and functions throughout the city (e.g., aquatic invasive species affecting drinking water supplies).

An Audit of the 2010 City of Portland Terrestrial and Aquatic Invasive Animal Assessment

Background

The City of Portland conducted a terrestrial and aquatic invasive animal assessment in 2010 to identify invasive animal species present and established, present but not established, and likely to invade the city within the next decade. In addition, the assessment identified roles and responsibilities of various entities involved in invasive animal species management and outreach, reviewed existing regulatory authority for invasive animal species management, defined gaps and overlaps in regulatory authority, articulated opportunities for collaboration, and recommended and prioritized invasive terrestrial and aquatic species management actions that could be implemented by the City to mitigate the risk of invasive species introductions, spread, and establishment.

More than a decade has passed since the 2010 assessment was conducted. In 2021, the City of Portland contracted with Creative Resource Strategies, LLC to conduct an audit of the 2010 assessment to:

- analyze the assumptions that were made for assessment species, and determine if those assumptions remain relevant;
- compile actions the City and its partners took in response to the assessment recommendations (e.g., actions that were fully implemented, partially implemented, or not implemented);
- document the outcomes of actions taken;
- determine changes since the original assessment that would inform modifications of previously proposed actions, or the development of new actions to address emerging threats;
- review and compile information on other terrestrial and aquatic invasive animal assessments that have been conducted since the 2010 City of Portland strategy was formulated; and
- describe lessons learned since 2010.

Assumptions from 2010 Assessment

In 2010, a total of 41 individuals with varying levels of expertise working with invasive animal species (excluding fish and zooplankton) and who were familiar with the City of Portland, participated in an 18-question online survey to inform the development of three draft lists: invasive animal species that are present and established; invasive animal species that are present, but not yet established; and invasive animal species that are not yet known to occur in the City of Portland, but are predicted to invade within the next 5-10 years. The Non-native Terrestrial and Aquatic Wildlife Species of Management Concern in the City of Portland matrix (developed in 2008 by the Terrestrial Ecology Enhancement Strategy Advisory Group (TEESAG) and presented at the 2008 Invasive Species Summit in Portland) was used as a baseline to develop the lists. Abundance and distribution information (Appendix B) for each of the species listed in the matrix was compiled to provide basic background on each species, including a description of the species, its origin, its impact, and its current distribution. A subjective assessment of the quality of the information provided by experts, recommendations by professionals in their respective fields, and information available on the species (including past risk assessments) were used to inform list development.

Assumptions:

- The 2010 assessment did not include many of the 14 currently accepted minimum standards for classifying risk: (1) basic species description; (2) likelihood of invasion; (3) distribution, spread and impacts; (4) assessment of introduction pathways; (5) assessment of impacts on biodiversity and ecosystems; (6) assessment of impact on ecosystem services; (7) assessment of socio-economic impacts; (8) consideration of status (threatened or protected) of species or habitat under threat; (9) assessment of effects of future climate change; (10) completion possible even when there is a lack of information; (11) documents information sources; (12) provides a summary in a consistent and interpretable form; (13) includes uncertainty; (14) includes quality assurance (Roy et al. 2017).

- Inventory and monitoring programs and high-quality distribution data are necessary to manage invasive species and conduct quantitative assessments (Poland et al. 2021). Although it was not assumed that there was ongoing adequate inventory and monitoring programs as well as supporting data, it was assumed that existing information was sufficient to inform list development.

- Attempts were made to solicit input from numerous experts throughout the region. Although it was not assumed that the experts that participated in the survey and assessment comprehensively represented all taxa and invasive animal issues, it was assumed there was adequate representation across organizations (federal, tribal, state, local, academic, and private industry) and taxa focus (e.g., terrestrial invertebrates, aquatic invertebrates, birds) to inform list development. The selection of experts was not well-balanced (i.e., generalists, subject-matter experts, and normative, or policy/impact experts) (Turbé 2017) in that there were fewer policy experts and generalists and more subject matter experts. In addition, there

is inherent bias in expert opinion (Turbé 2017), and the 2010 assessment did not incorporate objective methods for eliciting expert judgement while minimizing cognitive limitations and overconfidence.

- At the time the 2010 assessment was developed, climate-related impacts were estimated to begin to occur at a scale and scope significantly different from what the Pacific Northwest and the City of Portland have experienced during the past decade.

- It was assumed that there would be similar levels of enthusiasm and support to address invasive animal issues as was demonstrated previously by the City's commitment to addressing invasive plant issues. Based on the number of 2010 assessment recommendations that were not, or were partially, implemented, that assumption did not materialize. One key contributing factor to the lack of implementation of invasive animal strategies can be the lack of an explicitly defined and documented decision process linked to specific objectives and corresponding quantitative metrics (Schwartz et al. 2019). At the time of the 2010 City of Portland assessment, invasive animal assessments were not commonly conducted, and robust protocols had not yet been established for conducting these types of assessments and establishing risk.

- Projections for invasive animal introduction and establishment potential were based on existing technologies and models. Since the 2010 assessment, new tools (e.g., eDNA) and new approaches to modeling have been further developed to help detect and predict invasive animal presence as well as scope and extent of an invasive animal invasion. In addition, during the past decade, the U.S. Fish and Wildlife Service has developed Ecological Risk Screening Summaries[2], which provide a rapid evaluation of a species' potential invasiveness.

- Invasive animal behavior and the impacts of introduced species are significantly dependent on the community in which the animals exist (Kolar and Lodge 2001, Pyšek et al. 2012). There was some level of assumption that impacts of invasive animals on the lists would be similar to their impacts across other ecosystems and communities.

- There was an assumption that information in the gray and scientific literature represented the best available information on animal invasive species, however, information from indigenous and local knowledge systems may exist and could potentially inform invasive species priorities (Caceres-Escobar 2019, McElwee et al. 2020), but this type of information was not incorporated.

- During the development of the 2010 assessment, it was assumed that ecological effects of invasive animals significantly outweighed social and other effects, primarily because the

[2] https://www.fws.gov/fisheries/ans/species_erss.html

science and information on invasive animals is researched and documented more often than sociological and other effects. In addition, approaches and paradigms to managing invasive animals are often developed in a rural context (Gaertner et al. 2016). Management interventions of invasive animals can generate social impacts that must be understood (Crowley et al. 2016) and should be included in assessments, however, there was little discussion about social and other impacts as part of the 2010 assessment.

- During the development of the 2010 assessment, it was assumed that there would be little to no acceptance of invasive species, however, urban management frameworks should allow for acceptance of some invasive species, and stakeholder perceptions need to be considered explicitly and transparently (Gaertner et al. 2016) (only invasive species experts participated in the 2010 assessment).

- The 2010 assessment did not prioritize species for management actions and did not incorporate the costs and potential effectiveness of management actions when determining risk. Proposing management actions based solely on risk assessment without considering management feasibility may result in inefficient use of limited resources (Robertson et al. 2021).

- The species listed in the "invasive animal species not yet known to occur, but that may invade the City of Portland in the next 5-10 years" were considered the highest priority species for detection and eradication because of their occurrence on the Oregon Invasive Species Council 100 Worst List of dangerous invasive species. However, several of the species on the Council's list at the time of the 2010 assessment had risk assessments that were somewhat outdated, and the Council has not maintained its aggressive schedule of completing and/or updating its 100 Worst List.

Lessons Learned Since 2010

Generally, risk assessments document uncertainties, assumptions made, and the effects of these uncertainties and assumptions on final risk estimates (World Organization for Animal Health 2012, Roy et al. 2017). Examples of causes and types of uncertainty include (Clarke et al. 2021):

Cause of uncertainty	Uncertainty type
Human error	Measurement error
Incomplete information searches	Systematic error
Documented data and knowledge not readily or widely accessible	Systematic error from lack of knowledge
Species identification	Systematic error
Information regarding indigenous and/or alien range is insufficient	Systematic error from lack of knowledge; subjective judgment from lack of knowledge
Limitations of assessment framework	Context dependence
Species designation as invasive	Vagueness
Unclear mechanisms and/or extent of impact	Subjective judgment from lack of knowledge
Extrapolation of evidence	Subjective judgment

Identifying and communicating cause and variety of uncertainty can contribute to uncertainty reduction and enhance risk assessment outcomes (Clarke et al. 2021). Given that the 2010 assessment was the first attempt at characterizing invasive animal risk to the City of Portland (and was one of the first of its kind by a metropolitan area in North America), the causes, types, and effects of uncertainties and assumptions were not factored into predicted risk.

In addition, other planning deficiencies may compromise the ability to implement actions that address invasive animal issues (Dana et al. 2019). Failure to use evidence-based and standardized protocols to guide decision making may:

- affect the ability to define objectives, actions and resource constraints (Game et al. 2013);
- result in different and conflicting strategies among neighboring municipalities, or at the state, or regional levels (Keller et al. 2011; Monceau et al. 2014);
- result in implementing brief actions with high failure rates (Blossey 1999);
- contribute to inefficient use of limited available resources (Pluess et al. 2012);
- cause entities to overlook introduction pathways (Simberloff 2006; Brasier 2008); and
- cause management entities to overlook other potentially invasive species, or the effects other species have on important ecosystems (Águas et al. 2014; Buckley and Han 2014).

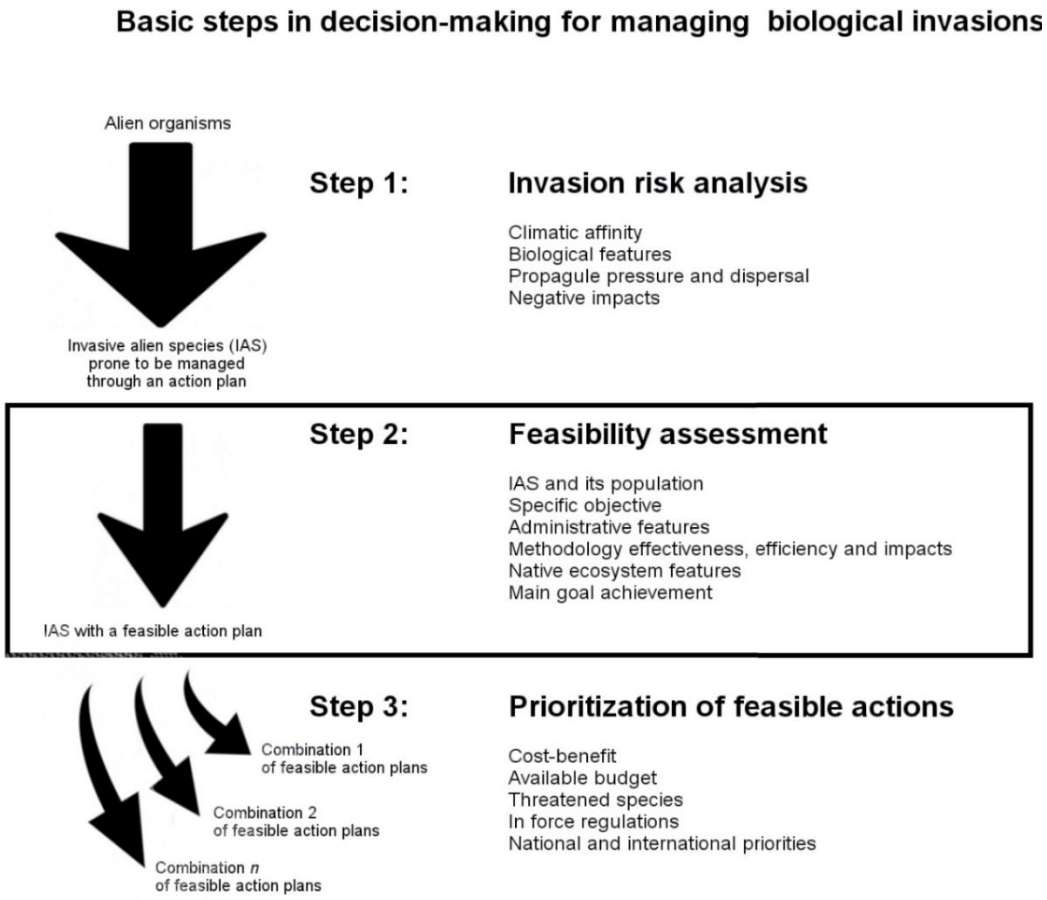


Figure 1. Basic steps in decision making for managing biological invasions (Dana et al. 2019).

Invasive Animal Assessments

Since the 2010 City of Portland assessment, several invasive animal assessments have been conducted in other locales that incorporate new protocols and information that may inform City of Portland efforts.

- The World Organization for Animal Health published *Guidelines for assessing the risk of non-native animals becoming invasive* (WHO 2012), incorporating unique elements, such as using an ecosystem-level approach, a systems-based approach, analysis of both direct and indirect harm, and climate change factors, which can influence the effects of invasive animal species.

- The Environmental Protection Agency in Guyana completed an *Invasive Alien Species in Guyana: Assessment Report, National Strategy, and Action Plan*[3] in 2011. The assessment included invasive invertebrate and vertebrate species, although the basis for identifying major invasive animal threats was via meetings with stakeholders and concerns expressed by specialists (Guyana EPA 2011) versus the use of formal decision support tools.

- The Northern Research Station published a book in 2021, "*Invasive species in forests and rangelands of the United States: A comprehensive science synthesis for the United States forest sector."* The report documented key regional effects of invasive species, including invasive animals:
    - The Northwest region contains major ports, waterways, and highway arteries that provide pathways for invasive plants, pathogens, insects, and vertebrates.
    - The region has a major horticultural industry, extensive areas of mesic and dryland agriculture, and abundant urban and native forests that provide hosts or alternate hosts for invasive species.
    - Forested lands are regionally vital to the forest industry and for millions of recreationists in the Northwest.
    - Nearly 190 species and species groups have been identified as regional invasive or nuisance species of key concern.
    - European and Spongy gypsy moths are constant and recurring threats that are continually detected in the region. Established invasive insects of concern include balsam woolly adelgid (*Adelges piceae*), hemlock woolly adelgid (*Adelges tsugae*), larch casebearer (*Coleophora laricella*), spotted wing drosophila (*Drosophila suzukii*), and brown marmorated stink bug (*Halyomorpha halys* Stål).
    - The most significant invasive aquatic and terrestrial animals: Asian clams (*Corbicula fluminea*), New Zealand mud snails (*Potamopyrgus antipodarum*), zebra mussels and quagga mussels, American bullfrogs (*Lithobates catesbeianus*), red-legged frogs, Atlantic salmon (*Salmo salar*), Amur goby (*Rhinogobius brunneus*), golden shiners (*Notemigonus*

[3] https://www.cabi.org/Uploads/isc/caribbean-legislation/BEAP-IAS-guyana-national-strategy-nov-2011.pdf

crysoleucas), mute swans (*Cygnus olor*), feral swine, and nutria (*Myocastor coypus*).

- The U.S. Fish and Wildlife Service developed Ecological Risk Screening Summaries (https://www.fws.gov/fisheries/ans/species_erss.html) that provide a rapid evaluation of a species' potential invasiveness, categorizing them as:
    - **High risk**: Species that are considered high risk have a well-documented history of invasiveness in at least one location globally and a high or medium climate match to the contiguous United States. While a high-risk species may not be an invasive risk to every locality in the United States, great caution is needed when trading or acquiring high-risk species, particularly in parts of the United States where environmental conditions in the wildlife have been identified as suitable for their survival.
    - **Low risk**: Species that are considered low risk present a minimal risk of invasiveness because the climate where they are established is sufficiently different from the United States climate AND there is no evidence of invasiveness globally.
    - **Uncertain risk**: Species that are considered uncertain risk need a more in-depth assessment beyond the Risk Summary to better define the species' risk to U.S. environments. This additional information will help inform decisions on where, when, and how the species may be used to minimize risks of them becoming invasive.

- Michigan's Terrestrial Invasive Species State Management Plan (2018) identified the need to "develop and implement a methodology to assess the risk of new invasive species based on their potential to cause harm to the environment, economy, and human health (Michigan Department of Agriculture and Rural Development et al. 2018)". The methodology recommends focusing on identifying and prioritizing vulnerable ecosystems, identifying and prioritizing current and potential high-threat terrestrial invasive species, analyzing the impacts of landscape-level factors, and analyzing pathways of terrestrial invasive species introduction and spread. In addition, the plan articulates prevention, Early Detection Rapid Response, control and restoration, and collaboration goals.

- New York State Invasive Species Comprehensive Management Plan (2018) includes non-native animal assessments, documenting ecological ranking and scoring (http://nyis.info/non-native-animal-assessments/).

- The Washington Invasive Species Council conducted risk assessments for priority invasive animal species: (https://invasivespecies.wa.gov/find-a-priority-species/?_sft_priority-specie-type=invasive-animals). Invasive animal priority species include the African clawed frog, Apple maggot, Asian Carp, Asian giant hornet, brown marmorated stink bug, American bullfrog, Citrus long-horned beetle, Asian long-horned beetle, Red-necked longhorned beetle, Emerald ash borer, European chafer, European green crab, Feral swine, Gypsy moth, invasive crayfish, invasive zooplankton, Japanese beetle, marine clam, Mediterranean white

snail, Mitten crab, New Zealand mud snail, Northern Pike, Northern Snakehead, Nutria, Onion leaf miner, Scarlet lily beetle, Sirex woodwasp, Spotted lanternfly, Spotted wing drosophila, tunicate, and Zebra and Quagga mussels.

- Indiana Department of Natural Resources completed a *Division of Fish and Wildlife Terrestrial Invasive Species Plan* in 2020 (Keller 2020). The plan examined existing authorities and programs, prioritized invasive species, and articulated four goals relative to prevention, early detection, rapid response, and management and control. The plan identified eight invasive animals and pathogens that agency staff believed are causing, or have the potential to cause, considerable harm to native wildlife and habitats in Indiana.

Crosswalk of 2010 and Current City of Portland Invasive Animal Lists

Table 1 is a crosswalk of 2010 and current City of Portland invasive animal lists. The 2010 list was developed based on the results of the 2010 assessment, discussions with regional and national experts as well as stakeholders, and the recommendations of the City of Portland's Terrestrial Ecology Enhancement Strategy Advisory Group (TEESAG).

Table 1. Crosswalk of 2010 and current City of Portland invasive animal lists.

Species	Present and established		Present, but not yet established		Likely to invade in the next 5-10 years	
	2010	Current	2010	Current	2010	Current
Amphibians						
American bullfrog (*Lithobates catesbeianus*)	X	X				
Birds						
Chukar (*Alectoris chukar*)*	X					
Feral, Domestic duck and goose spp.	X	X				
Eurasian collared dove (*Streptopelia decaocto*)		X	X			
European starling (*Sturnus vulgaris*)	X	X				
House sparrow (*Passer domesticus*)	X	X				
Monk parakeets (*Myiopsitta monachus*)*	X					
Mute swan (*Cygnus olor*)			X	X		
Peafowl (*Pavo cristatus*)*	X					
Ring-necked pheasant (*Phasianus colchicus*)*	X					
Rock pigeon (*Columba livia*)	X	X				
Invertebrates, Aquatic						
Freshwater clam (*Corbicula fluminea*)	X	X				
New Zealand mudsnail (*Potamopyrgus antipodarum*)					X	X
Quagga mussel (*Dreissena rostriformis bugensis*)					X	
Ringed crayfish (*Faxonius neglectus*)					X	
Rusty crayfish (*Faxonius rusticus*)					X	X
Siberian prawn (*Exopalaemon modestus*)		X				
Virile crayfish (*Faxonius virilus*)				X	X	
Zebra mussel (*Dreissena polymorpha*)					X	X
Invertebrates, Terrestrial						
Alder leaf beetle (*Agelastica alni*)						
Apple snails (Ampullariidae spp.)					X	X
Asian ambrosia beetle (*Xylosandrus crassiusculus*)					X	
Asian longhorned beetle (*Anoplophora glabripennis*)					X	X
Banded European woodsnail (*Cepaea nemoralis*)		X	X			
Black stem borer (*Xylosandrus germanus*)		X				
Brown garden snail (*Cornu aspersum*)		X				
Bronze birch borer (*Agrilus anxius*)		X				
Brown marmorated stink bug (*Halyomorpha halys*)	X	X				
Cherry bark tortrix (*Enarmonia formosana*)		X				
Chinese mystery snails (*Cipangopaludina chinensis*)		X			X	X
Dark-bodied glass snail (*Oxychilus* spp.)		X				
Dusky arion (*Arion subfuscus*)		X				
Emerald ash borer (*Agrilus planipennis*)				X	X	
European chafer (*Rhizotrogus majalis*)					X	X
European gypsy moth (*Lymantria dispar*)			X			X

*These species were included in the 2010 assessment, but were excluded in this analysis, because agency experts determined they were incorrectly characterized as invasive species in 2010 and their assessment of being present and established as an invasive species was incorrect.

Species	Present and established		Present, but not yet established		Likely to invade in the next 5-10 years	
	2010	Current	2010	Current	2010	Current
Garlic snail (*Oxychilus alliarius*)		X				
Giant hornet (*Vespa mandarinia*)						X
Greenhouse slug (*Milax gagates*)		X				
Grey garden slug (*Deroceras reticulatum*)		X				
Japanese beetle (*Popillia japonica*)			X	X		
Leopard slug (*Limax maximus*)		X				
Light brown apple moth (*Epiphyas postvittana*)					X	X
Nun moth (*Lymantria monacha*)					X	
Oak ambrosia beetle (*Monarthrum* spp.)					X	
Oak splendour beetle (*Agrilus biguttatus*)					X	
Red slug complex (*Arion rufus*)		X				
Rosy gypsy moth (*Lymantria mathura*)					X	
Shelled slug (*Testacella haliotidea*)		X				
Spongy moth (*Lymantria spp.*)[4]					X	
Spotted lanternfly (*Lycorma delicatula*)						X
Spotted wing drosophila (*Drosophila suzukii*)	X	X				
Three-banded garden slug (*Lehmannia valentiana*)		X				
Viburnum leaf beetle (*Pyrrhalta viburni*)					X	X
Woodwasps (Siricid spp.)					X	
Wrinkled dune snail (*Candidula intersecta*)					X	X
Yellow slug (*Limacus flavus*)		X				
Mammals						
Black rat (*Rattus rattus*)	X	X				
Brown rat (*Rattus norvegicus*)	X	X				
Eastern cottontail (*Sylvilagus floridanus*)	X	X				
Eastern fox squirrel (*Sciurus niger*)	X	X				
Eastern gray squirrel (*Sciurus carolinensis*)	X	X				
Feral rabbit (*Oryctolagus cuniculus*)		X				
Feral cat (*Felis catus*)	X	X				
Feral dog (*Canis lupus familiaris*)	X					
Feral swine (*Sus scrofa*)					X	
House mouse (*Mus musculus*)	X	X				
Nutria (*Myocastor coypus*)	X	X				
Red fox (*Vulpes vulpes*)	X					
Common opossum (*Didelphis marsupialis*)	X	X				
Reptiles						
Common snapping turtle (*Chelydra serpentina*)	X	X				
Red-eared slider (*Trachemys scripta elegans*)	X	X				
Spiny softshell (*Apalone spinifera*)			X	X		
Yellow-margined box turtle (*Cuora flavomarginata*)			X			

[4] During the past three decades, spongy moth has been detected and eradicated three times (Oregon Dept. Agriculture 2016).

In 2010, it was documented that 25 invasive animal species were present and established: one amphibian, eight birds, one aquatic invertebrate, two terrestrial invertebrates, 11 mammals, and two reptiles; in addition, seven invasive animal species were present, but not yet established: two birds, three terrestrial invertebrates, and two reptiles. The 2022 review of the 2010 assessment resulted in experts stating that the following species were likely not present and established in 2010: chukars, monk parakeets, ring-necked pheasants, and peafowl, noting that sightings of chukars and ring-necked pheasants were likely rare sightings attributed to occasional releases of pen-reared birds, disputing monk parakeets were not established in 2010, and noting that peafowl are a domestic species, not an invasive species (ODFW, pers. comm.). These four species were excluded from any further analysis in the 2022 audit and are recommended to be removed from the City of Portland invasive animal list.

Of the 22 invasive animal species experts predicted in 2010 were likely to invade in the next 5-10 years (six aquatic invertebrates, 15 terrestrial invertebrates, and one mammal), one (5%) is currently present and established (Chinese mystery snail) and two (9%) are present, but not yet established (Virile crayfish and Emerald ash borer). A total of 19 of the 22 species, or 87% of the invasive animal species that were predicted to invade, were not detected during the 10-year period. It is unknown why so many of the terrestrial invertebrates that were predicted to invade and become established have not been detected during the past decade, but in several instances, lack of adequate and comprehensive monitoring programs, particularly in forested areas in and around the Portland metropolitan area, could simply have prevented their detection to date. Just recently, in July of 2022, Emerald ash borer was detected in Forest Grove, Oregon. It is unknown how long this species has been present, or how widely distributed the species is within the Portland metropolitan area.

It is likely that quagga and zebra mussels have not been detected yet in Oregon because of the significant increase in coordination and implementation of watercraft inspection and decontamination stations throughout the West, and in particular, in the Columbia River Basin states. In addition, states have significantly increased coordinated messaging on aquatic invasive species transported by trailered watercraft through outreach campaigns, such as *Clean, Drain, Dry*. And the *Call Before You Haul* program, a new (2022) national program that provides a 24-7 hotline for anyone transporting a boat to the Pacific Northwest, is raising awareness among boat transporters about a) the need to haul clean, drained, and dry watercraft, and b) locations where they can get their boats inspected, and if need be, decontaminated. All of these prevention efforts, in addition to what has been achieved to date, are contributing to a more knowledgeable public, which will lessen the rate at which some invasive species, depending on likely pathway of introduction, will be introduced.

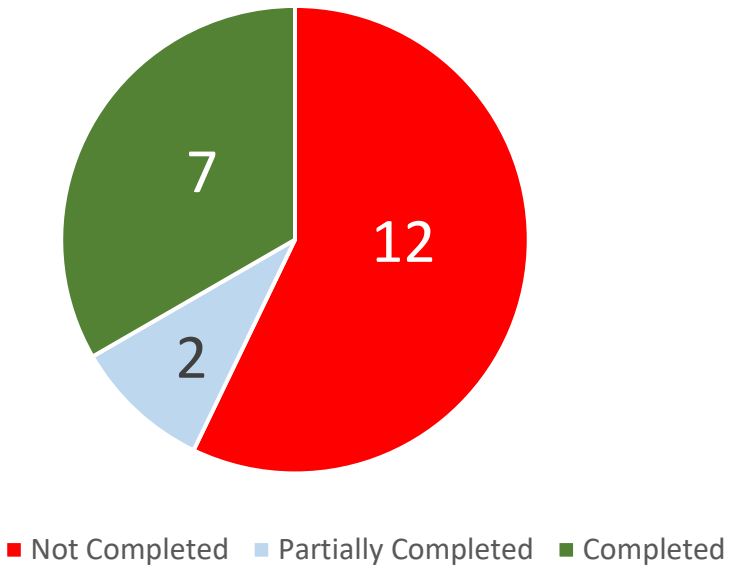
Feral swine are present in Oregon, however, aggressive management efforts by the Oregon Department of Fish and Wildlife to reduce the populations via trapping and aerial hunting has reduced their numbers from 3,000 to about 200. They are considered present in Oregon, and are predicted to be detected in the Portland metropolitan area within the next decade (ODFW, pers. comm.), however, if aggressive monitoring and management actions continue, it likely the City will be able to minimize their impacts.

The disparity in 2010 predictions versus actual detection and establishment a decade later calls for the use of a more robust suite of minimum standards for classifying risk, including (1) basic species description; (2) likelihood of invasion; (3) distribution, spread and impacts; (4) assessment of introduction pathways; (5) assessment of impacts on biodiversity and ecosystems; (6) assessment of impact on ecosystem services; (7) assessment of socio-economic impacts; (8) consideration of status (threatened or protected) of species or habitat under threat; (9) assessment of effects of future climate change; (10) completion possible even when there is a lack of information; (11) documentation of information sources; (12) a summary in a consistent and interpretable form; (13) include uncertainty; and (14) include quality assurance (Roy et al. 2017). In addition, the City of Portland needs a more quantitative approach to estimating "likely to invade" and "possible future colonization."

Status of Recommendations from 2010 Assessment

The status of the eight recommendations and sub-actions from the 2010 assessment are listed below, including characterizing them as fully completed, partially completed, or not completed.* Additional context is provided for each status designation. (*Note: The status of actions illustrates the efforts and support of numerous partner organizations and entities at the local, state, regional, and federal levels). Of the 21 total actions, a total of 12, or 58% were not completed, 2, or 10% were partially completed, and 7, or 34%, were completed.

Table 2. List and status of actions and sub-actions recommended in the 2010 invasive animal assessment.



1. Adopt the proposed finalized list of invasive animal species present and established in the City of Portland, present but not yet established in the City of Portland, and likely to invade the City of Portland within the next 5–10 years.
    a. **Status**: Not completed. Although the list of invasive animal species was finalized by the Terrestrial Ecology Enhancement Strategy Advisory Group (TEESAG), a technical working group of the City of Portland Watershed Science Advisory Group, the lists were never formally adopted by Portland City Council.

2. Create comprehensive EDRR networks in the City — work with local CWMA to include all taxa— analyze the efficacy of monitoring efforts.
    a. **Status**: Not completed. The Four-County Cooperative Weed Management Area (Clackamas, Clark, Multnomah, and Washington Counties) revised its 5-year management plan in 2019. Currently, neither the CWMA website (4countycwma.org) nor the management plan reference taxa other than plants.

3. Develop an invasive animal strategic plan and ensure it is costed.
    a. **Status**: Not completed. An invasive animal strategic plan with cost elements was not developed. However, key recommendations were made as part of the assessment.

4. Develop performance measures to track progress in preventing the introduction of invasive animal species and controlling/eradicating existing invasive animal species in the City of Portland.
    a. **Status**: Not completed. Performance measures have not been established to track progress preventing the introduction, or spread, of invasive animal species. In addition, further discussion is warranted at the local and state level regarding the role of the City in controlling/eradicating invasive animals.

5. Conduct a year-long awareness and engagement campaign in the City of Portland targeting specific audiences with key messages about invasive animal prevention and control.
    a. Identify all outreach efforts relative to invasive animal species and determine if a strategic initiative that pools resources would better serve the City long-term.
        - **Status:** Not completed.
    b. Provide consistent information to the public regarding resources available to address invasive animal issues, including clear explanations of invasive species laws.
        - **Status:** Partially completed. The City of Portland Bureau of Environmental Services has a website page that provides information on invasive animals (www.portlandoregon.gov/bes/55085).
    c. Expand the partnerships created by the Audubon Society of Portland and the Feral Cat Coalition to enhance awareness and education about abandonment and feral petissues and reduce the number of animals in the City over time.

- **Status**: Completed. Portland Audubon, the Feral Cat Coalition of Oregon, Multnomah County Animal Services, and the Bonnie L. Hayes Animal Shelter partnered to launch the *Cats Safe at Home* campaign to educate cat owners about keeping their cats safely indoors to help reduce free-roaming cats, decrease the feral cat population, and protect wildlife.

d. Broaden the scope of entities that work on invasive animal issues by reaching out to organizations listed in survey responses and articulating a clear niche for them to participate.
    - **Status:** Not completed. The scope of entities that work on invasive animal issues within the geographic scope of the City of Portland has not increased since 2010.

e. Focus on vectors.
    - **Status:** Completed. The City of Portland completed Invasives 2.0 in 2021, a strategy that emphasizes addressing invasive species vectors.

f. Increase work with residents.
    - **Status:** Not completed. City staff continue to work with residents, on an ongoing basis, to increase awareness and understanding of all invasive species.

g. Seek industry partners for funding.
    - **Status:** Not completed.

h. Encourage coordination of resources.
    - **Status:** Completed. The City of Portland's Invasives 2.0 includes several strategies to promote enhanced cooperation, collaboration, and coordination of resources to address invasive species.

6. Enact legislation to address deficiencies — focus on vectors and pathways.
    a. Impose stiff penalties for pet abandonment.
        - **Status**: Fully supported and completed. Oregon enacted ORS 167.340 Animal abandonment. The law states:
            - A person commits the crime of animal abandonment if the person intentionally, knowingly, recklessly or with criminal negligence leaves a domestic animal or an equine at a location without providing minimum care.
            - It is no defense to the crime defined in subsection (1) of this section that the defendant abandoned the animal at or near an animal shelter, veterinary clinic or other place of shelter if the defendant did not make reasonable arrangements for the care of the animal.
            - Animal abandonment is a Class B misdemeanor. [1985 c.662 §8; 2001 c.926 §11; 2009 c.233 §1].
                a. A Class B misdemeanor in Oregon is a $2,500 fine and/or six months in jail.

    b. Feeding invasive animals.
        i. Make it illegal to feed invasive animals (except feral cats and dogs).

1. **Status**: Not completed. No law has been enacted that makes it illegal to feed invasive animals.

ii. Continue to feed feral cats and dogs only as part of an overall strategy, in combination with outreach and education to the public, to ultimately reduce breeding populations of feral cats and dogs.

1. **Status**: Completed. Portland Audubon, the Feral Cat Coalition of Oregon, Multnomah County Animal Services, and the Bonnie L. Hayes Animal Shelter partnered to launch the *Cats Safe at Home* campaign to educate cat owners about keeping their cats safely indoors to help reduce free-roaming cats, decrease the feral cat population, and protect wildlife.

iii. Establish a framework, program, and timeline to eliminate feral cat feeding stations.

- **Status:** Partially completed. The Feral Cat Coalition of Oregon has been working with several entities that manage feral cat feeding stations to Trap-Neuter-Return cats.

7. Support state legislation that:
   a. penalizes nonnative introductions;
      - **Status**: Fully supported and completed. Oregon's Statute 635-056-0000 regulates human actions involving nonnative wildlife and includes a list of prohibited species (species that may not be imported, possessed, sold, purchased, exchanged, or transported in Oregon).
   b. provides for humane disposition of animals;
      - **Status:** Not completed. There are laws and associated penalties relating to humane disposition of dogs and cats (ORS 501.140 and ORS 609.405), however, there are no regulations that provide for humane disposition of all animals.
   c. allows for mandatory boat inspections; and
      - **Status**: Fully supported and completed. Oregon enacted ORS 830.589, which gives authority to three Oregon state agencies to conduct mandatory watercraft inspection stations, including the ability to decontaminate infested vessels. Failure to comply with inspection or decontamination is a Class D violation in Oregon, subject to a presumptive fine of $115 (minimum is $65 and maximum is $250).
   d. makes it legal for a public agency to treat invasives on private land.
      - **Status**: Not completed. As of 2021, The City can enter into abatement proceedings for entry onto private property to abate rank A species on the City's Nuisance Plants List and Required Eradication List. Eradication efforts can occur by the property owner, City staff, or private contractors.

8. Support national legislation regulating Internet sales of invasive species.

a. **Status**: Not completed but supported. To date, no federal regulations have been proposed to address Internet sales as an important and growing pathway for invasive species introductions and spread. The Great Lakes Detector of Invasive Aquatics in Trade (GLDIATR) is an example of a regional effort to use innovative software to search the Internet for sites where invasive species can be purchased and shipped to that region.

Recommendations for the City of Portland

A. Create two City working groups (one consisting of land managers and botanists and another consisting of wildlife biologists) to develop strategies that protect Portland metropolitan area natural assets from invasive species. Encourage Cooperative Weed Management Areas to expand their role and incorporate all taxa to assist the City and the region in the detection of new invasives.

B. Consider and incorporate climate change stressors in potential strategies to inform a risk assessment of animal invasive species. Identify the causes, types, and effects of uncertainties when determining risk potential for invasive species. Incorporate management feasibility (i.e., risk management assessment) with the scale of impact for each species to enhance the cost-effectiveness of species prioritization.

C. Use a thorough, rigorous, process and standardized protocols in the development of animal invasive species prioritization and strategies to obtain the necessary buy-in, support, and resources to address these species.

D. Develop measurable performance metrics to track progress implementing animal invasive species strategies.

E. Establish a robust monitoring and inventory program to inform progress made implementing animal invasive species strategies.

F. Use a combination of decision support tools at a variety of scales (local, regional, national, international) to inform priorities and actions.

G. Establish tiered priorities for animal invasive species to help direct more resources to the highest priority species.

H. Base management actions on management feasibility in addition to risk assessment.

I. Consider stakeholder perceptions when developing a management framework for addressing animal invasive species. Consider available knowledge and information from indigenous peoples to inform decisions.

J. Use a three-step process to inform decision making: invasion risk analysis, feasibility analysis, and priority setting (Figure 1).

K. Focus on pathways of introduction for taxa as well as individual species, to use limited resources efficiently.

L. Consider modifications to Title 13 to incorporate invasive animal strategies into City code.

M. Separate the lists of City of Portland aquatic and terrestrial invasive species because their presence affects different habitat types and functions throughout the city (e.g., aquatic invasive species affecting drinking water supplies).

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