United States Department of Agriculture

Animal and Plant Health Inspection Service

Plant Protection and Quarantine

New Pest Response Guidelines

Temperate Terrestrial Gastropods

First Edition Issued 2008

Temperate Terrestrial Gastropods

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Cover Images

Left. Theba pisana (Müller) massing on fence posts in South Australia. Courtesy of M. Leyson.

Top Right. Monacha cartusiana (Müller) from Scalier Park, Chicago, Illinois. Courtesy of D. Robinson. **Middle Right—***Cernuella virgata* (da Costa) collected from the Port of Tacoma. Courtesy of P. Marquez.

Bottom Right. Hygromia cinctella (Draparnaud) from Detroit, Michigan. Courtesy of J. Zablotny.

Chapter

1

Introduction

Contents

Introduction

Use *New Pest Response Guidelines: Temperate Terrestrial Gastropods* as a guide when designing a program to detect, monitor, control, contain, or eradicate an infestation of temperate climate pest snails and slugs in the United States and collaborating territories. Selected species in the gastropod families Arionidae, Cochlicellidae, Helicidae and Hygromiidae are discussed here as these are currently of particular concern, but these guidelines are applicable for most if not all temperate terrestrial gastropods (TTG). If TTG are detected, PPQ personnel will produce a site-specific action plan based on these guidelines. State agriculture department personnel and others concerned with developing local survey or control programs will find the *Guidelines* useful in developing an action plan for temperate terrestrial snail and slug pests.

United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine (USDA–APHIS–PPQ) developed the *Guidelines* through discussion, consultation, or agreement with staff at USDA–Agricultural Research Service (ARS), and university advisors. The Mollusk Action Plan Working Group assembled the *Guidelines* over the course of several months. State agriculture department personnel and others concerned with developing local survey or control programs for TTG may find the *Guidelines* useful when planning the program.

This document will be updated as new information becomes available. Specific emergency programs should be based on information available at the time of the incident.

Safety

WARNING

Consumption of snails and slugs, or of vegetables and fruits contaminated by snails and slugs, may lead to infection by pathogens that are easily transmitted by these pests. Wear rubber or latex gloves when handling gastropods, as well as associated soil, excrement, and other materials that may have come in contact with them. Immediately after removing protective gloves, thoroughly wash hands with hot soapy water and rinse well. Consult a physician if, after handling snails and slugs, you experience symptoms resembling forms of meningitis, including headache, stiff neck, tingling or painful feelings in the skin, low-grade fever, nausea, and vomiting. These symptoms could indicate an infection by *Angiostrongylus cantonensis*, a parasite carried by snails and slugs. These pests may also carry other diseases.

Pest Status

Temperate terrestrial gastropods can:

- Cause damage by feeding on agricultural and horticultural crops as well as native plants, thereby lowering crop yields and crop quality;
- Transmit pathogens to humans indirectly when humans consume vegetables and fruits contaminated by snails and slugs;
- Transmit pathogens of both plants and livestock in their feces; and
- Displace native species of snails and slugs.

Additionally, snails can disrupt agricultural operations when they mass together in a behavior known as massing. Helicid, hygromiid and cochlicellid snails are known for climbing on vegetation, fence posts, and other upright objects, in response to temperature extremes. The snails aggregate in sometimes enormous numbers and estivate *en masse* (McKinney and Lockwood 1999; Cowie and Robinson 2002).

The species included in this *Guidelines* are just a few of the temperate land snails and slugs that have been introduced into the American mainland. Some of these species have established self-sustaining populations.

Although efforts have been made to eradicate or suppress these introduced species, there remains the possibility that they have been introduced further afield from known introduction sites, and therefore represent a credible threat to agriculture and the environment.

Document Comprehensiveness

This document is not intended to be complete and exhaustive, but provides a foundation, based upon the literature available, to assist further work. Some key articles were not available at the time of writing, and not all specialists and members of the research community were consulted for their advice.

Commercial Suppliers or Products

Any references to commercial suppliers or products should not be construed as an endorsement of the company or product by the U.S. Department of Agriculture.

Contacts

When an emergency program for temperate terrestrial mollusks has been implemented, its success depends on the cooperation, assistance, and understanding of other involved groups. The appropriate liaison and information officers should distribute news of program progress and developments to interested groups, including the following:

- Other Federal, State, county, and municipal agricultural officials;
- Grower groups (such as specific commodity or industry groups);
- Commercial interests;
- Academic entities with agricultural interests;
- Land-grant universities and Cooperative Extension Services;
- State and local law enforcement officials;
- Tribal governments;
- Public health agencies;
- Agricultural interests in other countries;
- National, State and local news media; and
- The public.

Initiating an Emergency Pest Response Program

An emergency pest response program or incident response consists of detection and delimitation, and may be followed by programs in regulation, containment, eradication and control. The New Pest Advisory Group (NPAG) will evaluate the pest. After assessing the risk to United States plant health and consulting with experts and regulatory personnel, NPAG makes a recommendation to PPQ management for a course of action.

Follow this sequence in any order when initiating an emergency pest response program:

1. A new or reintroduced pest is discovered and reported.
2. The pest is examined and pre-identified by regional or area identifier.
3. Pest identity is confirmed by national taxonomic authority recognized by USDA–APHIS–PPQ–National Identification System.
4. Existing *Guidelines* are consulted or new NPAG is assembled to evaluate the pest.
5. Depending on the urgency, official notifications are made to the National Plant Board, cooperators, and trading partners.
6. A delimiting survey is conducted at the site of detection.
7. An incident assessment team may be sent to evaluate the site.
8. A recommendation is made, based on the assessment of surveys, other data, and recommendation of the Incident Assessment Team or an NPAG, as follows:
   - ❖ Take no action,
   - ❖ Regulate the pest,
   - ❖ Contain the pest,
   - ❖ Suppress the pest, or
   - ❖ Eradicate the pest.
9. State Departments of Agriculture are consulted.
10. If appropriate, a control strategy is selected.
11. A PPQ Deputy Administrator authorizes a response.
12. A command post is selected and the Incident Command System is implemented.
13. State Departments of Agriculture cooperate with parallel actions using a unified command.

14. Traceback and trace forward investigations are conducted.
15. Field identification procedures are standardized.
16. Data reporting is standardized.
17. Regulatory actions are taken.
18. Environmental assessments are completed as necessary.
19. Treatment is applied for required pest generational time.
20. Environmental monitoring is conducted, if appropriate.
21. Pest monitoring surveys are conducted to evaluate program success.
22. Programs are designed for eradication, containment, or long-term use.

Chapter

2

Pest Information

Contents

Introduction

Use *Chapter 2 Pest Information* to learn more about the classification, history, host range, and biology, of temperate climate pest snails and slugs in the United States and collaborating territories. Selected species in the gastropod

families Arionidae, Cochlicellidae, Helicidae and Hygromiidae are discussed here as these are currently of particular concern, but these guidelines are applicable for most if not all temperate terrestrial gastropods (TTG).

Classification

Use *Table 2-1* and *Table 2-2* as aids to classify temperate terrestrial gastropods.

Table 2-1 Classification of Temperate Terrestrial Gastropods in the Families Arionidae, Cochlicellidae, Helicidae and Hygromiidae

Phylum	Mollusca
Class	Gastropoda
Subclass	Pulmonata
Order	Stylommatophora (terrestrial snails and slugs)
Families	Arionidae, Cochlicellidae, Helicidae, Hygromiidae

Table 2-2 Species of Temperate Terrestrial Gastropods in the Families Arionidae, Cochlicellidae, Helicidae and Hygromiidae Included in the *Guidelines*

Family	Species
Arionidae	*Arion vulgaris* (Moquin-Tandon) (=*Arion lusitanicus* of authors, *non* Mabille)
Cochlicellidae	*Cochlicella acuta* (Müller) *Prietocella barbara* (Linnaeus)
Helicidae	*Theba pisana* (Müller)
Hygromiidae	*Candidula intersecta* (Poiret) *Cernuella virgata* (da Costa) *Hygromia cinctella* (Draparnaud) *Microxeromagna lowei* (Potiez and Michaud) *Monacha cantiana* (Montagu) *Monacha cartusiana* (Müller) *Monacha syriaca* (Ehrenberg) *Xerolenta obvia* (Menke) *Xeropicta derbentina* (Krynicki) *Xeropicta krynickii* (Krynicki) *Xerotricha conspurcata* (Draparnaud)

Ranking of Exotic Snail and Slug Pests

Inclusion of species of temperate climate pest snails and slugs in the *Guidelines* was based on the following criteria used by Cowie *et al.* (2002):

- Species prevalence in native range,
- Species ability to survive the environmental conditions of shipment,
- Difficulty of detecting pest through visual inspection,
- Probability that the pest survives existing phytosanitary procedures,
- Frequency of pest movement into at-risk areas,
- Frequency of approach of commodities potentially containing the pest,
- Intended use of commodities,
- Pest is invasive elsewhere in the world, and
- Organism is a major pest elsewhere in the world.

Additional pest species were added to the *Guidelines* in 2010 based on the Cooperative Agricultural Pest Survey's Analytic Hierarchy Process Prioritized Pest List and expert advice.

Economic Importance

Limited information is available concerning the potential impact of an infestation of temperate climate snails and slugs on host crops in the United States. Most estimates of the costs associated with their damage are from Australia, where gastropods are significant pests. In addition, many of the pest snails and slugs have a wide host range. See *Damage to Host Plants* on page 2-4 for additional information on the crop damage associated with each species.

Costs Associated with Crop Damage

An infestation of the temperate climate snails *Candidula intersecta* (Poiret), *Hygromia cinctella* (Draparnaud), *Monacha cartusiana* (Müller), and *Xerolenta obvia* (Menke), could impact States that produce wheat and alfalfa hay (L. J. Garrett, *personal comm.*). During the years 1999 to 2008, the average value of wheat production at risk was $7.12 billion. States with the greatest wheat production area at risk include North Dakota, Montana, and Washington. During the same period, the average value of alfalfa hay production at risk was $6.2 billion. States with the greatest alfalfa hay production at risk include California, Idaho, Iowa, Minnesota, and Wisconsin.

In Australia, temperate climate snails have contaminated harvested grain, resulting in a product that is unacceptable to grain-handling authorities, or is downgraded in quality. For example, gastropod-damaged barley (*Hordeum*) grain intended for malting will be downgraded to animal feed, resulting in a reduced payment from Australia$150 to $120 per ton.

Contamination of citrus exports by *Microxeromagna lowei* (Poteiz and Michaud) has caused significant economic losses in Australia (Lush, 2007). If found in exports to the United States, the fruit has to either be repacked and re-exported or fumigated and destroyed at the cost of the industry (Lush, 2007).

Costs Associated with Survey, Prevention, and Treatment

Recognizing that early detection plays a role in preventing crop damage, surveys for exotic mollusks have been conducted in the Pacific Northwest. The States of Oregon, Washington, and Alaska have recently conducted such surveys. In Washington in 2008, the statewide snail survey—with adequate emphasis on port environs—was funded by USDA–APHIS at a cost of roughly $63,000 (C. L. Campbell, *personal comm*.).

Cernuella virgata (da Costa) found at the Port of Tacoma, Washington, in late 2005, became an active eradication target in 2007. Initial eradication activity costs were borne together by USDA–APHIS, the State, the Port, the city, and some private landowners. In 2008, as part of a proposed 5-year eradication plan, USDA–APHIS provided $86,000 for eradication activities in Washington. The funding requested was considerably higher (C. L. Campbell, *personal comm*.).

Damage to Host Plants

Temperate terrestrial gastropods:

- Cause damage by feeding on agricultural and horticultural crops as well as native plants, thereby lowering crop yield and quality,
- Transmit pathogens to humans indirectly when they consume vegetables and fruits contaminated by snails and slugs,
- Transmit pathogens of both plants and livestock in their feces, and
- Displace native species of snails and slugs.

Additionally, snails can disrupt agricultural operations when they mass together in a behavior known as massing. Helicid, hygromiid and cochlicellid snails are known for climbing on vegetation, fence posts, and other upright objects, in response to temperature extremes. The snails aggregate in sometimes enormous numbers and estivate *en masse*.

Due to their apparent lack of host specificity, few reports as to specific damage caused by snail or slug species to agriculture have been published in the malacological or agricultural literature. The following is a summary of some of the damage attributed to temperate terrestrial gastropods in the *Guidelines*.

Arionidae

Arion vulgaris (Moquin-Tandon)

Arion vulgaris (Moquin-Tandon) is widely recognized as a major pest of European agriculture. Like most phytophagous slugs, it is not specific in terms of its associated host plant species, but it feeds on a wide range of horticultural plants and vegetables, including potatoes, as well as oilseed rape (Friedl and Frank, 1998).

Problematically, it is frequently confused with two closely related taxa, *Arion ater* (Linnaeus) and *A. rufus* (Linnaeus) and in some reports it is not absolutely clear which species is being associated with specific crop damage.

In Sweden and Denmark, *Arion vulgaris* Moquin-Tandon causes considerable damage to grassland, parks and commons (von Proschwitz and Winge, 1994), strawberries, and a wide variety of vegetables (Weidema, 2006). Related *Arion* species are associated with damage to carrots, potatoes, winter and summer rape, wheat, barley and rye seedlings, greenhouse cucumbers, and tobacco. They also transmit tapeworm species that affect livestock, and rust. *Alternaria* sp., *Fusarium* sp. and *Phytophthora* sp. have been found in the feces of these species (Godan, 1983).

Cochlicellidae

Cochlicella acuta (Müller)

Cochlicella acuta (Müller) is a pest of fodder crops (alfalfa, clover, lupine, sainfoin, seradella), particularly of their seeds (Godan, 1983).

Prietocella barbara (Linnaeus)

Prietocella barbara (Linnaeus) has also been reported as a pest in legume-based pastures in southern Australia, particularly annual medics and alfalfa (*Medicago* spp.), and clovers *(Trifolium* spp.) (Baker, 2002).

Hygromiidae

Members of the family Hygromiidae are pests of fodder crops and are considered serious pests in Europe.

Candidula intersecta (Poiret)

Candidula intersecta (Poiret) is a recognized pest of fruit farms (apples, pears, plums and peaches), damaging fruit and, while still on the tree, making them open to attack by fungi such as Monilia. The species causes feeding damage to seeds, seedlings and young plants of spring grain in southern Germany (Godan, 1983).

Hygromia cinctella (Draparnaud)

Hygromia cinctella (Draparnaud) exhibits massing behavior when populations reach high levels. This behavior has been observed in introduced populations in the United States.

Microxeromagna lowei (Potiez and Michaud)

Microxeromagna lowei (Potiez and Michaud) feeds on decaying organic material in leaf litter (Lush, 2007). The species climbs on tree trunks, foliage, and fruit, but does not damage the fruit (Lush, 2007). It is considered a citrus crop pest in some orchards in southern Australia (Shea, 2007).

Monacha cantiana (Montagu)

In most countries, this species is not considered a serious pest. However, reports from Egypt state that this species is a pest of agricultural crops including sugar beets (Shalaby and Elkhamesv, 2007), navel oranges, lemons, guava, lettuce, and Egyptian clover (El-Khodary et al., 2000). The identification of the species in Egypt has not been confirmed by specimen identification or by interceptions from Egypt, but will be determined when PPQ's National Malacologist receives samples from Egypt (Newton, 2011).

Monacha cartusiana (Müller)

Monacha cartusiana (Müller) is known to act as an intermediate host of parasites potentially harmful to livestock including sheep lungworm (Robinson, 1999).

Monacha syriaca (Ehrenberg)

Monacha syriaca (Ehrenberg) is reported to damage *Ruscus hypoglossum* and *Aspidistra elatior* in shade houses in Israel (Moran *et al*., 2004). *Monacha* species, as well as *Hygromia cinctella* (Draparnaud) and *Xerolenta obvia* (Menke) also show massing behavior when populations reach high levels; this has been observed in introduced populations in the northern United States.

Xerolenta obvia (Menke)

Xerolenta obvia (Menke) has been shown to feed on a wide range of plant species of minimal economic importance (Hatziioannou *et al*., 1994). However, it has been reported as a pest of fodder crops, causing feeding damage to alfalfa, clover, lupine, sanfoin, seradella in southern Germany, and is considered a serious pest in Italy and Bulgaria, where it is a contaminant of fruits and vegetables exported to other European countries. It has been shown to transmit spores of *Alternaria* sp., *Fusarium* sp., and *Phytophthora* sp. Spores of rust have been found in its feces, and it is a vector of *Protostrongylus rufescens* (a sheep lungworm), *Davainea proglottina* (a cestode), and *Dicrocoelium dendriticum* (a trematode) (Godan, 1983). Georgiev *et al.*, (2003) found that in southern Bulgaria this species had the high infection levels of protostrongylid larvae that parasitize sheep and goats.

Xeropicta spp.

Although *Xeropicta* species are considered to be predominantly detritivorous, high populations of *Xeropicta derbentina* (Krynicki) are considered to be problematical in vineyards and orchards, causing significant damage such as bud canker in southern France (Kiss *et al.*, 2005). *Xeropicta krynickii* (Krynicki), a very closely related species, is expected to have similar pestiferous habits, as would another xerophilous hygromiid, *Xerotricha conspurcata* (Draparnaud).

Theba pisana (Müller) and *Cernuella virgata* (da Costa)

Theba pisana (Müller) (Helicidae) and *Cernuella virgata* (da Costa) (Hygromiidae), collectively known in Australia as white snails, are considered by many agricultural authorities as among the more serious molluscan pests. In southern Australia the species have produced populations so great as to interfere with grain production. The snails climb on to heads and stalks of the crops close to harvest, clogging harvesting machinery as well as contamination of the grain.

White snails are also pests on seedling crops such as wheat, barley, oil seeds, seed carrots, and legume-based pastures (*e.g.* annual medics, lucerne, clovers, peas, beans) causing severe damage and occasionally total destruction. Ornamental crops are also affected. Livestock will refuse to feed on pasture and hay that are heavily contaminated by the slime trails (Baker, 1986; 1996; 2002).

Theba pisana (Müller) *is* also considered a minor pest of *Citrus* orchards, feeding on leaves and fruit. Vegetables and ornamental plants are also eaten. It is also is a pest of grape in South Africa and south Australia, the juveniles feeding on foliar buds and young leaves, resulting in stunted growth and decreased yield. The snails may also be harvested with the grapes bunches, particularly when mechanical harvesting is conducted. In addition, active juveniles and adults leave mucus trails on the developing grapes, rendering them unsuitable for consumption and export markets (Sanderson and Sirgel, 2002).

Cernuella virgata (da Costa) is also implicated in protostrongylid transmission affecting livestock (Georgiev *et al.*, 2003).

Health Risks

⚠ WARNING

Consumption of snails and slugs, or of vegetables and fruits contaminated by snails and slugs, may lead to infection by pathogens that are easily transmitted by these pests. Wear rubber or latex gloves when handling gastropods, as well as associated soil, excrement, and other materials that may have come in contact with them. Immediately after removing protective gloves, thoroughly wash hands with hot soapy water and rinse well. Consult a physician if, after handling snails and slugs, you experience symptoms resembling forms of meningitis, including headache, stiff neck, tingling or painful feelings in the skin, low-grade fever, nausea, and vomiting. These symptoms could indicate an infection by *Angiostrongylus cantonensis*, a parasite carried by snails and slugs. These pests may also carry other diseases.

Distribution and Detections

Arionidae

Arion vulgaris (Moquin-Tandon)

Common name(s)—Lusitanian slug

Known distribution—Widespread in Europe. Although not yet introduced to the United States, it represents a very serious threat.

Reported introduction site(s) and year detected—None to date.

Cochlicellidae

Cochlicella acuta (Müller)

Common name(s)—Pointed snail, conical snail

Known distribution—Predominantly a species of the countries in the Mediterranean Basin, this species has populations in coastal Ireland, Britain, France and Belgium. The species is also established in southern Australia.

Reported introduction site(s) and year(s) detected—None to date

Prietocella barbara (Linnaeus)

Common name(s)—Potbellied helicellid, banded conical snail, conical snail

Known distribution—Predominantly a species of the countries in the Mediterranean Basin, this species is introduced to southwestern Britain, Belgium and adjacent coastal France. The species is also established in Bermuda, South Africa, southern Australia and New Zealand. The current status of populations in California requires verification.

Reported introduction site(s) and year(s) detected—California (several 20th century introductions), including Alameda, Santa Cruz, San Luis Obispo and San Diego Counties.

Helicidae

Theba pisana (Müller)

Common name(s)—White garden snail, white snail, sandhill snail

Known distribution—Predominantly a species of the countries in the Mediterranean Basin; also introduced to Great Britain, the Netherlands and Belgium. Established populations in South Africa, Cape Verde Islands, Canary Islands, Madeira, the Azores, Bermuda, Iran, southern Australia, and southern California.

Reported introduction site(s) and year(s) detected—San Diego, Orange, and Los Angeles Counties, CA (several 20th century introductions); current distribution is restricted to San Diego County.

Hygromiidae

Candidula intersecta (Poiret)

Common name(s)—Wrinkled helicellid, wrinkled snail

Known distribution—Known primarily as a western and northwestern European species; native from southern Sweden, Denmark and south through Germany, the Netherlands, Belgium, France, the British Isles, to Spain and Portugal. The species is established as an invasive in New Zealand, and southern Australia. PPQ interceptions from South America indicate the species may also have established populations in Colombia and Chile, but this requires confirmation.

Reported introduction site(s) and year(s) detected—Detroit, MI (2004; eradicated 2005); Port of Seattle, WA (2006); Port of Tacoma, WA (2006) (C. Campbell, *personal comm.*); Coos Bay, OR (2006); Curry Co., OR (2006).

Cernuella virgata

Common name(s)—Striped snail, zoned snail, white snail

Known distribution—Predominantly a species of the countries in the Mediterranean Basin, it is also widespread in western France, Belgium, the Netherlands and the British Isles. The species is also established in southern Australia, where it is an important pest of cereal crops.

Reported introduction site(s) and year(s) detected—San Diego, CA (unconfirmed; current status unknown); Sunny Point, NC (2000; eradicated 2001); Port of Tacoma, WA (2005, 2006) (C. Campbell, *personal comm.*).

Hygromia cinctella (Draparnaud)

Common name(s)—Girdled snail

Known distribution—Southern France, southwestern Switzerland, northern Italy, and the northern Balkans. Established populations in the Netherlands, southern Germany, Hungary, and the British Isles.

Reported introduction site(s) and year(s) detected—Detroit, MI (2004; eradicated 2005)

Microxeromagna lowei (Potiez and Michaud)

Common name(s)—Small brown snail, citrus snail

Known distribution—Native to Mediterranean Europe, the Middle East and North Africa. Introduced into Australia (Shea, 2007) and Madeira (Seddon, 2008).

Reported introduction site(s) and year(s) detected—None to date

Monacha cantiana (Montagu)

Common name(s)—Kentish garden snail, clover land snail

Known distribution—This species is found in Austria, Belgium, Czech Republic, France, Germany, Italy, Netherlands, and the United Kingdom (England, Scotland, Wales). It has been introduced into Canada (Chatfield, 1968, 1977; Grimm et al., 2009; Hlavac and Peltanova, 2010). *Monacha cantiana* (Montagu) is also reported to be in Egypt (El-Khodary et al., 2000; Genena and Mostafa, 2010) but this has not been confirmed by specimen identification or by interceptions from the area (Newton, 2011).

Reported introduction site(s) and year(s) detected—*Monacha cantiana* (Montagu) was detected on August 15, 2011 on vegetation at an Oakland County, Michigan, rail yard (Newton, 2011).

Monacha cartusiana (Müller)

Common names—Carthusian snail, chartreuse snail

Known distribution—Predominantly a species of the countries in the Mediterranean Basin and southeastern Europe, this species is also widespread in southeastern Britain, France, Belgium, the Netherlands, and the Rhine valley in Germany.

Reported introduction site(s) and year(s) detected—Chicago, IL (2001; current status unknown); Wilmington, DE (2001); Detroit, MI (2004).

Monacha syriaca (Ehrenberg)

Common name—None

Known distribution—Turkey, Syria, the Lebanon, Israel and Jordan.

Reported introduction site(s) and year(s) detected—Sunny Point, NC (2000; eradicated 2001).

Xerolenta obvia (Menke)

Common name(s)—Heath helicellid

Known distribution—Southeastern and eastern Europe; with isolated colonies in western Germany and southern France. Long established populations in southern Ontario.

Reported introduction site(s) and year(s) detected—Detroit, MI (2001).

Xeropicta derbentina (Krynicki)

Common name—None

Known distribution—Eastern Mediterranean and Black Sea Basins: the Balkans, Greece, Bulgaria, Romania, Turkey, Georgia, and southern Russia; established populations in Provence, southeastern France.

Reported introduction site—None

Xeropicta krynickii (Krynicki)

Common name—None

Known distribution—Black Sea Basin to Azerbaijan and Iran; established populations in Crete and Egypt.

Reported introduction site(s) and year detected—Sunny Point, NC (2000; eradicated 2001).

Xerotricha conspurcata (Draparnaud)

Common name—None

Known distribution—Western Mediterranean Basin; established populations in Greece, Turkey, and Israel. Introduced into Madeira (Seddon, 2008).

Reported introduction site(s) and year detected—San Francisco Bay area, CA (1996); current distribution: Alameda, San Mateo, Contra Costa, and Santa Clara Counties, California.

Life Cycle

An understanding of the gastropod life cycle can be important in determining an appropriate course of action and its timing. Unfortunately, our understanding of the biology of many of these species is still in its infancy.

Some studies have been conducted in the life histories of a few economically-important species. In general, the studies reflect populational and specific differences in life history in Europe, where they are native, as well as where they have been introduced elsewhere in the world. Similar studies should be conducted in the United States.

Temperate terrestrial gastropods are hermaphroditic, but most likely reproduce by out-crossing rather than self-fertilization. In Australia, where substantial research on *Theba pisana* (Müller), *Cernuella virgata* (da Costa), *Cochicella acuta* (Müller) and *Prietocella barbara* (Linnaeus) has been conducted, a complex picture emerges.

Arionidae

Arion vulgaris Moquin-Tandon

Due to its increasing importance as an agricultural, horticultural and environmental pest in Europe, *Arion vulgaris* (Moquin-Tandon), perhaps better known as *Arion lusitanicus* (Auctt. non Mabille), increasing research is being conducted into its identification and life habits (Grim *et al*., 2000; Grimm, 2001). In the areas in Europe where it has been studied, the slug is generally considered to have an annual life cycle, the adults reaching peak population density in June, and generally dying in fall after laying their eggs. However, in mild winters and the warmer areas of Europe, some individuals may survive into the following spring. Each adult slug produces a total of about 400 eggs, laid in clutches of 20 to 30 in soil or in leaf litter over several months in late summer and early fall (Grimm, 2001; Weidema, 2006).

Helicidae

Theba pisana (Müller)

Theba pisana (Müller) may have annual or biennial life cycles, depending on whether the population is established in permanent pastures or pasture-cereal rotations. In primarily non-agricultural habitats in Europe, Israel and South Africa, annual and biennial life cycles can occur, even in the same populations (Baker, 2002).

Cowie (1984) reported a biennial life cycle in Wales, with annual and biennial life-cycles with breeding in summer and fall in Britain and northern France, and later in fall and winter in Mediterranean countries. The differences in life cycles are probably in response to environmental factors triggering periods of dormancy or the availability of food and calcium. Individuals of *Theba pisana* (Müller) (in Wales) at a conservative estimate produced 300 to 340 eggs, in clutches of approximately 75 eggs each in soil cavities, the larger snails laying more eggs (Cowie, 1984).

Hygromiidae

Cernuella virgata

Cernuella virgata (da Costa) in Australia mate after late summer or early fall rains, each snail laying 100 to 200 eggs in leaf litter or just below the soil surface; the species has lower fecundity when population levels are high (Baker, 1996). Baker (2002) also noted both Cernuella virgata (da Costa) and *Cochlicella* acuta (Müller) are biennial in pasture-cereal rotations and annual in permanent pastures as seen in Theba pisana (Müller). Observations in Washington state support the occurrence of a two-year life cycle (C. Campbell, *personal comm*.).

Microxeromagna lowei (Potiez and Michaud)

Microxeromagna lowei (Potiez and Michaud) can lay approximately 500 eggs per year in semi-field conditions (Lush, 2007). Juveniles reach sexual maturity when the shell diameter reaches 6 mm and when they can self-fertilize (Lush, 2007). The species prefers leaf litter but can move in the tree canopy (Lush, 2007). Lush (2007) found that *M. lowei* laid eggs in soil (although eggs have also been found in leaf litter) and that they exhibited an iteroparous egg laying strategy. The species can lay double embryo eggs that can lead to a hatch rate of over 100 percent (Lush, 2007).

Monacha cantiana (Montagu)

This species occurs in open habitats that can be characterized by loose vegetation, recent disturbance, and neutral to alkaline soil (Chatfield, 1972). *Monacha cantiana* (Montagu) can also be found in some grassy habitats and can live on soils with different water content, but not in woodlands (Chatfield, 1972). Based on observations in southeast England, Chatfield (1968) found that *M. cantiana* laid eggs over several months with most being observed in autumn. In south England, this species is most numerous in autumn due to recent hatching (Chatfield, 1972). Little feeding or growth occurs during winter and hibernation occurs during times of prolonged frost. *Monacha cantiana* (Montagu) feeds on litter cover of the soil (Moreno et al., 2006) and can live 12 months or more (Chatfield, 1968).

Monacha cartusiana (Müller)

One study on *Monacha cartusiana* (Müller) in France indicates an annual life cycle, laying 40 to 80 eggs in loose, damp soil from mid-September to October. Some individuals may live up to 18 months. However, the species is found throughout southern Europe, and a biennial life cycle cannot be discounted in warmer climes (Chatfield, 1968).

Xeropicta spp.

In established populations in southern France, *Xeropicta dorbentina* (Krynicki) exhibits annual and biennial life cycles dependent upon climatic characters as well as population density. Populations in France tend to be biennial, with some individuals surviving up to 30 months, while those in northern Greece are typically annual, with a life span of 12 to 20 months (Kiss *et al.*, 2005). Egg-laying occurs from September to early January, with fecundity of about 54 to110 hatchlings per adult. A similar life-cycle, both annual and biennial, is reported for *Xerolenta obvia* (Menke) (Lazaridou and Chatziioannou, 2005).

Chapter

3

Identification

Contents

Introduction

Use *Chapter 3 Identification* as a guide to recognizing temperate climate pest snails and slugs in the United States and collaborating territories. Selected species in the gastropod families Arionidae, Cochlicellidae, Helicidae and Hygromiidae are discussed here as these are currently of particular concern, but these guidelines are applicable for most if not all temperate terrestrial gastropods (TTG). Accurate identification is pivotal to assessing potential risk, developing a survey strategy, and determining the level and manner of control.

The protection of native non-target snails and slugs is also important. Some species are integral elements of a healthy natural environment, and some may be protected by local, State or Federal laws. See ***Environmental Compliance*** on page 7-1 for further information regarding environmental regulations.

Authorities

Qualified local personnel may perform preliminary identification and screening of suspected snail and slug pests. Before survey and control activities are initiated in the United States, an authority recognized by USDA–APHIS–PPQ–National Identification Services must confirm the presence of such pests. Please submit specimens to Dr. David G. Robinson.

Address

Dr. David G. Robinson
USDA–APHIS National Malacologist
Department of Malacology
Academy of Natural Sciences
1900 Benjamin Franklin Parkway
Philadelphia, PA 19103
Telephone: 215-299-1175
Fax: 215-567-7229
Email: Robinson@ansp.org or David.G.Robinson@usda.gov

Reporting

Reports of positive identifications by National specialists will be forwarded to PPQ–National Identification Service (NIS) in Riverdale, Maryland, as per the agency protocol. NIS reports identification status of these tentative and confirmed records to PPQ–Emergency and Domestic Programs (EDP). EDP reports results to all other appropriate parties.

Address

PPQ–National Identification Service (NIS)
Web site: http://www.aphis.usda.gov/plant_health/permits/
Telephone: 301-734-8758

Plant Protection Act

PPQ permit and registration requirements for plant pests falls under the Plant Protection Act (7 CFR Part 330). Plant Protection Act permit requirements apply to all plant pests and infected plant material, including diagnostic samples, regardless of their quarantine status. If any material is shipped interstate, the receiving laboratory must have a permit.

For further guidance on permitting of plant pest material, consult PPQ Permit Services or visit the Web site of the PPQ–Permits Program.

Address

PPQ–Permits Program
Web site: http://www.aphis.usda.gov/plant_health/permits/
Telephone: 301-734-8758

Snail Anatomy

The body of a snail has two pairs of tentacles: a short, lower pair that are sensitive to touch and chemical signals; and one long, upper pair with eye spots at the tips (Schotman 1989 and USDA 1960). The body is moist, slimy, and rubbery. Body coloration varies with species and/or population. The foot sole is flat, with coarse tubercles most evident on the sides and upper surface of the extended body.

Shell characters that are important for identification are the columella, whorls, sutures, transverse striae, parietal wall, apex, and lip (*Figure 3-1*).

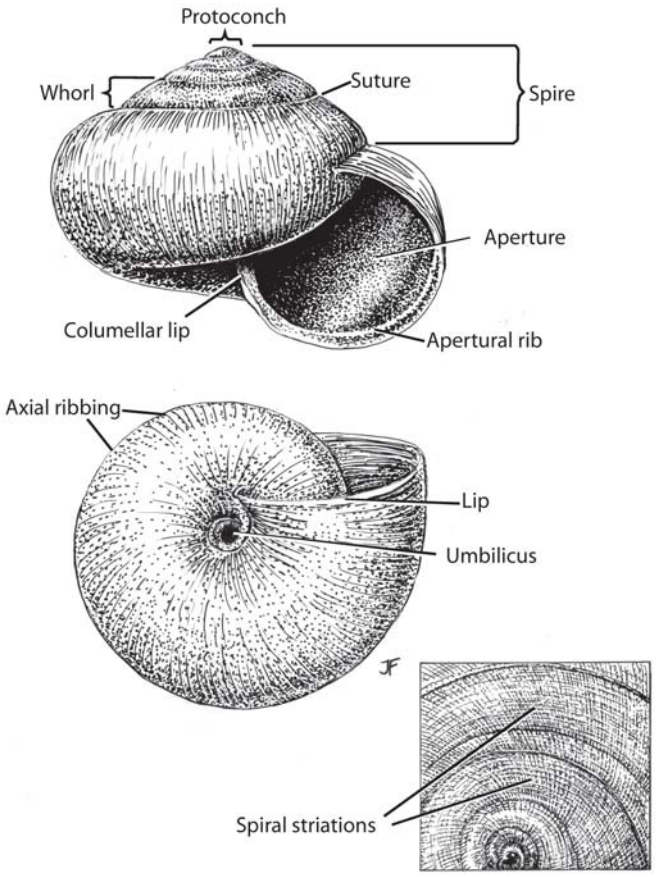

Figure 3-1 Anatomy of a Temperate Terrestrial Land Snail. (Illustration by Joel Floyd, USDA–APHIS–National Identification Service.)

Characteristics

Hygromiidae

Candidula intersecta (Poiret)

Shell description—Refer to *Figure 3-2*, *Figure 3-3*, and *Figure 3-4 on page -5*. Maximum dimension is usually about 10 mm. in diameter, but up to 13 mm. Shell is solid, depressed helicoid, with a convex spire of 5 to 6 1/2 whorls that are somewhat convex, producing shallow sutures. Most specimens exhibit a characteristic peripheral angle in the approximate middle of the whorl. Sculpture of irregular axial ribbing is stronger on the apical side than on the base. Under higher magnification, irregular spiral striations can be seen crossing the axial sculpture, and are generally more clearly visible on the base.

Shell aperture is ovoid, with a thickened apertural rib just inside the lip (in adult specimens only; juvenile and immature shells lack any apertural rib). The umbilicus is moderately large and deep. Color is highly variable, but usually white to cream overlain with reddish brown to pale brown, irregular spiral stripes of variable strength, with usually the strongest occurring just above the periphery. Some individuals from populations found in Washington exhibit a heavily-pigmented base. There is usually an irregular white band at and just below the peripheral angle. Pure white or brown shells have been reported in Europe.

Figure 3-2 *Candidula intersecta* (Poiret) Collected from Port of Seattle (Specimen 1) (Images courtesy of P. Marquez)

Figure 3-3 *Candidula intersecta* (Poiret) Collected from Port of Seattle (Specimen 2) (Images courtesy of P. Marquez)

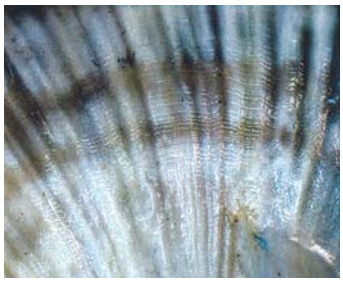

Figure 3-4 *Candidula intersecta* (Poiret) with Spiral Striations on Shell Base; Collected from Port of Seattle (Image courtesy of P. Marquez)

Cernuella virgata (da Costa)

Shell description—Refer to *Figure 3-5*, *Figure 3-6*, and *Figure 3-7 on page -6*. Maximum dimension is usually about 10 mm in diameter, but can be up to 25 mm. Shell is solid, globular helicoid, with a convex spire of 5 to 7 whorls that are somewhat convex, producing moderate sutures. Whorl outline is quite rounded. Shell sculpture consists primarily of faint axial growth lines that may be somewhat accentuated if the shell was broken during growth; no axial or spiral ribbing, is present, nor is there evidence of spiral striation.

Shell aperture rounded, with a thickened apertural rib just inside the lip (in adult specimens only). Apertural lip may be darkened brown to bright red, the apertural rib may be white to red. Juvenile and immature shells lack any apertural coloration. Umbilicus moderately large and deep; in some populations the apertural lip may flare when fully adult, partially obscuring the

umbilicus. Color is highly variable, from white or cream, with or without dark or light brown spiral banding.

Figure 3-5 *Cernuella virgata* (da Costa) collected from Port of Tacoma (Images courtesy of P. Marquez)

Figure 3-6 *Cernuella virgata* (da Costa) collected from Port of Tacoma (Images courtesy of P. Marquez)

Figure 3-7 *Cernuella virgata* (da Costa) Collected from Port of Tacoma (Image courtesy of P. Marquez)

Hygromia cinctella (Draparnaud)

Shell description—Refer to *Figure 3-8* and *Figure 3-9 on page -7*. Maximum dimension is usually about 12 mm. in diameter. Shell is delicate, helicoid, with a somewhat conical spire, 5 to 6 somewhat convex whorls and shallow sutures. There is usually an angulate periphery. Shell is translucent, the mantle pattern showing through the shell.

Umbilicus is minute, and partially obscured by the columellar lip. Aperture is elliptical, wide; adults with a slightly flaring lip and a thickening along the apertural edge producing an internal rib. Shell is sculptured with faint axial growth lines, with irregularly spaced axial riblets. Color can be very pale yellow to reddish-brown, and almost always with a well-defined cream spiral band running around the periphery.

Figure 3-8 *Hygromia cinctella* (Draparnaud) (Images courtesy of D. Robinson)

Figure 3-9 *Hygromia cinctella* (Draparnaud) from Detroit, Michigan (Image courtesy of J. Zablotny)

Microxeromagna lowei (Potiez and Michaud)

Shell description—The shell is “small, subglobose to turbinate with low to domed spire, narrow umbilicus, rounded whorls, strongly impressed sutures, thickened ring inside aperture, sculpture of rugose radial growth corrugations.

White to yellowish with spirally and radially arranged brown speckles and broken bands" (Shea, 2007). Adults are approximately 7 mm in length (Shea, 2007). The species differs principally from *Xerotricha conspurcata* (Draparnaud) in possessing short, dense periostracal hairs that are most evident in juveniles.

Monacha cantiana (Montagu)

Shell description—"The medium sized shell of this snail is 10.5 to 14 mm high and 15.5 to 20 mm wide with 5 1/2 - 6 whorls. The shell has a narrow umbilicus (navel-like opening at the base of the shell), is globosely depressed, and slightly transparent. The top of the shell is somewhat whitish in color and becomes progressively brownish toward the base. This thin shell is glossy in appearance and possess fine, weak, irregular lines and courser growth wrinkles. The aperture of the shell is broadly lunate while the lip is slightly expanded and shortly dilated at the columellar insertion. A narrow white or brown rib strengthens this insertion" (White-McLean, 2011).

Monacha cartusiana (Müller)

Shell description—Refer to *Figure 3-10* and *Figure 3-11 on page -9*. Maximum dimension is usually up to 15 mm. in diameter. Shell is somewhat solid, translucent (the mantle pattern showing through the shell), depressed helicoid, with a low convex spire of up to 5.5 convex whorls; sutures are shallow. Whorl outline is rounded, with the periphery higher than the mid-point. Shell sculpture consists of faint axial growth striations that become a little stronger at the suture; under magnification, the surface may show indistinct hair scars—the shell of juveniles is often covered with fine prehistorical hairs. Aperture is ovate, with a strong, thickened apertural rib just inside the lip (in adults only); the apertural rib shows up as a distinct white to brown to bright red band. Juvenile and immature shells lack any apertural coloration. The umbilicus is variable; it may be narrow or just a pin prick, but is always present; it may be partially obscured by the flaring aperture in the adult. Color is white to pale brown.

The mantle of the snail is irregularly but strongly marbled with black, brown and pure white, producing a very different appearance to the living animal as compared with the empty shell.

Figure 3-10 *Monacha cartusiana* (Müller) (Images courtesy of D. Robinson)

Figure 3-11 *Monacha cartusiana* (Müller)
From Scalier Park, Chicago, Illinois
(Image courtesy of D. Robinson)

Monacha syriaca (Ehrenberg)

Shell description—Refer to *Figure 3-12 on page -10*. Maximum dimension is up to 13.5 mm. in diameter. Shell is somewhat solid, depressed helicoid with a low spire; the pyrotechnic may protrude somewhat, producing a malamute appearance. Shell shape is depressed-globular, with 4½ and 5½ barely convex whorls, and very shallow sutures. Sculpture is generally smooth, with only fine axial growth-lines and vague incised spiral striations; on the base, irregular malleations are evident. Coloration is translucent brown (the mantle pattern showing through the shell), with two opaque, well-defined white bands: one below the suture and one at the periphery. Aperture is ovate to almost circular, with a strong, thickened apertural rib just inside the lip (in adults only); the

apertural rib shows up as a distinct white to brown to bright red band. There is no umbilicus, being completely filled by the apertural callus.

Figure 3-12 *Monacha syriaca* (Ehrenberg) (Images courtesy of D. Robinson)

Xerolenta obvia (Menke)

Shell description— Refer to *Figure 3-13* and *Figure 3-14 on page -11*. Maximum dimension is usually about 16 mm. in diameter, but up to 19 mm. The shell is solid, very depressed helicoid, with the spire barely rising above the subsequent whorls. Whorls numbering 5 to 6, flattened, with very shallow sutures. Last whorl turning downward out of the coiling plane in mature specimens. Shell sculpture consists of faint axial growth lines, with irregular malleations and scars from breaks in the shell. Aperture is ovate, thin (often broken) and never showing an internal apertural rib. Base color is opaque white, with dark brown spiral bands, the strongest and best defined above the periphery, others at and below the periphery weaker and irregular. Protoconch is usually dark brown. The umbilicus is large and irregular, in some specimens the coiling of the shell appearing haphazard.

Figure 3-13 *Xerolenta obvia* (Menke) (Images courtesy of D. Robinson)

Figure 3-14 *Xerolenta obvia* (Menke) in Detroit, Michigan (Image courtesy of D. Robinson)

Xeropicta derbentina (Krynicki)

Shell description—Refer to *Figure 3-15 on page -12*. Maximum dimension is usually about 18 mm. in diameter, but up to 22 mm. Shell is solid, very depressed helicoid, with the spire rising barely above the subsequent whorls.

Shell has low conic above, with 5 to 6 rounded whorls that evenly increase, resulting in a fairly open umbilicus, so that the previous whorls may be seen. Aperture is slightly elliptical, the peristome edge thin and often broken, with rarely a barely visible internal apertural rib. Protoconch is smooth and dark (in fresh specimens) and consists of approximately 1¼ whorls. Shell is opaque, dirty to pure white, occasionally with subtle brown spiral bands. Sculpture is

nearly smooth, growth-ridges fine and irregular, with characteristic fine and irregularly-spaced spiral striations of *Xeropicta* species. Mature specimens may also show irregular malleations and breaks in the shell surface.

Figure 3-15 *Xeropicta derbetina* (Krynicki) (Images courtesy of D. Robinson)

Xeropicta krynickii (Krynicki)

Shell description—Refer to *Figure 3-16 on page -12*. Maximum dimension is usually about 18 mm. in diameter. Shell is solid, depressed helicoid, with the spire rising slightly above the subsequent whorls. Whorls numbering 5 to 6, rounded, producing distinctly impressed sutures. Umbilicus is particularly narrow in juveniles and immatures, but in the last third of the last whorl (in adults) it widens abruptly so that the penultimate whorl can be seen, and becomes somewhat eccentric (not quite symmetrically coiled around the central axis).

Aperture is slightly elliptical, the peristome edge thin and often broken, with a subtle, internal apertural rib. Protoconch smooth and dark (in fresh specimens) and consists of approximately 1¼ whorls. Shell is white opaque, usually well-marked with light to dark brown spiral bands, although rarely all white. The spiral bands can be broken up into a checkered pattern due to uneven growth, particularly on the umbilical side. Growth ridges are nearly smooth, fine and irregular, with characteristic fine and irregularly-spaced spiral striations of *Xeropicta* species.

Figure 3-16 *Xeropicta krynickii* (Krynicki) (Images courtesy of D. Robinson)

Xerotricha conspurcata (Draparnaud)

Shell description—Refer to *Figure 3-17 on page -13*. The maximum dimension is usually about 8 to10 mm. in diameter. The shell is somewhat delicate, depressed helicoid with a low spire. The spire is conical with 5 to 6 somewhat convex whorls and shallow sutures; there is a slight shoulder or angulation along the upper periphery. The umbilicus is small and can be somewhat eccentric (not quite symmetrically coiled around the central axis). The sculpture is of fine, axial growth lines and irregularly-spaced riblets. Coloration is highly variable; ground color is translucent pale brown to reddish brown, overlain with irregular, opaque white lines and/or blotches, that may coalesce into spiral bands. The color pattern may also produce an almost checkered appearance. The shell surface is covered with a pale brown periostracum with relatively long, widely spaced curved or bent hairs; these may be rubbed off in adults, leaving tiny pits that are visible under magnification.

Figure 3-17 *Xerotricha conspurcata* (Draparnaud) (Images courtesy of P. Marquez)

Cochlicellidae

Cochlicella acuta (Müller)

Shell description—Refer to *Figure 3-18 on page -14*. The maximum dimension is usually about 20 mm. in height, but rarely up to 30 mm. The shell is somewhat delicate: a very elongated cone, with 8 to 10 convex whorls producing moderately indented sutures. The aperture is elliptical, higher than wide, and there is no evidence of an internal rib. Axial sculpture consists of little more than axial growth lines. The umbilicus is minute, almost completely obscured by the reflected columellar lip. The color is variable, even within the same population; ground color can be pure white to pale yellow, and there is often a dark brown spiral band below the periphery. The ground color may be

overlain with light to dark brown axial flames, separated by opposing lighter axial flames, or the entire surface can appear mottled.

Figure 3-18 Color Forms of *Cochlicella acuta* (Müller) (Images courtesy of D. Robinson)

Prietocella barbara (Linnaeus)

Shell description—Refer to *Figure 3-19 on page -15*. Maximum dimension is usually about 10 mm. in height, but occasionally up to 14 mm. The shell is delicate, highly conical, with 7 to 8 convex whorls producing moderately indented sutures. The aperture is elliptical, somewhat higher than wide, and there is no evidence of an internal rib. Axial sculpture consists of axial growth lines with periodic irregular, malleated ribs. The umbilicus is minute and partially obscured by the columellar lip. The color is quite variable, even within the same population; ground color is white to very pale yellow, with

often one or two brown spiral bands that may be interrupted by irregular, white, axial lines, producing a mottled appearance.

Figure 3-19 Color Forms of *Prietocella barbara* (Linnaeus) (Images courtesy of D. Robinson)

Helicidae

Theba pisana (Müller)

Shell description—Refer to *Figure 3-20 on page -16* through *Figure 3-24 on page -17*. Maximum dimension is usually about 25 mm. in diameter. Shell is solid, globular helicoid, with a somewhat depressed convex spire of up to 6 whorls, with shallow sutures. Last whorl turns down slightly in adults. Whorl outline is quite rounded. Shell sculpture consists of strong, irregularly spaced, spiral striations, crossed by axial striations, producing a diagnostic cross-hatching over the entire shell surface. Superimposed on this are irregular malleations, especially on the base.

Aperture is rounded, with an internal rib that may be white to yellow to bright pink; the entire aperture may be similarly colored. Coloration is extremely variable; the shell can be pure white without any markings. Many specimens are white to orange in base coloration, overlain with pale to dark brown spiral bands, lines of dots, or checkered squares, or any combination of these markings. The protoconch is usually (but not always) dark brown, almost black. The umbilicus, although small, is always present, and in adults is partially obscured by the flaring of the columellar lip.

The juvenile and immature shells appear quite different, so much so as to appear to some to belong to a distinct species. At first, the shell is quite carinate, producing an angular aperture, with the spire that can be almost flat. As the shell matures, the later whorls adhere to the earlier whorls just below

the peripheral carina, producing a small but distinct spiral shelf that breaks the otherwise smooth outline of the shell.

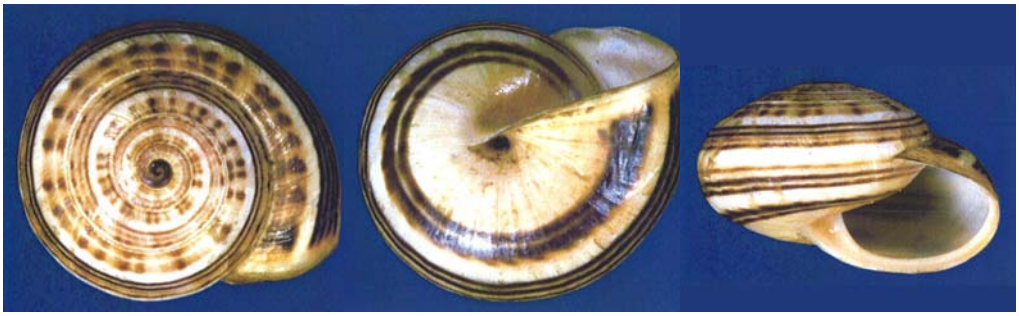

Figure 3-20 *Theba pisana* (Müller) (Images courtesy of D. Robinson)

Figure 3-21 *Theba pisana* (Müller) (Images D. Robinson)

Figure 3-22 *Theba pisana* (Müller): Close-up of shell surface showing diagnostic cross-hatching sculpture and dark protoconch (Image courtesy of D. Robinson)

Figure 3-23 *Theba pisana* (Müller) juveniles and immatures (Images courtesy of D. Robinson)

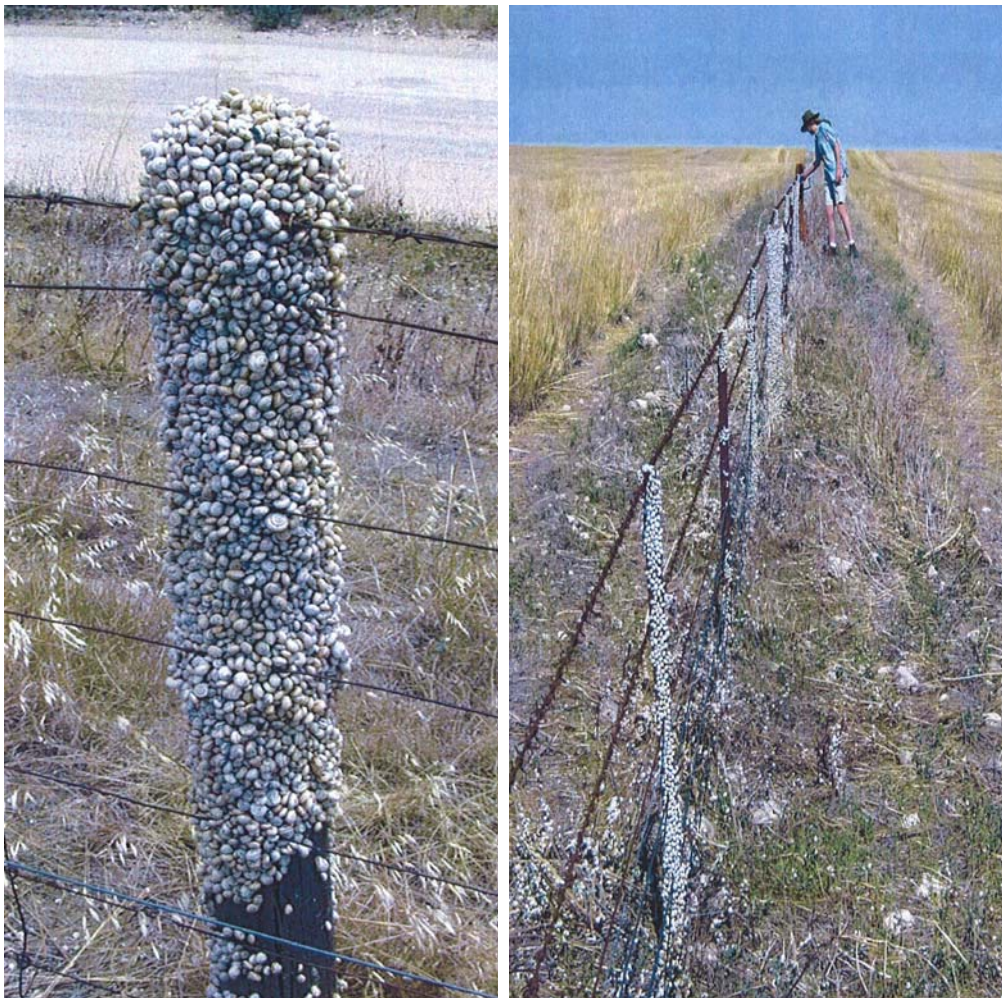

Figure 3-24 *Theba pisana* (Müller) massing on fence posts in South Australia (Images courtesy of M. Leyson)

Arionidae

Arion vulgaris (Moquin-Tandon) (=*Arion lusitanicus* of authors, *non* Mabille)

Description—Refer to *Figure 3-25 on page -18*. *Arion vulgaris* (Moquin-Tandon) is a large slug, up to 15 cm (rarely 20 cm) in length, with the distinct foot-fringe that is characteristic of all *Arion* species. As a sexually-mature adult, color is usually brick-red or dull red, but can be brown; usually the head and ocular tentacles are black. Immatures can show a darker stripe on either side the length of the body. The striped immature can sometimes be mistaken for the widespread *Arion subfuscus* (Draparnaud). A very similar species, *Arion rufus*, which is already widespread in Oregon and Washington, can be virtually indistinguishable and either species may only be accurately identified by dissection of the genitalia or molecular analysis.

Figure 3-25 Top: Mature *Arion vulgaris* (Moquin-Tandon) Bottom: Immature *Arion vulgaris* (Moquin-Tandon) (Images courtesy of I. Richling)

Chapter

4

Survey Procedures

Contents

Introduction

Chapter 4 Survey Procedures was designed to assist with the detection, delimitation and monitoring of infestations of temperate climate pest snails and slugs in the United States and collaborating territories. Selected species in the gastropod families Arionidae, Cochlicellidae, Helicidae and Hygromiidae are discussed here as these are currently of particular concern, but these guidelines are applicable for most if not all temperate terrestrial gastropods (TTG).

Detection Survey

The purpose of a detection survey is to determine if a pest species exists in an area in which it is ***not*** known to occur. Detection surveys increase the chance of early detection of new pest infestations. A detection survey may be initiated after a specific risk or a pest pathway has been identified.

An ideal detection survey site is a single point identified to be at high-risk introduction of an exotic species. The site may be one property, or may include several property owners. Use the following tools to conduct a detection survey for TTG:

Pest Pathway Analysis

Pest pathway analysis is a pre-survey tool used to identify likely sources of introduction and to help focus survey efforts on specific geographic sites. Survey managers can use this analysis for an initial detection survey or to identify additional infested sites after detection is made. Use the following protocol:

1. Consult import pest interception records available in the Web-based USDA–APHIS–PPQ–Emergency Action Notification (EAN) System. (A user name and password are required to view or enter data in the database.)

Address	USDA–APHIS–PPQ–Emergency Action Notification System https://mokcs14.aphis.usda.gov/aqas/login.jsp

2. Search the records for local ports of entry, noting pest species, commonly-intercepted commodities, and countries of origin. Also query the EAN database and ATS databases for out-of-state Ports of entry that may serve as entry points for high-risk shipments destined for the host state. Review the movement of containers, cargo, and equipment into and from a target site.
3. Use the *Pre-Survey Interview* on page B-4 as a guide to interview importers to gather information on business import practices, and to identify pathways.
4. With the information gained from pre-survey interviews, use the ***Pathway Risk Index for Importers of Tile, Marble, Granite, Travertine, and Natural Stone*** on page B-8 to identify the sites at greatest risk.

For additional information on this topic see *Pathways* on page 9-1.

Targeting and Site Selection

New introductions of temperate terrestrial gastropods will likely be related to commerce and human-assisted movement. For detection surveys, use the information from the *Pest Pathway Analysis* on page 4-2 to develop a list of survey sites to target. The habitat and land-use type of each survey site may be variable, ranging from agricultural land, to residential or industrial features.

Conduct on-site analysis of the survey area to determine any direct points of introduction, such as ports, rail yards, container yards, and cargo distribution centers. Also consider habitats with features snails and slugs prefer, such as vegetated areas, and natural and anthropogenic sources of calcium, including:

- Alkaline soil;
- Limestone quarries and outcroppings;
- Construction sites or dumpsites containing concrete, limestone, or marble;
- Graveyards, headstones, or tombstones; and
- Agricultural fields, orchards or plantations that use lime to alkalize the soil.

Most snail and slug species will thrive in moist vegetated areas. Some species will prefer slightly drier microhabitats, and others such as the wrinkled dune snail *Candidula intersecta* (Poiret) will prefer sandy well-drained soils. Preferences for microhabitats vary with species. Consult the biology of the target pests to identify any habitat or host preference information. If no information is available, or multiple species are targeted, allow surveys to cover a number of diverse habitats. See *Damage to Host Plants* on page 2-4 for related information.

Once target sites are identified for survey, conduct a visual inspection of survey sites. See *Visual Inspection* on page 4-7 for related information.

Sentinel Survey Sites

A sentinel survey site is a fixed location for doing survey inspections on a repeated basis. This method can be used to detect temperate terrestrial gastropods (TTG). Sentinel survey sites were described in Anonymous (2008). According to the source, if a particular area is considered at high risk for mollusk introduction based on pathway studies, surveyors can use their time efficiently by establishing sentinel survey sites in that area. The best sentinel survey sites within the high risk area are chosen based on the biology and preferences of the TTG. Examples of preferred sites include areas of dense vegetation, garbage piles, or calcium carbonate deposits. Use the following protocol:

5. Use Visual Sample Plan Software (VSP) to determine the number of potential sample sites needed (per sentinel site) to detect an infestation within the high risk area (for example, a large rail yard or seaport). Contact Edward (Ned) Jones, USDA–APHIS–PPQ–CPHST, for information on using VSP.

Address	Edward (Ned) Jones USDA–APHIS–PPQ–CPHST Raleigh, North Carolina Telephone: (919) 855-7433

6. Draw a grid around the areas chosen for sentinel site establishment.
7. Record the coordinates.
8. Establish and follow a schedule for inspecting the sentinel survey sites. The schedule should be on a regular time interval that coincides with weather and temperature conditions most suitable for TTG activity. The total number of visits may vary depending on the sample area and the length of time it may take to arrive at the site.

Delimiting Survey

After temperate terrestrial gastropods are detected in an area, use a delimiting survey to establish the magnitude of the infestation. Results from the delimiting survey will be used to determine the type and extent of control measures to apply.

First, establish a survey area by mapping the delimitation zone, based on the previous positive detection(s). The delimitation zone is the survey area where active delimitation sampling is focused.

Procedure

9. Identify the center of the infestation as the epicenter by marking the location of positive detections on a map.
10. Demarcate a circle with a 200-meter radius around each epicenter to define each delimitation zone (*Figure 4-1*).
11. Combine any overlapping delimitation areas. The core infested area is the area included between adjacent detection points (*Figure 4-2*).
12. Discard non-habitat areas such as paved areas or bodies of water (*Figure 4-2*).

13. Enlarge the delimitation zone to include commercial or residential properties where gastropods may have been introduced. Also consider environmental and structural features that create corridors that may encourage natural dispersal.
14. Conduct delimitation surveys in this zone. Deploy line sampling, plot sampling, and/or trapping, within the delimitation zone.
15. Interview property owners of infested areas to determine if any human activities may have contributed to the spread of the species to an adjacent or remote site. Conduct a detection survey at any of these remote sites. See *Detection Survey* on page 4-1 for related information.

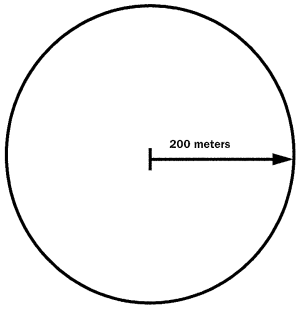

FIGURE 4-1Circle with a 200-meter Radius Around Each Epicenter to Define Each Delimitation Zone

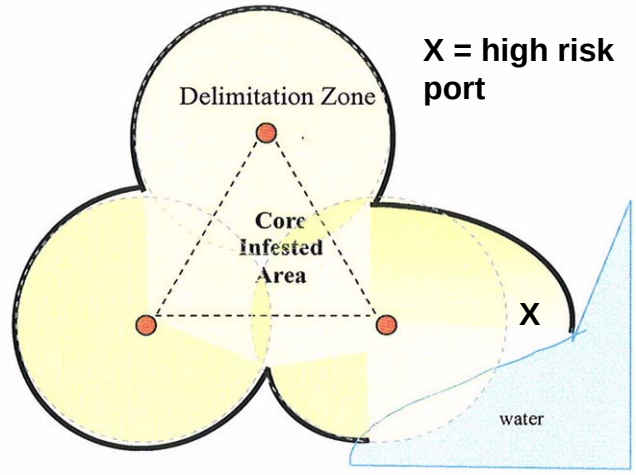

Figure 4-2 Combine any overlapping delimitation areas and eliminate non-habitat such as paved areas or bodies of water. Include areas at high risk.

Monitoring Survey

Use a monitoring survey to gather population and activity information that will assist in planning a strategy for containment, suppression or eradication. The monitoring survey is also used to evaluate the effectiveness of an action taken to contain, suppress or eradicate the pest.

Continue eradication measures for two to four years. After the termination of eradication or suppression measures, monitor the success of the program for one to two years.

Eradication Zones

Use data from delimitation surveys to establish eradication and regulated zones. To plan control strategies and halt the natural and human-assisted spread of the infestation, divide the infested area into separate management zones. See ***Regulatory Procedures*** on page 5-1 for related information.

Conduct a plot survey to determine:

- Density of snails,
- Phenology and seasonal activity of snails,
- Efficacy of treatment, and
- Behavioral or biological responses of snails to treatments.

See *Plot Survey* on page 4-9 for information on conducting a plot survey.

Visual Inspection

WARNING

Consumption of snails and slugs, or of vegetables and fruits contaminated by snails and slugs, may lead to infection by pathogens that are easily transmitted by these pests. Wear rubber or latex gloves when handling gastropods, as well as associated soil, excrement, and other materials that may have come in contact with them. Immediately after removing protective gloves, thoroughly wash hands with hot soapy water and rinse well. Consult a physician if, after handling snails and slugs, you experience symptoms resembling forms of meningitis, including headache, stiff neck, tingling or painful feelings in the skin, low-grade fever, nausea, and vomiting. These symptoms could indicate an infection by *Angiostrongylus cantonensis*, a parasite carried by snails and slugs. These pests may also carry other diseases.

Visual inspection is the most effective method of survey for snails and slugs.

Other survey methods, such as trapping, may be effective at capturing certain temperate terrestrial gastropod species, and may be used as effective supplements to visual methods. See *Trapping* on page 4-12 for more information on platform and baited traps.

One challenge with using visual sampling techniques for TTG surveys is the risk of inconsistent sampling effort. Variability in surveyor experience and habitat type may result in different sampling effort between sites, and may affect the confidence in the results of a survey. To minimize this variability, a survey program should include surveyor field training in visual sampling techniques. Subjectivity of a visual survey can also be addressed through the use of plot sampling, introduced in the following paragraphs. See *Training Survey Personnel* on page 4-14 for more information on training personnel.

Procedure

Use the following survey criteria to standardize visual inspection techniques and increase the chance that targeted snail and slug species will be detected:

16. Conduct visual inspections during the ideal sampling season, and in microhabitats attractive to TTG. See *Targeting and Site Selection* on page 4-2, *Survey Season and Timing* on page 4-11, and *Microhabitats* on page 4-11 for more information.
17. Use a global positioning device if available to determine the coordinates of the survey site or plot. Keep records on all plots surveyed, whether the results are positive or negative.
18. Collect and label any suspect snails or slugs and note the exact location of the find. Note the substrate, microhabitats and plant hosts on the *Snail Detection Survey Data Sheet* on page B-2. See *Collection and Preparation of Specimens* on page 4-13 for additional information.
19. Surveyors must be trained. See *Training Survey Personnel* on page 4-14 for pertinent information.
20. Define survey protocols using time-based line survey or plot survey.

If:	Then use this method of visual inspection:
Quantification is not feasible	Line survey
Standardization and quantification is required for the detection survey	Plot survey
Other	Use *Combined Line and Plot Sampling* on page 4-9

Line Survey

A line survey is a transect across a target property that allows the surveyor the flexibility to choose inspection points likely to shelter TTG. This flexibility is useful for detection surveys, when several target species and habitat types need to be sampled. Line sampling can be used alone when survey resources are low, or can be combined with a plot survey when more quantification is needed, as with delimitation and monitoring surveys.

To conduct a line survey, examine microhabitats that include vegetation, duff, and structures that might serve as diurnal or seasonal refuge sites for TTG. Estimate the survey area, and coordinate line survey routes for each surveyor.

Standardize survey efforts between sites by requiring a minimum survey time. Require a minimum of one survey hour per two-acre site. Each survey hour is the sum of active survey time spent by each surveyor.

Example — A 4-acre field surveyed by two technicians would require each person to actively survey for a minimum of one hour.

Plot Survey

Use the plot survey method if further standardization and quantification is required. A plot is a small, defined area (for example, 1 square meter) that is used to conduct detailed, standardized subsampling throughout a target site. This method is effective for detecting immature and minute TTG species. See *Accuracy* on page 4-9 for a statistical application of this method.

Construct a plot template of any size that is easy to use. A template is a precisely measured, reusable tool used to define a plot sample. Use PVC tubing or wood to construct a lightweight template. A square template measuring 1 meter on each side is easy to use, but the size can be adjusted to fit the goals of the survey program.

To begin surveying, randomly toss the template into the habitat. Stand outside of the plot while examining rocks, boards, litter, vegetation and other structures within the plot. Look under leaves, duff, and at the base of plants. Spend a standardized minimum amount of time surveying each plot. Repeat four times per acre of target property. Do ***not*** overlap plots in a survey site.

Accuracy—Using the plot sampling method, visual survey can be statistically supported. For example, to report with 95 percent confidence that less than 1 percent of the delimitation zone is infested, a minimum of 330 negative plot samples need to be gathered within the delimitation zone. To standardize and quantify the survey, the following protocols are required:

- Surveyors must be trained in survey procedures (*Training Survey Personnel* on page 4-14),
- Plot samples ***cannot*** overlap,
- Plot samples must be searched for a minimum time of five minutes per plot, and
- Surveys must be conducted during the ideal sampling season (*Survey Season and Timing* on page 4-11).

Combined Line and Plot Sampling

Detection Survey—If the target property is small (less than one acre), conduct one plot sample and then line survey the entire property.

By using both methods, the surveyor has the benefits of each, including the flexibility and swiftness of the line survey and the statistic supportability of the plot survey.

Delimitation Survey—Use a combined line and plot sampling method to survey within the delimitation zone. See *Targeting and Site Selection* on page 4-2 for information concerning site selection, environmental factors, and local conditions. One efficient method is to assign surveyors a survey route.

Use the survey route method to ensure different areas of the delimitation zone are covered and ***not*** overlapping. While walking between plot sites, surveyors should use visual line sampling techniques.

21. Place a 1 square meter template at least 25 meters apart, targeting likely habitat (i.e., vegetation, daily refuge areas, etc).
22. Examine the entire area within the 1 square meter plot for a minimum of 5 minutes. Inspect any surface substrate or vegetation, especially under leaves, rocks and in the whorl of plants.
23. Collect any suspect TTG found. Place specimens in a sealed vial with water and label. Label should include the site name, transect number, plot number and date. Collect the same information on the survey report form. Note the exact location of the longitude/latitude for **each plot** with a GPS.
24. Records should be kept on each plot, even if no specimens were collected.
25. Consult the following sections within this NPRG: Specimen Handling, Labeling Samples, and Sample Submission Procedures. Lab screening will confirm identification of snails and slugs and verify live/dead status. Other information will be gathered on address, ownership, and habitat type.
26. Conduct plot sampling survey within the delimitation zone until 330 plots have been taken with negative results (no target TTG were found).

If:	Then:
No target TTG were found	Continue sampling plots within the delimitation zone until 330 plots have been sampled.
New positive collections of snails and slugs are found within this area	Add a new 200-meter radius circle to the existing delimitation zone and plot a new survey.

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Figure 4-3 Left: Platform Trap (left) and Plot Survey Tool (right). Right: Platform Trap.

Survey Season and Timing

Most species of TTG are active during nocturnal hours, when environmental conditions are cool and wet. Some species may also be active during daylight, especially during overcast and rainy days in the Spring and Fall. During dry, hot periods, TTG species will seek shelter in cool, moist places shaded from the sun. Refuge preferences can differ between species. Slugs can be found in refuges such as cracks in mud, under rocks, in tree crevices, and under refuse. During extended periods of drought, slugs may move deep into the soil or refuge structure, too deep to be observed during a visual survey. If possible, plan surveys during spring and summer, and during early morning and overcast days.

In hot and dry environments, some snails will estivate to survive. Several snail species have the ability to survive long periods of dry conditions by withdrawing into their shell and sealing the opening with a mucus membrane or epiphragm. Several hygromiid and helicid species will climb rock walls, vegetation and fences to escape high ground temperatures. These snails can attach themselves to the elevated surfaces and estivate until more favorable environmental conditions return. Surveys for these species should be directed at plant stems, fence posts, and other elevated surfaces.

Some species of TTG are difficult to identify in juvenile form. Mature adult specimens possess genitalic features that can help differentiate closely-related species. If possible, plan survey activities during the time when adult life stages are present. If phenology of target species is not known, surveys should be conducted in both spring and fall, when environmental conditions are ideal.

Microhabitats

Terrestrial snails and slugs may be found in cool refuges, near vegetation, under rocks, boards, and refuse. Some also climb into sheltered areas, such as tree crevices, and plant canopies. In some crops, such as vineyards and orchards, tree canopies serve as a cool refuge site for some snail species.

For survey, examine vegetation, and the underside of a variety of structures, refuse and litter, that is in contact with the ground. If the structure is safely movable, the item should be lifted and the underside examined for TTG. Most snails and slugs require calcium for proper formation of the shell and for successful reproduction in creating new eggshell for their offspring. Snails obtain calcium from numerous sources in the environment. Calcium carbonate ($CaCO_3$) can be found in alkaline soils. Plants also provide a store of calcium silicates where free calcium is not readily abundant in the soil. In large populations, snails obtain mineral content from the empty shells of dead snails. When planning the survey route for a particular site, examine the following microhabitats:

- Near heavily vegetated areas, especially gardens and fields where plants have been damaged by feeding;
- Under rocks, asphalt or cement pieces that are in loose contact with the ground surface;
- Discarded wooden boards and planks, fallen trees, logs, and branches;
- Damp leaf litter (not wet or soggy), compost piles, and rubbish heaps.;
- Under flower pots, planters, rubber mats, tires and other items in contact with the soil; and
- Standing rock walls, cement pilings, broken concrete, grave markers.

While conducting a survey, look for clues that suggest the presence of terrestrial snails and slugs. Evidence may include the following:

- Snails, juveniles and adults;
- Eggs;
- Empty snail shells;
- Mucus and slime trails; and
- Ribbon-like feces.

Trapping

Although visual inspection is the recommended method for surveys, other methods can also be employed. Use platform and baited traps to supplement visual inspection.

Platform Traps

Use platform traps as artificial diurnal refuges for TTG. Platform traps are square cardboard or wood sheets, placed directly on the ground. If target species include large snails or slugs, the platform can be elevated one inch off the ground (*Figure 4-3*). Platform traps may be used for repeat monitoring at high-risk sites, or where existing refuges are lacking (for example, open fields) and or difficult to survey (brambles, dense grass). This method may not be effective for some target species.

Baited Traps

Make a baited trap for TTG by placing a food attractant inside a cup or bowl set into the ground. Use one of the following dry or wet feeding attractants:

- Bran,
- Molluscicide,
- Beer, or
- Other preferred food source.

Bran-based baits are generally attractive to TTG, but also attract mammals and arthropods. Dry molluscicide baits are also commonly used to attract and kill snails and slugs in back yard environments. Unfortunately, TTG that ingest the pesticide are not killed immediately, nor are they contained in the trap after feeding. Beer is generally effective at attracting and trapping many slug species; unfortunately, they are not effective for trapping many target species of exotic snails. Another trapping strategy uses trap crop stations, which involve placing a preferred food source such as lettuce or fruit at the site and examining daily.

Collection and Preparation of Specimens

⚠ WARNING

Consumption of snails and slugs, or of vegetables and fruits contaminated by snails and slugs, may lead to infection by pathogens that are easily transmitted by these pests. Wear rubber or latex gloves when handling gastropods, as well as associated soil, excrement, and other materials that may have come in contact with them. Immediately after removing protective gloves, thoroughly wash hands with hot soapy water and rinse well. Consult a physician if, after handling snails and slugs, you experience symptoms resembling forms of meningitis, including headache, stiff neck, tingling or painful feelings in the skin, low-grade fever, nausea, and vomiting. These symptoms could indicate an infection by *Angiostrongylus cantonensis*, a parasite carried by snails and slugs. These pests may also carry other diseases.

Specimen Handling

When collecting live samples, specimens should be placed directly into water and sealed for 24 hours or until drowned, then transferred to 70 percent ethyl alcohol. Replace the water with a 70 to 80 percent alcohol solution after the snail has extended from the shell. Label the container with the appropriate information.

Labeling Samples

Collection information is vital and should be completed immediately after a collection is made. Write directly on the collection container or on a paper label. Write the date, collector's name, and location, including any transect and plot numbers. If multiple vial samples are collected from a location, assign individual sample numbers. When transferring the specimens to alcohol, ensure the label accompanies the sample.

Sample Submission Procedures

Submit suspect TTG specimens according to sample handling guidelines. All snails and slugs found will be collected and placed in vials of water with a collection label. All collected specimens should be mailed or taken to an area malacologist for screening and identification. When submitting specimens for identification to PPQ, complete ***PPQ 391 Specimens For Determination*** on page B-10 and include with the specimen. If special preparations are necessary, the area identifier will perform these techniques in consultation with the National malacologist.

Training Survey Personnel

Although visual inspection is very effective, the subjective nature of visual inspection, variability in habitat types, and differences in survey technician experience level, may cause a challenge with standardizing detection survey efforts between sites. To minimize this variability, a survey program should include surveyor field training in visual inspection techniques.

Due to the reliance on visual observation for a TTG survey, standardized protocols should be used by all surveyors. Sufficient time should be allowed for training in survey methods. Use defined experience levels (*Table 4-1*) to stratify surveyor responsibilities.

TABLE 4-1 Defined experience levels

Level	Description
Untrained	No prior TTG training or survey experience.
Trained	Trained and with survey experience at three or more sites.
Skilled	Trained and with survey experience at 20 or more sites.
Expert	Trained and with survey experience at 100 or more sites over multiple seasons and in variable habitats.

New surveyors who lack training and survey experience should only survey in tandem with another surveyor. Only after a surveyor has been trained should they be authorized to survey independently. Conduct in-field training when possible to encourage standardized survey techniques. Training should address the biology, life history, and behavior of TTG. Discuss details of site selection, habitat selection, identification, specimen handling, data collection and sample submission procedures. Adequate training on the various survey techniques, sampling procedures, and data management will likely require two to three working days. Some of the topics to cover in a training session include the following:

- Snail and slug biology,
- Target species,
- Survey methods,
- Specimen labeling,
- Specimen submission,
- Data collection procedures,
- Safety issues and concerns,
- TTG identification (if taxonomic screening),
- Personnel requirements (time records, travel vouchers, etc.), and
- Equipment assignment.

Surveyors will require the following equipment:

- Forceps (soft),
- Large permanent marker,

- Collecting vials with water-tight caps,
- Water (1 gallon),
- Blank collection labels,
- Survey forms,
- GPS unit,
- Disposable vinyl gloves,
- Plot sampler (PVC for m^2 samplers),
- Resealable bags,
- Platform traps,
- Boots,
- Magnifying lens,
- Resealable freezer bags,
- Pocket notebook,
- Scoopula spatula, and
- Rain clothing.

Survey Records

Records should be kept for each survey site. Negative survey data must be recorded even if ***no*** TTG are found or ***no*** samples are collected at a surveyed site. Survey records and data recording formats should be consistent, to allow for standardized collection of information.

If automated field collection devices are used, such as the Integrated Survey Information System (ISIS), ensure that all surveyors are training in the technology before beginning survey. Use appropriate ISIS templates for TTG survey type. To reduce the burden on field data collectors, pre-enter any known contact or address information into the database and hand-held data recorders. At the end of the survey, all survey data should be entered into a designated State or National pest database.

For specific directions on how to access the ISIS template for snail and slug pests, contact ISIS Customer Support.

Address	Telephone: 866-910-9091 Email: ISIS.Support@aphis.usda.gov ISIS Web portal http://ppqcoop.aphis.usda.gov/web/Default.aspx?alias=ppqcoop.aphis.usda.gov/web/isis

Chapter

5

Regulatory Procedures

Contents

Introduction

Use *Chapter 1 Regulatory Procedures* as a guide to the regulations that must be followed by personnel when conducting pest survey and control programs against temperate climate pest snails and slugs in the United States and collaborating territories. Selected species in the gastropod families Arionidae, Cochlicellidae, Helicidae and Hygromiidae are discussed here as these are currently of particular concern, but these guidelines are applicable for most if not all temperate terrestrial gastropods (TTG).

Instructions to Officers

Officers must follow instructions for regulatory treatments or other procedures when authorizing the movement of regulated articles. Understanding the instructions and procedures is essential when explaining procedures to persons interested in moving articles affected by the quarantine and regulations. Only authorized treatments can be used in accordance with labeling restrictions.

Find instructions for regulatory treatments in the *PPQ Treatment Manual*. If a regulatory treatment does not appear in the manual, the proposed treatment must be reviewed and tested by CPHST treatment specialists.

Address	*PPQ Treatment Manual* http://www.aphis.usda.gov/import_export/plants/manuals/ports/treatment.shtml

Issuing an Emergency Action Notification

PPQ 523 Emergency Action Notification on page B-12 can be issued pending positive identification or further instruction from the USDA–APHIS–PPQ Deputy Administrator.

If necessary, the Deputy Administrator will issue a letter directing PPQ field offices to initiate a specific emergency action under the Plant Protection Act of 2000 until emergency regulations can be published in the *Federal Register.*

Emergency Quarantine Action

The Plant Protection Act of 2000 provides for authority for emergency quarantine action. This provision is for interstate regulatory action only. Intrastate regulatory action is not Federally mandated and provided under State authority.

However, if the Secretary of Agriculture determines that an extraordinary emergency exists and that the measures taken by the State are inadequate, USDA can take intrastate regulatory action provided that the governor of the State has been consulted and a notice has been published in the *Federal Register.*

If intrastate action cannot or will not be taken by a State, PPQ might find it necessary to quarantine an entire State.

Access to Private Property

PPQ works in conjunction with State departments of agriculture to conduct surveys, enforce regulations, and take control actions. PPQ employees must have permission of the property owner before accessing private property.

If an extraordinary emergency is declared or if a warrant is obtained, PPQ can enter private property without owner permission. PPQ prefers to work with the State to facilitate access when permission is denied; however, each State government has varying authorities regarding accessing private property. A General Memorandum of Understanding (MOU) exists between PPQ and each State. PPQ officers must have permission of the owner before accessing private property. For clarification, check with your State plant health director (SPHD) or State plant regulatory official (SPRO) in the affected State.

Cooperation With Tribal Governments

PPQ works with Federally recognized Indian tribes to conduct surveys, enforce regulations and take control actions. Each Tribe stands as a separate governmental entity (sovereign nation) with powers and authorities similar to State governments. Permission is required to enter and access Tribal lands.

Executive Order 13175, Consultation and Coordination with Indian and Tribal Governments, states that agencies must consult with Indian Tribal governments about actions that may have substantial direct effects on tribes. Whether an action is substantial and direct is determined by the tribes. Effects are not limited to current Tribal land boundaries (reservations) and may include effects on off-reservation land or resources which tribes customarily use or even effects on historic or sacred sites in States where tribes no longer exist.

Consultation is a specialized form of communication and coordination between the Federal government and Tribal government. Consultation must be conducted early in the development of a regulatory action to ensure that tribes have the opportunity to identify resources which may be affected by the action and to recommend the best ways to take actions on Tribal lands or affecting Tribal resources. Communication with Tribal leadership follows special communication protocols.

For additional information, contact PPQ's Tribal liaison or visit the Web site of the APHIS Native American Working Group. To determine if there are sacred or historic sites in an area, contact the State Historic Preservation Officer (SHPO).

Address	APHIS Native American Working Group http://www.aphis.usda.gov/anawg
Address	State Historic Preservation Officer http://www.nps.gov/history/nr/shpolist.htm

Guidelines for Gaining Compliance From Industry and Property Owners

Conducting surveys and taking actions to stop movement of potentially infested articles or conveyances will require cooperation from land owners or managers. The issuance of an Emergency Action Notification may not always be necessary if cooperation can be gained. In order to enhance efforts to control TTG, it is critical to gain cooperation and compliance from the parties

involved at the new or existing infested site. The parties involved can vary from large corporations and industry such as rail companies to small property owners.

The first step is to make contact with the property owner or company that has or may have an established population of TTG. This ensures that you are dealing with the person who has authority to speak and act for the company. Follow the company's chain of command. If you encounter resistance, you may have to go higher in their chain of command.

Send an email or letter to gain permission to survey the property. This allows the property owner to understand your authority. After an exotic snail is found on the property, verify its identification. Send a letter of confirmation and arrange to meet.

Before the meeting, conduct research to learn more about the client's business and how the exotic snails will impact them. In the worst case, they will be directly impacted and will have to be regulated by USDA–APHIS–PPQ.

During the meeting, discuss the pest and why it is of concern. Most people are unaware that snails can be important pests. If the company needs to be regulated, discuss with them what they can do to resolve this issue. If cooperation with a control program is achieved, they will no longer be regulated and the result will be the same but done in the spirit of cooperation. In every meeting, use science-based arguments yet be flexible to gain compliance.

Ask clients about their property management in order to identify existing practices that can enhance control of the snails. This lessens the financial impact on the company and only requires fine-tuning. For example, vegetation management can be used to do habitat alteration that will increase the effectiveness of treatments performed. Companies may already have plans, such as paving areas, expanding buildings or other site alterations. These can be used to the advantage of snail management, as long as snails are not moved during the process. Do not hesitate to ask what they can and are willing to do to help with snail control. These may include purchasing and applying molluscicide bait, habitat modification (weed maintenance, debris removal) and additional control methods that can be implemented based upon unique site characteristics.

Many meetings, site visits, emails and calls may be required so that PPQ and the property owner are both working together to achieve the common goal of eradicating these invasive pests. Always be available to answer any question or concerns and address them in a timely manner. Always thank them for their efforts and cooperation. There is no set way to handle every company or

landowner that is involved. By doing research, working with existing practices and having a cooperative approach, a company or property owner can greatly increase your chances of success in managing a snail control program.

Use the ***Snail Detection Survey Data Sheet*** on page B-2 and ***Pre-Survey Interview*** on page B-4 as job aides when working with clients.

Potential Regulated Articles

Regulated articles may include any product, article, or means of conveyance, of any character whatsoever, when it is determined by an inspector that they present a hazard of spread of snails and the person in possession thereof has been notified. Depending on the species and risk situation at a site, the following articles may present a risk of dissemination of snails or snail eggs:

Plant Material—

- Preferred food plants in the regulated area
- Crops harvested from quarantine areas
- Crops harvested from high-risk crops
- Potted plants rooted in soil or media[1]
- Compost
- Forest products (leaves, needles, wood, mushrooms)
- Vegetation used as packing material
- Nursery stock
- Sod

Soil and Building Materials—

- Bricks, blocks, and tiles
- Concrete
- Compost
- Soil from the infested area
- Sand
- Stone, gravel, and rocks

Miscellaneous Items—

- Cargo transportation conveyances (containers, truck trailers, railcars)
- Discarded household or yard items
- Containers
- Manure
- Used equipment

1 Plants may be removed and washed with pressure sprays to facilitate visual inspections. Plants that pass inspection can be repotted in sterile media, certified, and sold or shipped

Regulated Establishments

Field personnel will attempt to detect these pests within the regulated area at all establishments where regulated articles are sold, grown, handled, moved, or processed. Establishments may include the following:

- Ports, container yards, rail yards;
- Airports;
- Landfill sites;
- Processing plants;
- Vehicle depots;
- Sod and soil firms;
- Farmers' produce and flea markets;
- Nurseries;
- Flower shops;
- Schools;
- Swap meets;
- Pet shops; and
- Any other establishments that handle regulated articles.

Regulatory Procedures

Surveys may be set up at establishments deemed to be at risk by project personnel. Set and service two traps baited with a molluscicide, or equivalent, per establishment. Service traps daily if catches of snails are great, or every week if trap catches are few.

Property Survey

Set traps on properties in the regulated area on which snail detections have been made when snails are active. This includes periods of rainfall, after rains, or on properties where watering or irrigation will keep the snails active. See ***Survey Procedures*** on page 4-1 for related information.

Use of Pesticides

The *PPQ Treatment Manual* and this document identify authorized pesticides, and describe methods, rates of application, and special application instructions. Concurrence by PPQ is necessary before using any other pesticide or procedure for regulatory purposes. See ***Laws Pertaining to Pesticide Use*** on page 6-1 for related information.

Approved Treatments for Regulatory Articles

Approved regulatory treatments for temperate terrestrial gastropods are determined by program management or a technical panel in conjunction with the USDA–APHIS–Center for Plant Health, Science, and Technology (CPHST). Find directions for utilizing the treatments in the *PPQ Treatment Manual*.

Address	*PPQ Treatment Manual* http://www.aphis.usda.gov/import_export/plants/manuals/ports/treatment.shtml

Apply the following approved treatments before removing or moving regulated articles from a quarantine area:

Cold Treatment—Application of cold temperatures lethal to a target snail (below the biological threshold or for a time period beyond the snail's ability to endure). May be used alone or in combination with fumigation.

Fumigation/Cold Treatment—Application of an approved fumigant in conjunction with cold treatment procedures.

Fumigation/Vacuum—Application of an approved fumigant in conjunction with vacuum procedures.

Sanitation—Removal and destruction of leaves, flowers, stems, stalks, rotting or fallen fruit, vegetables, and other food plant material.

Soil Treatment—An approved molluscicide applied to the soil within the drip line of food plants. Hold plants for one week after treatment before certifying for movement after reinspection.

Principal Regulatory Activities

The degree of regulatory activity required depends, among many other factors, on the degree of the infestation. For example, it may not be necessary to safeguard vegetable stands throughout the regulated area if they are engaged in local retail activity only and the infestation is limited.

Regulatory Inspection for Snails and Slugs

Make a thorough inspection of all material and personal household effects prior to movement from a known snail area to any designation. Because of the tendency of snails to hide, inspect the interior as well as the exterior of containers, when likely entry holes are noted. The smaller snails resemble ordinary pebbles, in color, markings and size. Therefore, a significant infestation could be overlooked on a superficial inspection of contaminated articles. The presence of snails may be indicated by a faint slime trail.

Boxes, particularly when they have been in contact with soil, offer a number of havens for snails: bottom runners (some of which are hollow), life hook slots, and holes in weathered boxes. Closely examine all sides of each likely item, noting any cracks, crevices, or other areas not readily observable. Fork lifts will frequently be required in order to inspect bottoms of boxes, crates, and the heavier articles.

Steel cylinders present good hiding places: under the screw cap and adhering to the pallets of which the cylinders are often fastened. Pipes of all types are especially attractive to snails since caps or plugs are seldom feasible.

In the case of half-tracks, cranes, and other heavy equipment, steam or water-jet cleaning is recommended in lieu of or in addition to examination. In the examination of ships before loading, attention should be given to the bottom of holds and ledges around the sides.

Hold bulkheads near the engine room, being warmer, are favored snail sites. Snail-free cargo should never be loaded until holds have been thoroughly inspected and found or made snail-free.

Additional Factors Involving Movement

Equipment (fork-lifts, tractor-trailers, trucks, and rail cars) and materials (pallets, dunnage, and tarpaulins) utilized in the storage and transportation of supplies must be snail-free. When not in use, equipment and materials should

be returned to snail-free areas. Equipment and materials that are utilized to handle or transport snail-infested supplies should not be utilized to transport snail-free cargo unless it has been fumigated.

To prevent the contamination of military or commercial cargo carried during the movement of supplies from one location to another, limit shipments to snail-free cargo.

Household Movement

Establish adequate procedures to prevent snail stowaways in personal household effects of military and civilian personnel. Packing should be accomplished indoors or in a place equally secure from snails. Lawn furniture, garden hoses and tools, sporting goods (boats, motors, etc.), bicycles, motor scooters, and utility trailers that are allowed to remain outdoors must be fumigated before packing for shipment from snail infested areas.

Household furniture and packing materials should never be placed on the ground or lawns while being prepared or packed for shipment.

Yard and Landscape Maintenance

Such companies may need to be under compliance agreement if their activities present a risk of dissemination of snails or snail eggs in the course of their normal work. After training of workers, compliance agreements can be implemented detailing the conditions and precautions companies and their employees must adhere to safeguarding the movement of potentially infected plant materials, machinery, vehicles, or tools.

Snail-Free Storage Areas

Only snail-free supplies, equipment, or vehicles should be stored in warehouses or permitted access to snail-free storage areas. Infested, noninspected, or untreated items should never be mixed with snail-free cargo in storage or in transit.

Snail-free storage areas should be established at those installations where large quantities of items are stored in open areas. The snail-free area will serve two purposes:

- Incoming snail-free items can be stored to prevent infestation, and
- Noninspected or untreated items that are scheduled to be moved can be decontaminated several weeks before the scheduled shipping date and placed in the snail-free area.

See ***Treatment Zones*** on page 6-6 for related information concerning the creation of snail-free areas within storage areas of rail yards or ports.

Transporters and heavy equipment including buses, trains, trucks, bulldozers, etc., when not in use must be stored in snail-free areas to prevent infestation. Containers have been a major source of snail interceptions at the ports of entry in the past. They must not be stored or allowed to remain on the open ground. Cargoes or household effects infested with snails should never be packed in containers for shipment.

Interior Storage

Supplies, equipment, and vehicles coming in from outside the regulated area should be stored in warehouses. Land snails do not normally enter buildings to estivate, therefore, enclosed structures provide the greatest protection against infestation.

Exterior Storage

If warehouses are not available, use paved open storage. However, such areas must be protected by a sound, aggressive, and continuous snail control program. Areas covered with asphalt or concrete provide the most suitable and lasting types of ground cover for storage areas, and less maintenance will be required.

However, in the event neither warehousing nor paved areas are available for supply storage, it will be necessary to construct an area of suitable storage. Concrete or asphalt is preferred, but crushed stone may be utilized. A layer of crushed stone six inches or more deep should be laid on the soil. The depth will depend on the soil conditions.

Ground Maintenance Equipment

Equipment utilized in ground maintenance work must not be parked, stored, or left idle in snail infested areas. Clean and return equipment to a protected storage area at the end of each work day to prevent further spread of the snails.

Principal Activities

Principal activities for conducting a regulatory program to contain snails include the following:

1. Advise regulated industry(ies) of required treatment procedures.
2. Supervise, monitor, and certify commodity treatments of commercial lots of regulated articles.
3. Make regulatory visits to the following:
   - ❖ Security and airline personnel
   - ❖ Soil and sod firms
   - ❖ Vegetable stands
   - ❖ Flower stands
   - ❖ Local growers, packers, and processing plants
   - ❖ Farmer's associations, produce markets, and flea markets
   - ❖ Local vehicle and maintenance depots, vehicle fleet operators
   - ❖ Local building contractors
   - ❖ Local vehicle dealers, garages, service stations
   - ❖ Truck and trailer rental firms
   - ❖ Commercial haulers of regulated articles
   - ❖ Public transportation
   - ❖ Post offices
4. Visit warehouses, canneries and other processing and storage establishments.
5. Monitor the movement of waste material to and from landfills to ensure adequate disposal of regulated articles.
6. Monitor the movement of regulated articles through major airports and other transportation centers.
7. Observe major highways and quarantine boundaries for movement of host materials.

Removing Areas From Quarantine

Project managers should identify and remove areas from quarantine requirements after the snail is declared eradicated from those areas.

Eradication is achieved when sufficient time, equal to two years, has passed since the last specimen recovery. Regular monitoring and control will help to minimize a population increase. At a minimum, one year must elapse after

control activities have ceased. APHIS will publish a Notice of Quarantine Revocation in the *Federal Register* when areas are removed from quarantine requirements.

Chapter

6

Control Procedures

Contents

Introduction

Use *Chapter 6 Control* to learn more about the methods used to eradicate an infestation of temperate climate pest snails and slugs in the United States and collaborating territories. Selected species in the gastropod families Arionidae, Cochlicellidae, Helicidae and Hygromiidae are discussed here as these are currently of particular concern, but these guidelines are applicable for most if not all temperate terrestrial gastropods (TTG).

Laws Pertaining to Pesticide Use

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) authorizes the Environmental Protection Agency (EPA) to regulate pesticides. All persons using and applying pesticides should understand the laws pertaining to pesticide use and application. The following are provisions of FIFRA that are most pertinent to emergency pest control programs:

- Restricted use pesticides must be applied by a certified applicator,
- Use of any pesticide inconsistent with the label is prohibited, and
- Violations can result in heavy fines or imprisonment.

States can register pesticides on a limited basis for special local needs according to the following Sections:

- ***Section 18***—EPA administrators can exempt federal or state agencies from FIFRA if it is determined that emergency conditions exist that require such exemptions; and
- ***Section 24e***—A state can provide registration for additional uses of federally registered pesticides formulated for distribution and use within that state to meet special local needs in accordance with the purposes of this act.

For additional information concerning exemptions, see *PPQ Emergency Programs Manual*, Section 14.

Address

PPQ Emergency Programs Manual, Section 14
http://www.aphis.usda.gov/import_export/plants/manuals/emergency/downloads/epm.pdf

Contact staff at PPQ–EDP–Environmental Compliance to be sure that any pesticide being considered as part of an eradication program conforms to pesticide use requirements. Obtain all required environmental documentation before beginning.

Address

USDA–APHIS–PPQ–Emergency and Domestic Programs
Environmental Compliance
4700 River Road, Unit 150
Riverdale, MD 20737
Telephone: 301-734-8247

Environmental Monitoring

Environmental monitoring is an important consideration in all programs. Contact staff at PPQ–EDP–Environmental Compliance to learn if environmental monitoring is required. Environmental Compliance staff may evaluate the environmental impact of controls by monitoring the following:

- Water, to detect insecticide levels resulting from direct application, leaching, and runoff;
- Soil, to determine insecticide levels and residues;
- Foliage, to identify residues;
- Non-target organisms before, during and after applications, to determine impact of pesticides; and

- Air, to determine presence of residual airborne pesticides.

Address	USDA–APHIS–PPQ–Emergency and Domestic Programs–Environmental Compliance http://www.aphis.usda.gov/regulations/index.shtml

Efficacy of Treatment

Continue eradication measures for two to four years. After the termination of eradication or suppression measures, monitor the success of the program for one to two years. See *Monitoring Survey* on page 4-6 for related information.

Site Assessment

Site assessment is the foundation of snail and slug control. Consult survey records prior to treatment. Interview all persons for relevant information on site history and property ownership. Information gained from the property owner may help to locate the source of infestation, or other sites where TTG remain undetected. Contact the area identifier to learn more about identification and characters of similar appearing species.

Address	Lists of PPQ Area Identifiers and National Specialists in PPQ *Manual for Agriculture Clearance*, Appendix G http://www.aphis.usda.gov/import_export/plants/manuals/ports/downloads/mac_pdf/g_app_identifiers.pdf

Assessment for modes of artificial and natural movement from a site is important during this stage. Review *Pest Information* on page 2-1 as well as recent research findings to learn more about behavior, life cycle and other information that may be useful in the control process. See ***Snail Detection Survey Data Sheet*** on page B-2 and ***Pre-Survey Interview*** on page B-4 for similar assessment job aides.

Site Visit

Communicate frequently with the person responsible for the site. Keep a log of your observations at the site. Mark areas with invasive species with flags or ribbon; record GPS readings or use other electronic devices. Take notes on who owns the property. In many cases more than one property owner is involved and research needs to be performed to gain this information. Much of this information may have already been recorded during survey investigations.

Use the answers to the following questions to prepare a status report:

- ☐ Is the terrain sloped or flat?

- ☐ Is there a source of calcium carbonate?
- ☐ Are water sources nearby?
- ☐ What is the property used for?
- ☐ Is the area secure?
- ☐ Does the area contain debris, trash or other obstacles?
- ☐ Does the area contain an overgrowth of weeds and brush?
- ☐ Are any hot zones close to other properties (for example, intermodal container yard or freight forward business)?
- ☐ What is the general condition of the property?
- ☐ Are snails climbing weeds, high brush or into trees?
- ☐ Are there modes for artificial movement at the site that need to be addressed to prevent movement? (See *Issuing an Emergency Action Notification* on page 5-2 for related information.)
- ☐ Are sensitive flora and fauna present at the site? (See ***Endangered Species Act*** on page 7-2 and ***Other Laws*** on page 7-3 for related information.)

Classification

Development of a control plan depends on the type of property infested. Site access, security, containment, and ownership type may dictate a particular direction in eradication options. Prepare a concise overview of the infested area. This means recording information about the infested property, including the following:

- ◆ Location;
- ◆ Type of property ownership (government, private, tribal, commercial, residential or agricultural);
- ◆ Current and past property uses;
- ◆ Snail distribution;
- ◆ Status of security and containment; and
- ◆ Modes of artificial movement.

Mapping

Prepare a detailed map of the infested site, pinpointing the location and severity of infestations of TTG. The map should include as much information as possible, such as acreage, roads, tree lines, water sources, property uses, and GPS coordinates. Map the property lines to indicate different property owners.

The use of aerial maps can save time. Many resources are available, such as Google Earth™. Aerial maps can be used in a graphics computer program to indicate details. ArcMap® can be used to produce excellent detailed maps. If

possible, consult your regional GIS personnel. They can produce detailed maps.

See an example of a site map in *Figure 6-1*.

Figure 6-1 Example of a map using grids to divide infestations into manageable units

Safeguarding Against Artificial Movement

Artificial movement occurs when pests are moved by cargo, conveyances, or passengers. Snails and slugs can hitchhike on many objects ranging from intermodal containers to nursery stock. When new infestations are found, search the site for items that might serve as carriers. After risks have been identified, immediately implement plans to prevent future spread. These risks need to be reviewed and some traceback work performed to insure movement has not occurred prior to the discovery of the infestation.

Each container in the infested area should be lifted by yard personnel and examined by an inspector. Do ***not*** go underneath a container when it is lifted off the ground. Use a flashlight to look at all areas under the container. When snails or slugs are found, use a long extension pole to remove them. Crush or

dispose of snails after the container has been removed. The container can be stored in an area free of snails. Apply a barrier of rock salt between the infested area and the TTG-free area. See *Salt* on page 6-11 for related information.

All objects of risks in an infested area become a regulated item and steps need to be taken to eliminate the TTG. An Emergency Action Notification may need to be issued to insure compliance and remove risk. By safeguarding risks the focus then can be on treatment plans and zones. See ***Issuing an Emergency Action Notification*** on page 5-2, and ***PPQ 523 Emergency Action Notification*** on page B-12 for related information.

Treatment Zones

Zones or grid areas can be implemented for containment strategies. The use of zones can be done for the total infested area or broken down to the level of property owner. The cost of a quarantine as well as the size of the infestation could require prioritizing treatment zones. Site zoning can be designed to meet the need specifically.

Primary Inner—The primary inner zone is the point of introduction and is also known as the core area. It is a source of information on introduction and possible spread where the TTG population is most heavily concentrated.

Primary Outer—The primary outer zone is characterized by a random distribution of TTG.

Secondary—The secondary area (also known as the barrier area) is crucial for containment and should be addressed first. Treat the outside of the infestation and then work inward.

Tertiary—The tertiary zone is characterized by the absence of TTG.

Treatment Options

Treatment may include the application of the following:

Molluscicides—Several products and formulations are effective. See *Molluscicides* on page 6-7 for more information.

Cultural Control—Cultural control methods used in combination with chemical control is the most effective treatment regime against this group of snail pests. See *Cultural Controls* on page 6-10 for more information.

Biological Control—Currently, there are no effective, specific non-invasive biological control methods available for control of TTG.

Eradication of snail species may be most feasible in port, railyard, or nursery environments. If adjoining neighborhoods or natural areas are generally infested, it may only be possible to maintain suppression or local eradication in these situations. A snail eradication program in residential or natural areas must be seriously considered because of the public outreach necessary to gain cooperation, the resources required to be successful, and the impacts of pesticides applied in these environments. The risk of the particular species spreading to agricultural areas of causing significant damage in residential and natural area must be balanced with the risk of control activities.

Formulate a treatment plan addressing specific issues based on the site classification and types of resources needed to complete the treatment.

Consider the following:

- All activity in infested area,
- Available resources and contacts,
- Need for counter measures, and
- Cooperation of property owner.

Widespread or random infestations may warrant treatment zones.

Molluscicides

At the initiation of an eradication or suppression program, evaluate all available molluscicides. Select a molluscicide after considering local conditions, survey results and efficacy of available products.

The labels for several products have been amended by their manufacturer to include non-crop areas such as rail yards, ports, and right-of-ways. Check also for registrations to assure the compound you have chosen is registered for use in the State where applications are taking place.

Use the highest rate allowed by the label in first time treated areas. Depending on the population levels, several repeated applications may be necessary in a particular area within a season or over the course of years in order to achieve effective eradication or suppression. Monitoring for snail mortality and population resurgence is an important consideration when deciding to make additional applications. See *Monitoring Survey* on page 4-6 for related information.

Prepare a Categorical Exclusions for National Environmental Policy Act (NEPA) compliance for each site or property owner where treatments will be performed. See ***National Environmental Policy Act*** on page 7-2 for more information.

Application

Strategy in control approaches must be flexible since infested sites and setting can vary greatly. Types of infested conditions could limit or preclude options utilized for one site while accommodating multiple chemical formulations for another. A multifaceted strategy will be needed to manage invasive TTG outbreaks.

Spread baits evenly. Reverse the pattern of application on repeat treatments, since spots may be missed during ground application. Pellets are usually colored and easy to see. Use a granular product if visible bait is undesirable. Schedule treatments before or after rains, since snails are active at this time and more likely to encounter bait. If this cannot be done, the area can be irrigated beforehand to help promote slug and snail activity (Flint and Wilen, 2009). Bait treatments are much more effective with moisture and should be applied in either late afternoon or evening.

Metaldehyde pellets are one of the most utilized form of bait. It is applied and used in a wide array of conditions. Granular metaldehyde formulations such as Durham® granules may be more appropriate in settings where pellets may be unsightly or pose a potential focus of curiosity.

Liquid applications may be effective when bait formulas cannot reach target snails. Metaldehyde spray formulations provide another application format that has potential to accommodate snail control needs alone or in concert with other approaches.

Difficult terrain areas which present problems in applying baits could indicate the need for a spray or even a more specialized form of application equipment such as bait blower. Baits are toxic to all slugs and snails, not just target species.

Metaldehyde

Metaldehyde is the most widely used chemical snail bait treatment. It comes in many formulations with various attractant systems. Metaldehyde baits containing 4 percent metaldehyde are significantly more effective than those products containing only 2 percent metaldehyde. Some metaldehyde products are formulated with carbaryl, partly to increase the spectrum of pests controlled to include soil and debris-dwelling insects, spiders, and sow bugs.

However, carbaryl is toxic to soil-inhabiting beneficial organisms, such as ground beetles and earthworms, and should be avoided if snail and slug management is all that is required.

Deadline® M-Ps™ and Metarex are bait treatments that have been very effective in recent years for invasive snail eradication. Deadline® 40 and Slugfest are liquid formulations of metaldehyde. Metarex is a smaller bait pellet and has more bait points per given area applied at label rates. This bait also produces less dust and breaks down slower in moist conditions as compared to Deadline®.

Baits with only metaldehyde work well with warm temperatures or during low humidity periods. Watering after placement will reduce the effectiveness of the bait. Sunlight and high irrigation can lead to rapid breakdown of the bait, but using bullet or paste formulations will help reduce this (Flint and Wilen, 2009).

Metaldehyde baits are poisonous to other animals as well, including dogs, cats and other wildlife. These baits should not be sprayed or applied to plants, especially vegetables (Flint and Wilen, 2009).

Methiocarb

Methiocarb is an organophosphate chemical. Most formulations of methiocarb are classified as Restricted Use Pesticides. Restricted use products may only be applied by a certified pesticide applicator or under the direct supervision of a certified applicator. According to some researchers, methiocarb produces better kill than metaldehyde under wet conditions. Mesurol 75-W® is formulated as a wettable powder with 75 percent active ingredient. Mesurol Pro® is a food bait with 2 percent active ingredient.

Iron Phosphate

Iron phosphate is a relatively new active ingredient for slug and snail food baits. Iron phosphate baits are considered generally safe for the environment. Unlike metaldehyde and methiocarb products, baits containing iron phosphate are thought to be safe for pets and other non-target animals. After feeding on baits containing iron phosphate, slugs and snails will cease feeding but will not die until 3 to 6 days later. For some slug and snail species, there is evidence that iron phosphate baits are less effective than those containing metaldehyde or methiocarb. Indications are that iron phosphate, while not as effective as metaldehyde and methiocarb, has potential in chemically sensitive areas due to its low toxicity.

Iron phosphate pellet formulations can assist in filling a treatment void in cases in which a home or landowner’s may have reservations of chemical control

options. Iron phosphate may be impractical on large scale eradication but allow for treatment in smaller or sensitive areas.

Sluggo® is granular bait containing 1 percent iron phosphate. This bait can be used in areas that have public access or other areas of concern in place of metaldehyde use.

Cultural Controls

Rely on a combination of cultural methods in non-emergency situations. Cultural controls can also be used in combination with other treatments. Some cultural controls—such as draining wetlands—may be subject to obtaining environmental documentation under the National Environmental Policy Act (NEPA) and the Endangered Species Act (ESA). Check with the program manager to make sure documentation is in order. See *Microhabitats* on page 4-11 for related information concerning environments that TTG seem to prefer.

Alteration of Snail Habitat

In order to increase the efficacy of treatments, habitat modification or alteration is needed. Modification can range from extensive alteration of the landscape by removing vegetation and grading the site, to very basic alteration that includes keeping vegetation mowed in order to keep the snails closer to ground level for easy access to bait/treatments when treatments are applied. The least amount of modification at a site should be keeping the area clean and clear along with mowing vegetation. Treatments and site modification are best applied in concert with each other, as any one of them alone has limited impact.

The most cost effective approach is to gain the cooperation of property owners. Prior to treatments, assess the different properties in order to come up with a habitat modification site plan for each property. After the assessments, discuss with the property owners what they can do to help with site modifications.

If the property is overgrown with various types of vegetation, have the site mowed or otherwise maintained. Without modification, the snails will be difficult to control in overgrown areas. Perform extensive modification by removing small trees, brush, and other vegetation. When removing large areas of trees and brush, it should be chipped on-site to prevent artificial movement of snails and slugs. Inspect equipment before it leaves the site to prevent artificial spread.

After vegetation removal, manage the property by keeping regrowth mowed. The site can also be plowed and disked, or an herbicide can be applied. The property should be safeguarded by treatment around the border to prevent

reintroduction of snails to the modified area if infestations occur outside of the modified area. If snails still exist in the altered area, a treatment plan should be used. This aggressive alteration should drastically reduce population numbers of the snails in this area. Survey work is needed in this area in the following years to confirm this and treatments applied when detected.

Removal of trash, litter or debris must be done in such a way as to prevent the spread of an infestation. Equipment used for maintenance, roadwork, etc., should ***not*** be parked, stored or left idle in snail infested areas, but cleaned and returned to storage at the end of each work day. Idle equipment should be removed from the infested area, unless protected by barriers or stored inside buildings kept clear of any infestation.

Barriers

Copper Foil

Install strips of copper foil to repel snails and prevent their access to tree foliage or planting beds for several years. Snails will not cross the copper foil. Snail Barr® is a copper foil product widely available from suppliers of agricultural products.

Salt

Salt is an effective barrier for snails to safeguard items of risk or concern.

Soil

Snails limit their movement on bare soil. Consequently, a strip of bare earth about 1.5 meters wide around cultivated areas will give some protection. This form of control is made more effective if combined with chemical means of control and regular hand collection of snails.

Abrasives

Heaping abrasives in a band 1-inch high and 3-inches wide is an effective barrier. However, these are hard to maintain due to loss of effectiveness when damp or wet.

Bordeaux Mixture

Brush copper sulfate or Bordeaux mixture (10 pounds of copper sulfate, 10 pounds of lime, and 100 gallons of water) on tree trunks to repel snails. Bordeaux mixture will withstand rainy weather better than copper sulfate alone. See ***Resources*** on page A-1 for related information.

Hand Collecting

WARNING

Consumption of snails and slugs, or of vegetables and fruits contaminated by snails and slugs, may lead to infection by pathogens that are easily transmitted by these pests. Wear rubber or latex gloves when handling gastropods, as well as associated soil, excrement, and other materials that may have come in contact with them. Immediately after removing protective gloves, thoroughly wash hands with hot soapy water and rinse well. Consult a physician if, after handling snails and slugs, you experience symptoms resembling forms of meningitis, including headache, stiff neck, tingling or painful feelings in the skin, low-grade fever, nausea, and vomiting. These symptoms could indicate an infection by *Angiostrongylus cantonensis*, a parasite carried by snails and slugs. These pests may also carry other diseases.

Look for snails in areas with abundant calcium carbonate (limestone, marble, etc.) or when they are aestivating in high numbers on vegetation or other objects. Regular and extensive collection of snails should be carried out in tandem with other control methods or when performing survey work. Community cooperation can help to reduce snail numbers significantly, particularly in newly infested areas. Collecting has proven to be effective at small sites with low numbers of snails. Use the following methods to dispose of snails:

- Freeze at negative 10 °C for three days;
- Immerse in boiling water, rubbing alcohol, ethanol, or seawater; or
- Incinerate.

Disruption of Soil

In open fields, plowing the soil twice yearly will reduce small populations of TTG. Disking and cultipacking will help to reduce snail populations in areas of thin topsoil or where erosion is a problem.

Sanitation

Sanitation is a continual process. Destroy snail habitats by clearing underbrush, eliminating refuse piles and loose boards, and checking underneath stones. All infested properties must be cleaned thoroughly to facilitate survey operations and to improve the effectiveness of control treatments.

Trapping

Traps have limited use and are not effective on a large scale or site. This method is time-consuming and should be used on small sites in concert with hand collecting. Trap TTG under boards or flower pots positioned throughout the landscape. Inverted melon rinds also make good traps. See *Survey Procedures* on page 4-1 for other methods of trapping.

Burning

Collect, pile and burn host material if local ordinances and fire officials permit.

Controlled burning as a management tool might reduce snail numbers or eradicate snails. It will remove food sources and destroy snail habitat. There is a need for research and documentation to review the possibility of this management tool.

Application of Herbicides

Using herbicides to control wild and cultivated hosts has proven to be effective by removing food sources and habitat. If baits are also being used as a control tool, apply them after vegetation dies back. The bait then becomes the new and only food source. Without baiting, in an area in which herbicides were used to clear the vegetation the snails will migrate to new areas to find a new food source and habitat. See *Molluscicides* on page 6-7 for more information on using baits.

Approved Treatments for Regulated Articles

See *Approved Treatments for Regulatory Articles* on page 5-8.

Control in Commercial Nurseries

Temperate terrestrial gastropods can be easily spread to multiple environments through the sale and movement of plant material. Before addressing potential invasive TTG issues in the commercial environment, confirm the official position of PPQ for the particular outbreak through your SPHD. Clarity on the agency position, pest risk potential, site information and clear communication will be paramount.

Nursery Assessment and Considerations

After initial assessment and classification has been conducted, further control and safeguard issues for the commercial environment must be addressed. See ***Snail Detection Survey Data Sheet*** on page B-2, ***Pre-Survey Interview*** on page B-4, and ***Pathway Risk Index for Importers of Tile, Marble, Granite, Travertine, and Natural Stone*** on page B-8 for related assessment materials.

General Nursery Assessment

Determine the type of nursery, type of infestation, and type of material sold such as cuttings, potted material or shrubbery. Determine if the property includes both greenhouse and field locations.

Use the following checklist when assessing the structures and environment:

- ☐ Are greenhouses isolated?
- ☐ What is the construction type (plastic, glass, type of entry)?
- ☐ Are the greenhouses automated?
- ☐ Do the greenhouses contain multiple types of plant material?
- ☐ What is the general state of hygiene of the greenhouses?
- ☐ What is the type of floor (dirt, gravel, marl, concrete, asphalt)?
- ☐ What is the type of planting system (raised or floor)?
- ☐ What is the type and height of rack system?
- ☐ What type of material are the racks and their stands made of (metal, wood, concrete, plastic)?
- ☐ How are greenhouse debris and trash handled?
- ☐ Is an area designated for debris and waste media?

Nursery Field Assessment

Determine the type of growing system used (for example block plantings, varied, mixed species), and identify general types of soil and terrain.

Use the following checklist when assessing the nursery field:

- ☐ Are calcium carbonate sources present?
- ☐ What is the overall condition of the field area?
- ☐ Are the field areas clean and free of grass, weeds and other host materials?
- ☐ Are waste or debris piles in or near planting field areas?
- ☐ How is debris and plant waste material handled in field areas?

Pest Management

Obtain information on the type of pest management system used by the nursery. Use the following checklist when assessing the pest management at the nursery:

- ☐ Does the nursery already treat for TTG pests?
- ☐ Does the nursery use pesticides?
- ☐ Which TTG control strategies are used?
- ☐ What types of pests are targeted?

- ☐ Are herbicides used?
- ☐ Are pesticide dips or treatments used for plants being shipped?
- ☐ Are insecticidal soaps or washes used for plants being shipped?

Chapter

7

Environmental Compliance

Contents

Introduction

Use *Chapter 1 Environmental Compliance* as a guide to environmental considerations pertinent to an infestation of temperate climate pest snails and slugs in the United States and collaborating territories. Selected species in the gastropod families Arionidae, Cochlicellidae, Helicidae and Hygromiidae are discussed here as these are currently of particular concern, but these guidelines are applicable for most if not all temperate terrestrial gastropods (TTG).

A key element in designing a program or an emergency response is consultation with Environmental Services (ES), a unit of APHIS' Policy and Program Development Staff (PPD). ES prepares environmental documentation such as environmental impact statements (EIS) and environmental assessments (EA) to aid in program operational decisions, as well as Endangered Species consultation. ES also coordinates pesticide registration and approvals for APHIS programs, ensuring that registrations and approvals meet program use needs and conform to pesticide use requirements. In addition, PPQ's Environmental Compliance Team (ECT) assists ES in the development of required documentation and implements any environmental monitoring that may be required of program activities. Refer to the Resources Section of this document for additional information.

National Environmental Policy Act

The National Environmental Policy Act (NEPA) requires that federal agencies document the potential adverse effects of their actions. The process often requires public input. The exact nature of the documentation and public involvement is dictated by the potential for adverse effects and the significance of those effects.

It is likely that most pest control responses will include actions that need up to 30 days of public comment prior to initiation. Therefore, it is imperative to involve staff from PPQ Environmental Services and Environmental Compliance early in the planning process. Doing so assures public involvement and a quick response.

Depending on the proposed program, NEPA requirements will be met with a categorical exclusion, environmental assessment, or environmental impact statement. Some programs can prepare their own NEPA documentation. Contact PPQ Environmental Services or Environmental Compliance if you are unsure which document should be prepared, or if you have little experience writing such documents.

Address	USDA–APHIS–PPQ–Emergency and Domestic Programs Environmental Compliance 4700 River Road, Unit 150 Riverdale, MD 20737 Telephone: 301-734-8247
Address	USDA–APHIS–Policy and Program Development Environmental Services 4700 River Road, Unit 149 Riverdale, MD 20737 Telephone: 301-734-8565

Endangered Species Act

The Endangered Species Act (ESA) requires that all Federal actions, including emergency responses, do not harm Federally protected, threatened, or endangered species. ESA is administered by the Environmental Protection Agency (EPA). Before an action can begin, it must be determined if protected species are in the project area. If such species are present, measures must be put in place to protect them from potential adverse effects of the action. Such work requires coordination with the U.S. Fish and Wildlife Service and/or the National Marine Fisheries Service.

Several methods are available to ensure compliance with ESA, but the exact one chosen is dictated by the nature of the emergency, proposed response, and location. As soon as possible in the early stages of the response, contact staff at Environmental Services or Environmental Compliance, who can provide the necessary guidance and support in conducting the necessary analyses and developing the required documentation.

Federal Insecticide, Fungicide, and Rodenticide Act

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) requires that chemicals used for control have approved labels and that all label requirements are followed. These requirements can include applicable uses, maximum application rates, handling instructions, and personal protective equipment. If no label is available for the emergency in question (i.e., the pest of concern is not listed as one for which the chemical may be used), it is possible to obtain a new label or a label exemption. If a label change is needed or no label can be located for your program needs, immediately contact Environmental Services, who can assist in label changes and emergency use exemptions.

Address

USDA–APHIS–Policy and Program Development
Environmental Services
4700 River Road, Unit 149
Riverdale, MD 20737
Telephone: 301-734-8565

Other Laws

The National Environmental Policy Act, Endangered Species Act, and the Federal Insecticide, Fungicide, and Rodenticide Act, are of critical importance to all pest control programs, but other laws may apply depending on program locations and activities. These include the Migratory Bird Treaty Act, the Coastal Zone Management Act, and the Bald and Golden Eagle Protection Act. By including Environmental Services and Environmental Compliance early in program planning, guidance can be provided on meeting the requirements of these and other laws that may apply.

Environmental Monitoring

Environmental monitoring of APHIS pest control activities may be required as part of compliance with the above laws, as requested by program managers, or as suggested to address concerns with controversial activities. This is especially true for less benign chemical controls and aerial application of chemicals.

Monitoring may be conducted with regards to worker exposure, quality assurance and control, off-site deposition, or program efficacy. Different tools and techniques are used depending on the monitoring goals, program chemicals, and control techniques. Environmental monitoring is coordinated by Environmental Compliance (EC). Staff from EC will work with the program manager to develop an environmental monitoring plan, conduct training to implement the plan, provide day-to-day guidance on monitoring, and provide an interpretive report of monitoring activities.

Chapter

8

Public Education

Contents

Introduction

Use *Chapter 7 Public Education* as a guide to interacting with the public during an infestation of temperate climate pest snails and slugs in the United States and collaborating territories. Public education plays a key role in the early detection and eradication of snail and slug pests. In addition, education of homeowners, workers, and managers in areas at risk of snail and slug introduction can aid in identifying new infestations, and in estimating the size of survey areas.

Resources

Public education may provide clues helpful in identifying the source of the infestation. Once identification has been confirmed by a specialist, initiate a public education campaign utilizing the following resources:

- Media (newspaper, television and radio);
- Contact with local Cooperative Extension Service personnel;
- Contact with local horticultural and agricultural groups;
- Contact with city government officials;
- PPQ brochures, pest alerts, and posters;
- Flyers and pamphlets distributed in infested communities;
- Public meetings;
- Involvement of schools, community groups, and volunteer organizations; and
- Neighborhood liaisons.

Hand-picking of snails, and site clean-up to remove snail refuges, are simple yet effective tasks for communities experiencing an outbreak of these pests.

⚠ WARNING

Consumption of snails and slugs, or of vegetables and fruits contaminated by snails and slugs, may lead to infection by pathogens that are easily transmitted by these pests. Wear rubber or latex gloves when handling gastropods, as well as associated soil, excrement, and other materials that may have come in contact with them. Immediately after removing protective gloves, thoroughly wash hands with hot soapy water and rinse well. Consult a physician if, after handling snails and slugs, you experience symptoms resembling forms of meningitis, including headache, stiff neck, tingling or painful feelings in the skin, low-grade fever, nausea, and vomiting. These symptoms could indicate an infection by *Angiostrongylus cantonensis*, a parasite carried by snails and slugs. These pests may also carry other diseases.

Legislative and Public Affairs

All contact with news media sources and the public must be coordinated with APHIS Legislative and Public Affairs (LPA).

Address	APHIS–Legislative and Public Affairs http://www.aphis.usda.gov/contact_us/news_contacts.shtml

Chapter

9

Pathways

Contents

Introduction

Use *Chapter 1 Pathways* to learn more about interceptions of temperate climate pest snails and slugs in the United States and collaborating territories. Selected species in the gastropod families Arionidae, Cochlicellidae, Helicidae and Hygromiidae are discussed here as these are currently of particular concern, but these guidelines are applicable for most if not all temperate terrestrial gastropods (TTG).

Interceptions

Inspectors intercepted the temperate terrestrial gastropod species listed in *Table 9-1 on page]>-3* more than 9,400 times during the period 1985 to 2009. These species were detected on 254 genera of plants; containers; quarry products (including bricks, ceramic, earthenware, granite, limestone, marble, slate, and tiles); and military equipment (AQAS, 2010).

Travel

These terrestrial species were intercepted 187 times in passenger baggage (AQAS, 2010).

Natural

Natural spread of any of these fifteen species to the United States is not expected unless they become established elsewhere on the North American continent and move over land. Natural spread over water is unlikely (Garland, 2004; Godan, 1983; Sullivan *et al*., 2004).

Commerce

Over 70 percent of interceptions of these species of snails were via maritime, and most others were at airports. Many of these interceptions were found to be associated with containers on rail cars from Canada, but the containers with snails did ***not*** originate in Canada. More than 55 percent arrived via Italy, and the Mediterranean countries of Italy, Israel, and Spain accounted for 78 percent of interceptions. The majority of these interceptions were on quarry products such as tiles (45 percent) and on containers (13 percent), and the total of interceptions on containers, tiles, and other quarry products was 63 percent (AQAS, 2010; Robinson and Tang, 2003; Sullivan *et al.*, 2004).

Table 9-1 Interceptions of Fourteen Species of Invasive Terrestrial Snails at U. S. Ports of Entry 1985 to 2009 (AQAS, 2010; Robinson, 2006)

Species	Host Genera		Interceptions		Countries of Origin		Number of Destinations
	Number	Top Ranked	Number	Top Ranked[1]	Number	Top Ranked	
Arion spp.[2]	74	*Abies* *Narcissus*	357	P, M, QP	29	Canada France Netherlands	27
Candidula intersecta (Poiret)	12	1 each of various	92	C, QP, P	18	Colombia Italy France Germany	17
Cernuella virgata (da Costa)	21	*Pittosporum* *Citrus*	455	QP, C, P	16	Italy Spain Australia	29
Cochlicella acuta (Müller)	14	*Citrus* *Pittosporum*	131	QP, C, P	13	Italy Spain France Netherlands	24
Hygromia cinctella (Draparnaud)	12	*Ruscus* *Danae* *Pittosporum*	248	QP, C, P	10	Italy France Netherlands Germany	27
Microxeromagna lowei (Potiez and Michaud)	11	*Citrus* *Kochia*	86	P, QP, C	10	Australia France Israel Spain	17
Monacha cantiana (Montagu)	6	*Brassica*	74	QP, C, P	7	Italy United Kingdom France Netherlands	15
Monacha cartusiana (Müller)	1	*Aconitum* Brassia	367	QP, C, P	20	Italy Spain France Greece	30
Monacha syriaca (Ehrenberg)	82	*Phlox* *Aconitum* *Ruscus*	421	P, C, QP	16	Israel Turkey Lebanon Jordan Greece	25
Prietocella barbara (Linnaeus)	70	*Mentha* *Pittosporum* *Phlox*	608	P, C, QP	27	Italy Israel Spain Morocco France Tunisia Australia	29

Table 9-1 Interceptions of Fourteen Species of Invasive Terrestrial Snails at U. S. Ports of Entry 1985 to 2009 (AQAS, 2010; Robinson, 2006) (continued)

Species	Host Genera		Interceptions		Countries of Origin		Number of Destinations
	Number	Top Ranked	Number	Top Ranked[1]	Number	Top Ranked	
Theba pisana (Müller)	150	*Aconitum* *Pittosporum* *Brassica*	2,018	P, C, QP	45	Italy Israel Spain France Morocco Algeria Australia	39
Xerolenta obvia (Menke)	1	*Melilotus*	28	C, QP, P	6	Italy Germany Spain France Canada	11
Xeropicta derbentina (Krynicki)	3	*Rosmarinus* *Allium* *Trifolium*	39	C, P, QP	9	Turkey Israel Italy Russia Armenia	14
Xeropicta krynickii (Krynicki)	37	*Rosmarinus* *Origanum* *Thymus* *Mentha* *Satureja*	207	P, C, QP	8	Israel Turkey Lebanon Ukraine	19
Xerotricha conspurcata (Draparnaud)	53	*Ruscus* *Pittosporum* *Citrus*	4,425	QP, C, P	31	Italy Spain France Bulgaria Greece Turkey Israel	46

1 P=Plants; C=Containers; QP=Quarantine Products.

2 Most *Arion* spp. ***cannot*** be readily determined from immatures other than with DNA analysis. The actual count of confirmed *Arion vulgaris* (Moquin-Tandon) interceptions in PestID for the period 1985 to 2007 was three.

Countries of Origin

During the period 1985–2009, interceptions of these fourteen species of snails originated in 81countries around the globe. The majority of interceptions originated in Italy and nearly 25 percent more in other Mediterranean countries (AQAS, 2010; Robinson and Tang, 2003).

Destinations

When an actionable pest is intercepted, officers ask for the intended final destination of the conveyance. During the period 1985 to 2009, interceptions of these fifteen snail species were bound for 51 States or U.S. territories; many of them to areas where establishment could or has already occurred: Chicago, Detroit, Miami, Portland, and Seattle (AQAS, 2010; Hitchcox, 2006; Sullivan et al., 2004).

Risk of Establishment

The fourteen species of snails treated herein pose a medium to high risk of establishment to the United States because:

- At least four became established following entry into the United States via one or more of the pathways discussed (Hitchcox, 2006; Sullivan et al., 2004);
- All have been associated with at least 254 genera of plants (AQAS, 2010);
- Some feed on crops such as alfalfa and pose harvest risks to crops such as wheat (Baker and Hopkins, 2003; Godan, 1983; Hitchcox, 2006);
- At least one poses a threat to U. S. Fish and Wildlife Services threatened and endangered species (USFWS, 2003); and
- Some carry parasites that can infest cattle and sheep in the United States (Godan, 1983).

Prevention

Re-establishment of these snails should be prevented, and eradication of those established should be carried out wherever these snails are found in the United States. All pathways that serve to provide entry of these snails should be thoroughly inspected and determined to be free of these snails, including but not exclusive to: containers, either by ship or rail; contents of containers, especially quarry products such as Mediterranean tiles; cut flowers; nursery stock; and mushrooms. Mitigations should be applied to those pathways and conveyances that serve to provide entry for these snails (Baker and Hopkins, 2003; Hitchcox, 2006; Robinson and Tang, 2003; Sullivan et al., 2004).

References

Agricultural Quarantine Activity Systems (AQAS). 2009. Web-based database interception data. USDA–APHIS. Accessed in 2010.

Anonymous. 2008. Puerto Rico and the U.S.Virgin Islands: Mollusk Early Detection and Rapid Response Action Plan. 46 pp.

Baker, G.H. 1986. The biology and control of white snails (Mollusca: Helicidae), introduced pests in Australia. *CSIRO Division of Entomology Technical Paper,* 25: 1–31.

Baker, G.H. 1996. Population dynamics of the Mediterranean snail, *Cernuella virgata*, in a pasture-cereal rotation in South Australia. *In:* Henderson (ed.), Slug and Snail Pests in Agriculture. *BCPC Symposium Proceedings,* 66: 117–124.

Baker, G.H. 2002. Helicidae and Hygromiidae as Pests in Cereal Crops and Pastures in Southern Australia. *In*: G.M. Barker (ed.), Molluscs as Crop Pests. CAB International. Pp.193-215.

Baker, G. and D. Hopkins, eds. 2003. Bash ‘Em, Burn ‘Em, Bait ‘Em: Integrated snail management in crops and pastures. Government of South Australia.

Barker, G.M. 1999. Naturalized terrestrial Stylommatophora (Mollusca: Gastropoda). *Fauna of New Zealand, Ko te Aitanga Pepeke o Aotearoa*, No. 38. Manaaki Whenua Press. New Zealand: New Zealand. 251 pp.

Bequaert, J.C. and W.B. Miller. 1973. *The Mollusks of the Arid Southwest With an Arizona Checklist.* Tucson: Tucson University of Arizona Press. 271 pp.

Britton, J.C. 1991. Pathways and Consequences of the Introduction of Non-indigenous Freshwater, Terrestrial, and Estuarine Mollusks in the United States. Office of Technological Assessment, Congress of the United States, contract H3-5750.0. 66 + [17] pp.

Campbell, F. and F. Lowenstein. 2006. An Ounce of Prevention: How to Stop Invasive Insects and Diseases from Devastating U. S. Forests. The Nature

Conservancy, Global Forest Partnership, Forest Health Program. 24 pp. [http://www.nature.org/initiatives/forests/files/ounceofpreventionsingle1.pdf]

Chatfield, J.E. 1968. The life history of the helicid snail *Monacha cantiana* (Montagu), with reference also to *M. cartusiana* (Müller). *Proceedings of the Malacological Society of London,* 38: 233–245.

Chatfield, J. E. 1972. Observations on the ecology of *Monacha cantiana* (Montagu) and associated molluscan fauna. *Proceedings of the Malacological Society of London* 40: 59-69.

Chatfield, J. E. 1977. Preliminary studies on the distribution of the land snail genus *Monacha* in western Europe. *Malacologia* 16(1): 81-85.

Chatfield, J.E. 1976. Studies on food and feeding in some European land molluscs. *Journal of Conchology,* 29: 5–20.

Clinton L. Campbell, C.L. 2008. Email from C.L. Campbell, State Operations Support Officer, USDA–APHIS–PPQ, Des Moines, Washington, to P.S. Michalak; August 7, 2008.

Cowie, R.H. 1984. The life-cycle and productivity of the land snail *Theba pisana* (Mollusca: Helicidae). *Journal of Animal Ecology,* 53: 311–325.

Cowie, R.H. 1998. Patterns of introduction of non-indigenous non-marine snails and slugs in the Hawaiian Islands. *Biodiversity and Conservation,* 7: 349–368.

Cowie, R.H. and D.G. Robinson. 2002. Pathways of introduction of non indigenous land and freshwater snails and slugs. California Department of Food and Agriculture. [http://www.cdfa.ca.gov/] (Accessed January 29, 2007).

Cowie, R.H., D.G. Robinson, and R.T. Dillon. 2002. List of Potential Pest Mollusks in the USA. Report submitted to USDA–APHIS–PPQ–CPHST–PERAL, September, 2002. 8 pp.

El-Khodary, A. S., R. R. Helal, F. A. Sharshir, and W. A. Shahawy. 2000. Ecological studies on *Monacha cantiana* (Montagu) snails at Kafr El-Sheikh, Egypt. AHM-3-51-3, Abstracts, Communicating and Advancing Ecology, The Ecological Society of America. 85th Annual Meeting, August 6-10, 2000, Snowbird, Utah.

Fisher, G.C., J.T. DeFrancesco and R.N. Horton. 1997. Seasonal Populations of Gray Garden Slug in Four Species of Grasseed. Production Research at Oregon State University, USDA–ARS Cooperating.

Flint, M.L, and C.A. Wilen. 2009. Snails and slugs: integrated pest management for home gardeners and landscape professionals. Pest Notes Publication 7427. University of California, Statewide Integrated Pest Management Program, Agriculture and Natural Resources.

Forsyth, R. 2004. *Land Snails of British Columbia*. Royal BC Museum. Victoria. 188 pp.

Friedli, J. and T. Frank. 1998. Reduced applications of metaldehyde pellets for reliable control of the slug pests *Arion lusitanicus* and *Deroceras reticulatum* in oilseed rape adjacent to sown wildflower strips. *Journal of Applied Ecology,* 35(4): 504–513.

Garland, J. A. 2004. Pest Risk Assessment: Snails Recently Detected in Detroit Michigan, with particular reference to *Candidula intersecta*. PRA 04-20. Canadian Food Inspection Service.

Garratt, L.J. 2008. Email from L.J. Garratt, Agricultural Economist, USDA–APHIS–CPHST–Plant Epidemiology and Risk Assessment Laboratory, Raleigh, North Carolina, to P. S. Michalak; January 18, 2008.

Genena, M. A. M. and F. A. M. Mostafa. 2010. Biological control of the clover land snail, *Monacha cantiana* (Montagu) using the rhabditid nematode, *Phasmarhabditis hermaphrodita* (Schneider) under mini-plot field conditions. *Egypt Journal of Agronematology* 9(2): 149-156.

Georgiev, D.M., A. Kostadinova and B.B. Georgiev. 2003. Land snails in the transmission of protostrongylids on pastures in Southern Bulgaria: variability of infection levels related to environmental factors. *Acta Parasitologica,* 48(3): 208–217.

Glen, D.M. and R. Moens. 2002. Gastropod Pests on Cereals. *In*: G.M. Barker (ed.), Molluscs as Crop Pests. CABI Publishing. pp. 271–300.

Godan, D. 1983. *Pest Slugs and Snails: Biology and Control*. Berlin: Springer-Verlag. 445 pp.

Green, G.L. 1983. *Soil Survey of Multnomah County, Oregon.* USDA Soil Conservation Service.

Grimm, B. 2001. Life cycle and population density of the pest slug *Arion lusitanicus* Mabille (Mollusca: Pulmonata) on grassland. *Malacologia*, 43(1–2): 25–32.

Grimm, B., W. Paill and H. Kaiser. 2001. Daily activity of the pest slug *Arion lusitanicus* Mabille. *Journal of Molluscan Studies*, 66: 125–130.

Grimm, F. W., R. G. Forsyth, F. W. Schueler, and A. Karstad. 2009. Identifying Land Snails and Slugs in Canada-Introduced Species and Native Genera. Canadian Food Inspection Agency (CFIA). Ottowa, Ontario. pp. 243-294.

Hanna, G.D. 1966. Introduced Mollusks of Western North America. *Occasional Papers of the California Academy of Sciences*, (48): 1-108.

Hatziioannou, M., N. Eleutheriadis and M. Lazaridou-Dimitriadou. 1994. Food preferences and dietary overlap by terrestrial snails in Logos area (Edessa, Macedonia, northern Greece). *Journal of Molluscan Studies*, 60(3): 331-341.

Hitchcox, M.E. 2006. Detection of populations of the exotic snail *Candidula intersecta* in Oregon. United States Department of Agriculture report submitted November 2006. 11 pp. + attachments.

Hommay, G. 2002. Agriolimacidae, Arionidae and Milacidae as Pests in West European Sunflower and Maize. *In*: G.M. Barker (ed.), Molluscs as Crop Pests. CABI Publishing. pp. 245–254.

Kerney, M. P., and R.A.D. Cameron. 1979. *A Field Guide to the Land Snails of Britain and North-West Europe*. London: Collins and Sons Co. 288 pp.

Kiss, L., C. Labaune, F. Magnin and S. Aubry. 2005. Plasticity of the life cycle of *Xeropicta derbentina* (Krynicki, 1836), a recently introduced snail in Mediterranean France. *Journal of Molluscan Studies*, 71(3): 221–231.

Klassen, W. 2004. Invasive Species: A Florida and Third Border Perspective. *In:* Facilitating Safer U. S.-Caribbean Trade: Invasive Species Issues. Port of Spain, Trinidad. 2–4 June 2004. 13 pp.

Lazaridou, M. and M. Chatziioannou. 2005. Differences in the life histories of *Xerolenta obvia* (Menke, 1828) (Hygromiidae) in a coastal and a mountainous area of northern Greece. *Journal of Molluscan Studies*, 71(3): 247–252.

Lazaridou-Dimitriadou, M. 1981. Contribution á l'étude biologique et écologique des escargots *Cernuella virgata* (Da Costa) et *Xeropicta arenosa* Ziegler (Gastropoda, Pulmonata) vivant sur les microdunes de Poitdea,

Chalkidiki, (Grèce du nord). *In*: Anfossi, G. Brambilla and C. Violani (eds.), Vo. Convegno Nazionale della Società Malacologica Italiana, 20: 73–83.

Leonard, M., G. Baker, D. Hopkins, and P. Hoffman. 2003. Bash 'Em, Burn 'Em, Bait 'Em: Integrated snail management in crops and pastures. South Australian Research and Development Institute. Adelaide, South Australia. 40 pp.

Lush, A.L. 2007. Biology and ecology of the introduced snail *Microxeromagna armillata* in south eastern Australia, Masters Thesis, University of Adelaide, Australia. 229pp.

Marquez, P. and J. Cena. 2006. *Candidula intersecta* (Poiret) Infestation at the Port of Seattle, WA (King County): A First Recorded Find for the State of Washington. United States Department of Agriculture/Washington State Department of Agriculture report submitted to State Plant Health Director and State Operations Support Officer, State of Washington, July 12, 2006. 29 pp.

McKinney, M.L. and J.L. Lockwood. 1999. Biotic homogenization: a few winners replacing many losers in the next mass extinction. *Trends in Ecology and Evolution,* 14: 450–453.

Moran, S., Y. Gotlib and B. Yaakov. 2004. Management of land snails in cut green ornamentals by copper hydroxide formulations. *Crop Protection,* 23(7): 647–650.

Moreno, J., E. Galante, and M. A. Ramos. 2006. Impacts on animal biodiversity. In: Impacts of climate change in Spain. 52 pp. 243-294. ACCESS DATE. [http://firf.fr/team/martin/1fichiers/1pdf/06_animal_biodiversity_ing_2.pdf]

Newton, L. 2011. NPAG Report. *Monacha cantiana* (Montagu): Kentish garden snail, clover land snail. United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Center for Plant Health Science and Technology, Plant Epidemiology and Risk Analysis Laboratory, New Pest Advisory Group (NPAG). 8 pp.

Office of Technology Assessment. 1993. Harmful non-indigenous species in the United States. Unites States Congress Office of Technology Assessment, U. S. Government Printing Office, Washington, D. C. 391 pp.

Pilsbry, H. A. 1939. Land Mollusca of North America north of Mexico. *Academy of Natural Sciences in Philadelphia*, 1(1): 1-574.

Pilsbry, H. A. 1940. Land Mollusca of North America north of Mexico. *Academy of Natural Sciences in Philadelphia,* 1(2): 575-994.

Pilsbry, H. 1946. Land Mollusca of North America (north of Mexico). *Academy of Natural Sciences of Philadelphia,* 2(1):1–520.

Pilsbry, H. 1948. Land Mollusca of North America (north of Mexico). *Academy of Natural Sciences of Philadelphia,* 2(2): 521–1113.

Port, G. and A. Ester. 2002. Gastropods in Vegetable and Ornamental Crops. *In*: G.M. Barker (ed.), Molluscs as Crop Pests. CABI Publishing. pp. 337–351.

Proschwitz, T. von and K. Winge. 1994. Iberiaskogsnegl-en part på spredning i Norge. *Fauna,* 47: 195–203.

Raut, S.K. and G.M. Barker. 2002. *Achatina fulica* and Other Achatinidae. *In:* G.M. Barker (ed.), Molluscs as Crop Pests. CABI Publishing. pp. 55–114.

Robinson, D.G. 1999. Alien invasions: the effects of the global economy on non-marine gastropod introductions into the United States. *Malacologia,* 41: 413–438.

Robinson, D. G. 2006. Mollusk Identification Manual, ed. 2. National Identification Services.

Robinson, D.G. and J. Slapcinsky. 2005. Recent introductions of alien land snails into North America. *American Malacological Bulletin,* 20(1/2): 89–93.

Robinson, G. and W. Tang. 2001. Italian Tile Imports: A Pathway of Pest Introduction at the Maritime Work Unit of Miami. United States Department of Agriculture report submitted to the Miami Pest Risk Management Committee, May 2001. 8 pp.

Robinson, G. and W. Tang. 2003. Spanish Tile Imports: A Pathway of Pest Introduction at the Maritime Work Unit of Miami (presented to the Miami Port Risk Committee, April 21, 2003).

Sanderson, G. and W. Sirgel. 2001. Helicidae as pests in Australian and South African grapevines. *In*: G.M. Barker (ed.), Molluscs as Crop Pests. CABI Publishing. pp. 255–270.

Shalaby, G. A. and M. M. Elkhamesv. 2007. Land snails attacking sugar beet fields: 1- population density, damage and losses caused by *Monacha cantiana* snails at Kafr El-Sheikh governorate [abstract]. *Journal of Agricultural Science Mansoura University* 32(4):2801-2805.

Shea, M. 2007. Exotic snails and slugs found in Australia. *Malacological Society of Australasia Newsletter: Australian Shell News*, 131: 3-11.

Smith, B.J. 1989. Traveling Snails. *Journal of Medical and Applied Malacology* 1: 195–204.

Smith, J.W. 2005. Qualitative Pest Risk Analysis of Exotic Snails *Candidula intersecta* (Poiret, 1801: Hygromiidae), *Hygromia cinctella* (Draparnaud, 1801: Hygromiidae), *Monacha cartusiana* (Müller, 1774: Hygromiidae), and *Xerolenta obvia* (Menke, 1828: Hygromiidae) Discovered to be Established in Container Rail Yards in Detroit, Michigan. USDA–APHIS–PPQ–CPHST–PERAL, Raleigh, NC. 20 pp.

Sternberg, M. 2000. Terrestrial gastropods and experimental climate change: A filed study in calcareous grassland. *Ecol. Research*. 2000 (15). pp73–81.

Sullivan, B., D. Dehn, J. Manor and D. McKay. 2004. Report and Commentary: Exotic Snails Disocvered to be Established in Container Yards in Detroit, Michigan. USDA–APHIS–PPQ, State Plant Health Director's office. 16 pp.

Trautner, J. Ein Fernstransport der Kartaeuserschnecke, *Monacha cartusiana* (O. F. Mueller, 1774) (Gastropoda: Stylommatophora: Helicidae), mit Anmerkengan zur passiven Ausbreitung bei Schnecken. *Malakologische Abhandlungen (Dresden)* 20(1): 161–163.

Ward-Booth, J.F. and G.B.J. Dussart. 2001. Consistency in hand-searching for terrestrial snails. *Journal of Molluscan Studies*, (67): 502–506.

Weidema, I. 2006. NOBANIS–Invasive Alien Species Fact Sheet *Arion lusitanicus*. Online Database of the North European and Baltic Network on Invasive Alien Species–NOBANIS. Accessed September 2007. [http: www.nobanis.org]

White-McLean, J.A. 2011. Terrestrial Mollusc Tool. United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Center for Plant Health Science and Technology and the University of Florida. December 12, 2011. [http://idtools.org/id/mollusc]

USDA. 2003. Ad-hoc PIN-309 report results for Portland, Oregon, snails from 1994–2003. Pest Interception Network database.

USFWS. 2003. Final Recovery Plan for the Karner Blue Butterfly (*Lycaeides melissa samuelis*). U. S. Fish and Wildlife Service, Fort Snelling, Minnesota. [http://www.fws.gov/midwest/endangered/insects/kbb/index.html]

Temperate Terrestrial Gastropods

Glossary

Use the *Glossary* to find the meaning of specialized words, abbreviations, acronyms, and terms used by USDA–APHIS–PPQ–Emergency and Domestic Programs.

Definitions, Terms, and Abbreviations

***APHIS*.** Animal and Plant Health Inspection Service
***apex*.** tip of the spire of a snail shell, at the opposite end from the aperture
***aperture*.** mouth or principal opening of the shell, through which the body of the gastropod passes out of the shell
artificial movement. movement of pests by cargo, conveyances, or passengers; also see natural movement
***AQAS*.** Agricultural Quarantine Activity System, a Web database accessible from any USDA–APHIS computer
***attractant trap*.** trap employing a lure which incites the target snail to come to it and be caught
barrier. natural or artificial obstacle to movement**.**
biometric survey. survey succeeding the delimiting survey, in which properties are number- and letter-coded for survey purposes on a rotational basis
***body whorl*.** last whorl of a snail shell, from the aperture to the line directly above the aperture on the previous whorl; normally the largest portion of the shell; partially encloses the rest of the shell
***buffer zone*.** area extending 75 meters beyond the core zone
***columella*.** central column of the shell, around which the shell whorls coil
***commercial production area*.** area in which host material is grown for sale
***confirmed detection*.** positive laboratory identification of a submitted specimen
***core zone*.** minimum distance of 25 meters in all directions of any confirmed target snail infestation
***core infested area*.** known edges of infestation, defined by the area between several adjacent positive points; may include multiple positive points, and multiple properties; boundaries are established where positive species have been found
delimiting survey. survey to determine the extent of the infestation in an area after the target snail has been detected
***detection*.** collection of any life stage of the target snail

detection survey. survey conducted in a susceptible area not known to be infested with the target snail
dry heat. use of high temperatures as a treatment
egg survey. collection and holding of suspect eggs when no hatched snails are available to determine the extent and nature of an infestation
epicenter. initial site of an infestation
epiphragm. hardened mucous barrier that seals the aperture in most land snails and prevents desiccation during dry spells
eradication zones. areas or properties slated for eradication measures
fumigation. application of an approved fumigant, such as methyl bromide, as a treatment
generation. period of time for the pest to complete all stages of development predicated on the basis of biological information
ground spray. using ground spray equipment to apply molluscicide to the ground, selected resting places, or host vegetation in a target snail infested area
host. plant species, substrate, debris, or other food reproduction of the target snail
infestation. collection of one or more target snails from an area
infested area. infested properties or core areas of no less than 25 meters on a side each, unless biological factors indicate the need for more or less area
lip. flared margin surrounding the aperture of a shell
mantle. sheet of epithelial tissue that covers the viscera and secretes the shell
monitoring. using interdependent visual and/or trapping surveys in an area where treatment has been applied to evaluate the effectiveness of the application; also known as evaluation survey
natural movement. dispersal of pests without assistance from man or other means
PPQ. Plant Protection and Quarantine
pathway. means by which plant pests are introduced
parietal callus. layer of shell secreted over the parietal area
PestID. database containing all the information recorded from the PPQ Form 309 Pest Interception Record
positive point. single point where a specimen(s) of the target species was detected
regulated zone. zone that extends at least 100 meters in any direction from an infested property; may be extended to include any other nearby regulated areas as seems practical or within 1 kilometer
regulatory inspection. visual examination of host material, containers, and transport
SPHD. State Plant Health Director
steam sterilization. use of live steam as a treatment on selected regulated items
suture. line of contact or fusion between one shell whorl and the next
target snail. exotic species of snail found to be established in a given area of the United States against which it has been determined to conduct eradication and/or regulatory action

trap survey. determining the presence or absence of a pest by the use of traps placed in a predetermined pattern and serviced on a given schedule
TTG. temperate terrestrial gastropods; used in the *Guidelines* to refer to temperate climate pest snails and slugs in the United States and collaborating territories; includes selected species in the gastropod families Arionidae, Cochlicellidae, Helicidae and Hygromiidae
urban area. noncommercial crop production area containing multiple or single-family dwellings; Also known as residential area
USDA. United States Department of Agriculture
visual survey. examining hosts, substrate, or hiding places for eggs, adults, or visible damage; either in the field, in regulated establishments, or in monitoring the movement of regulated articles
whorl. turn on a spiral shell

Appendix

A

Resources

Use *Appendix A Resources* to find the contacts and products mentioned in the guidelines. To locate where in the guidelines a product is mentioned, refer to the Index.

Table A-1 Temperate Terrestrial Gastropods Resources (continued)

Function	Contact Information
Mesurol® Products	Gowan Company P.O. Box 5569 Yuma, Arizona 85366-5569 Telephone: (800) 883-1844 X 2 http://www.gowanco.com
Deadline® Products	Pace International 1011 Western Ave., Suite 505 Seattle, Washington 98104 (800) 936-6750 http://www.paceint.com
First Choice® Sluggo Slug and Snail Bait	Western Farm Service, Inc. P.O. Box 1168 Fresno, California 93711 (559) 436-2800 http://www.westernfarmservice.com
Copper Sulfate and Bordeaux Mixture	CR Chemical Corp. 4450 Trade Center Blvd., ITC Park Laredo, Texas 78045 (956) 753-0175 http://www.crchemical.com Statewide IPM Program Agriculture and Natural Resources University of California Pests in Landscapes and Gardens Bordeaux Mixture http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7481.html

Table A-1 Temperate Terrestrial Gastropods Resources (continued)

Function	Contact Information
Pest Management Supplies	BioQuip Products, Inc. 2321 Gladwick Street Rancho Dominguez, CA 90220 Telephone (310) 667-8800 http://www.bioquip.com/ Wards Natural Science P.O. Box 92912 Rochester, NY 14692-9012 Telephone 800-962-2660 http://www.wardsci.com/ Carolina Biological Supply Co. 2700 York Road Burlington, NC 27215-3398 Telephone (800)334-5551 http://www.carolina.com/ Hercon Environmental Corporation P.O. Box 467 Aberdeen Road Emigsville, PA 17318-0467 USA Telephone (717) 764-1191 Fax (717) 767-1016 http://www.herconenviron.com/ Cooper Mill Ltd R.R. 3 Madoc, Ontario K0K 2K0 CANADA Telephone (613) 473-4847 Fax (613) 473-5080 http://www.coopermill.com ISCA Technologies, Inc. P.O. Box 5266 Riverside, CA, 92521 Telephone (909) 686-5008 Fax (815) 346-1722 http://www.iscatech.com/exec/index.htm Great Lakes IPM, Inc. 10220 Church Road Vestaburg, Mi 48891-9746 Telephone (989) 268-5693 or (989) 268-5911 Fax (989) 268-5311 http://www.greatlakesipm.com/
Environmental Compliance Coordinator	USDA–APHIS–PPQ–Emergency and Domestic Programs 4700 River Road Riverdale, MD 20737 Telephone: (301) 734-7175
Environmental Services	USDA–APHIS–Policy and Program Development Environmental Services 4700 River Road, Unit 149 Riverdale, MD 20737 Telephone: 301-734-8565

Table A-1 Temperate Terrestrial Gastropods Resources (continued)

Function	Contact Information
Predicting Pest Development	University of California Integrated Pest Managemtn Program http://www.ipm.ucdavis.edu/WEATHER National Oceanic and Atmospheric Administration NAPPFAST (North Carolina State University, APHIS, Plant Pest Forecasting System) http://www.nappfast.org/index.htm) U.S. Department of Commerce Local Cooperative Extension Service Private, State, university, or industry sources

Appendix

B

Forms

Contents

Snail Detection Survey Data Sheet

Survey
Number:
Date:

Surveyor Information

Name
Code Affiliation

Client Information

Name(s) of resident(s) or landowner(s)
Business name Name of contact
Street address City, State, Zip Code
Telephone (office, home, or cell)

Site Information

Location or landmarks
Usage (farm, residence, nursery, etc.) Size (acres)
Longitude Latitude
Description of vegetation or habitat
Name of host plants exhibiting damage
Other observations

Sketch of site, route, or collections

Code	Description	Species	Identifier	Number of Molluscs			
				A[1]	E[2]	I[3]	T[4]
A							
B							
C							
D							
E							
F							

1 Adults

2 Eggs

3 Immatures

4 Total

Pre-Survey Interview

Business Information

Name
Address, City, State, Zip Code
Name of contact person
Telephone, FAX Email address
Latitude Longitude

Type	Description
☐ Maritime port	
☐ Rail yard	
☐ Container yard	
☐ Tile importer	

Questions

1. Do you import directly to this facility?

answer is:	Then:
☐ Yes	Use the following table to indicate how often you receive imported products from this location, and then go to the next question.
☐ No	Which distributor do you receive your products from? Write your answer here, and then go to the next question.

Code	Product or material	Country of Origin	Frequency	Volume
A				
B				
C				
D				
E				

2. For how long have you received products or materials from overseas?_____

3. Is the product stored at another location or warehouse?

If your answer is:	Then:
☐ Yes	What is the location? Write your answer here, and then go to the next question.
☐ No	Go to the next question.

4. Have you noticed snails, insects or other pests in any imported materials?

If your answer is:	Then:
☐ I don't know	Go to the next question.
☐ No	Go to the next question.
☐ Yes	Explain here, and then go to the next question. Include approximate frequency, types, locations:

5. Have you noticed snails or slugs around your property or neighboring properties?

If your answer is:	Then:
☐ No	Go to the next question.
☐ Yes	Explain here, and then go to the next question. Include locations:

6. What type of solid wood packing material (SWPM) is received with this product?

☐ none ☐ crates ☐ pallets ☐ spools ☐ dunnage
☐ spacers ☐ skidders ☐ chips ☐ shavings ☐ other

7. What is the quality of the solid wood packing material (SWPM) when it is received?

☐ bark ☐ dimensional lumber ☐ other:

8. Is foreign-origin tile or solid wood packing material (SWPM) forwarded from here to other locations?

If your answer is:	Then:
☐ No	Go to the next question.
☐ Yes	Explain here, and then go to the next question.

9. How is solid wood packing material (SWPM) normally handled and disposed of?

If SWPM is:	Then explain how, location, or frequency:
☐ Stored inside	
☐ Stored outside ☐ On-site ☐ Off-site	
☐ Reused as SWPM ☐ On-site ☐ Off-site ☐ Another way	
☐ Recycled into other wood products[1] ☐ Drop box ☐ On-site ☐ Off-site ☐ Other	
☐ Given away ☐ Free Wood sign ☐ Employees ☐ On-site ☐ Off-site	
☐ Burned ☐ On-site ☐ Off-site	
☐ Other ☐ On-site ☐ Off-site	

1 Include the name of the recycling company or site.

10. Have you noticed any damaged, dead or dying trees or shrubs on your property or nearby?

☐ Yes ☐ No ☐ Do not know

☐ Comments:

11. Are you aware of other businesses that regularly import products or materials from overseas?

☐ Yes ☐ No ☐ Do not know

☐ Comments:

Interviewer Date

Pathway Risk Index for Importers of Tile, Marble, Granite, Travertine, and Natural Stone

Use the answers to the questions in ***Pre-Survey Interview*** on page B-4 and the following pathway risk index to identify high-risk sites and prioritize field survey activities. The index scores the answers in the interview, and then tallies them for a total risk index to indicate the level of risk. The point allocations are based on reviews of historical pathway information and port interception data. As new risks and pathways are identified, this index may be adjusted.

If your business imports:	Then earn this score:	And tally score in this column:
Directly to this facility	4	
Indirectly from a local distributor	2	
From countries at high risk (Austria, Bulgaria, Croatia, Colombia, Germany, Greece, Hungary, Italy, Malta, Slovenia, S. Australia, Spain, Yugoslavia)	3	
From countries at medium risk (Brazil, Chile, China, France, Great Britain, India, New Zealand, Thailand, Turkey)	2	
From countries at low risk (Other countries)	1	
Once each year	0	
2 to 3 times each year	1	
4 times or more each year	2	
Less than 1 crate per shipment	0	
More than 1 crate per shipment, container whole or in-part	1	

If the length of the business at its current site is:		
Less than 1 year	0	
1 to 3 years	1	
More than 3 years	2	

Has your business reported seeing snails or other plant pests on imported material?	1	

Total Risk Index		

If your total risk index is this number:	Then the priority of your site is:
None	None
3 to 5	**Low**
6 to 8	**Medium**
9 to 13	**High**

PPQ 391 Specimens For Determination

This report is authorized by law (7 U.S.C. 147a). While you are not required to respond your cooperation is needed to make an accurate record of plant pest conditions. *See reverse for additional OMB information.*

FORM APPROVED
OMB NO. 0579-0010

U.S. DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE

SPECIMENS FOR DETERMINATION

Instructions: Type or print information requested. Press hard and print legibly when handwritten. Item 1 - assign number for each collection beginning with year, followed by collector's initials and collector's number. Example (collector, John J. Dingle): 83-JJD-001.
Pest Data Section – Complete Items 14, 15 and 16 or 19 or 20 and 21 as applicable. Complete Items 17 and 18 if a trap was used.

FOR IIBIII USE
LOT NO.
PRIORITY

1. COLLECTION NUMBER
2. DATE — MO | DA | YR
3. SUBMITTING AGENCY — ☐ State Cooperator ☐ PPQ ☐ Other _____

SENDER AND ORIGIN

4. NAME OF SENDER
6. ADDRESS OF SENDER
ZIP

INTERCEPTION SITE

5. TYPE OF PROPERTY *(Farm, Feedmill, Nursery, etc.)*
7. NAME AND ADDRESS OF PROPERTY OR OWNER
COUNTRY/ COUNTY

PURPOSE

8. REASON FOR IDENTIFICATION *("x" ALL Applicable Items)*

A. ☐ Biological Control (Target Pest Name)	E. ☐ Livestock, Domestic Animal Pest
B. ☐ Damaging Crops/Plants	F. ☐ Possible Immigrant *(Explain in* REMARKS*)*
C. ☐ Suspected Pest of Regulatory Concern *(Explain in* REMARKS*)*	G. ☐ Survey *(Explain in* REMARKS*)*
D. ☐ Stored Product Pest	H. ☐ Other *(Explain in* REMARKS*)*

9. IF PROMPT OR URGENT IDENTIFICATION IS REQUESTED, PLEASE PROVIDE A BRIEF EXPLANATION UNDER "REMARKS".

HOST DATA

10. HOST INFORMATION
NAME OF HOST *(Scientific name when possible)*

11. QUANTITY OF HOST
NUMBER OF ACRES/PLANTS
PLANTS AFFECTED *(Insert figure and indicate* ☐ Number ☐ Percent*):*

12. PLANT DISTRIBUTION
☐ LIMITED
☐ SCATTERED
☐ WIDESPREAD

13. PLANT PARTS AFFECTED

☐ Leaves, Upper Surface	☐ Trunk/Bark	☐ Bulbs, Tubers, Corms	☐ Seeds
☐ Leaves, Lower Surface	☐ Branches	☐ Buds	
☐ Petiole	☐ Growing Tips	☐ Flowers	
☐ Stem	☐ Roots	☐ Fruits or Nuts	

PEST DATA

14. PEST DISTRIBUTION
☐ FEW
☐ COMMON
☐ ABUNDANT
☐ EXTREME

15. ☐ INSECTS ☐ NEMATODES ☐ MOLLUSKS

NUMBER SUBMITTED	LARVAE	PUPAE	ADULTS	CAST SKINS	EGGS	NYMPHS	JUVS.	CYSTS
ALIVE								
DEAD								

16. SAMPLING METHOD
17. TYPE OF TRAP AND LURE
18. TRAP NUMBER

19. PLANT PATHOLOGY – PLANT SYMPTOMS *("X" one and describe symptoms)*
☐ ISOLATED ☐ GENERAL

20. WEED DENSITY
☐ FEW ☐ SPOTTY ☐ GENERAL

21. WEED GROWTH STAGE
☐ SEEDLING ☐ VEGETATIVE ☐ FLOWERING/FRUITING ☐ MATURE

22. REMARKS

23. TENTATIVE DETERMINATION

24. DETERMINATION AND NOTES *(Not for Field Use)*

SIGNATURE
DATE

FOR IIBIII USE
DATE RECEIVED
NO.
LABEL
SORTED
PREPARED
DATE ACCEPTED
RR

PPQ FORM 391 *Previous editions are obsolete.*
(AUG 02)

This is a 6-Part form. Copies must be disseminated as follows:
☐ PART 1 – PPQ ☐ PART 2 – RETURN TO SUBMITTER AFTER IDENTIFICATION ☐ PART 3 – IIBIII OR FINAL IDENTIFIER
☐ PART 4 – INTERMEDIATE IDENTIFIER ☐ PART 5 – INTERMEDIATE IDENTIFIER ☐ PART 6 – RETAINED BY SUBMITTER

Figure B-1 Example of PPQ 391 Specimens For Determination [side 1]

OMB Information
According to the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0579-0010. The time required to complete this information collection is estimated to average .25 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Instructions
Use PPQ Form 391, Specimens for Determination, for domestic collections (warehouse inspections, local and individual collecting, special survey programs, export certification).

BLOCK	INSTRUCTIONS
1	1. Assign a number for each collection beginning the year, followed by the collector's initials and collector's number **EXAMPLE** In 2001, Brian K. Long collected his first specimen for determination of the year. His first collection number is 01-BLK-001 2. Enter the collection number
2	Enter date
3	Check block to indicate Agency submitting specimens for identification
4	Enter name of sender
5	Enter type of property specimen obtained from (farm, nursery, feedmill, etc.)
6	Enter address
7	Enter name and address of property owner
8A-8L	Check all appropriate blocks
9	Leave Blank
10	Enter scientific name of host, if possible
11	Enter quantity of host and plants affected
12	Check block to indicate distribution of plant
13	Check appropriate blocks to indicate plant parts affected
14	Check block to indicate pest distribution
15	• Check appropriate block to indicate type of specimen • Enter number specimens submitted under appropriate column
16	Enter sampling method
17	Enter type of trap and lure
18	Enter trap number
19	Enter X in block to indicate isolated or general plant symptoms
20	Enter X in appropriate block for weed density
21	Enter X in appropriate block for weed growth stage
22	Provide a brief explanation if Prompt or URGENT identification is requested
23	Enter a tentative determination if you made one
24	Leave blank

Distribution of PPQ Form 391
Distribute PPQ Form 391 as follows:
1. Send Original along with the sample to your Area Identifier.
2. Retain and file a copy for your records.

Figure B-2 Example Of PPQ 391 Specimens For Determination [Side 2]

PPQ 523 Emergency Action Notification

According to the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information is 0579-0102. The time required to complete this information collection is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

FORM APPROVED - OMB NO. 0579-0102

U.S. DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
PLANT PROTECTION AND QUARANTINE

EMERGENCY ACTION NOTIFICATION

SERIAL NO.

1. PPQ LOCATION | 2. DATE ISSUED

3. NAME AND QUANTITY OF ARTICLE(S)

4. LOCATION OF ARTICLES

5. DESTINATION OF ARTICLES

6. SHIPPER

7. NAME OF CARRIER

8. SHIPMENT ID NO.(S)

9. OWNER/CONSIGNEE OF ARTICLES

Name:

Address:

PHONE NO. | FAX NO.

SS NO. | TAX ID NO.

10. PORT OF LADING | 11. DATE OF ARRIVAL

12. ID OF PEST(S), NOXIOUS WEEDS, OR ARTICLE(S)

12a. PEST ID NO. | 12b. DATE INTERCEPTED

13. COUNTRY OF ORIGIN | 14. GROWER NO.

15. FOREIGN CERTIFICATE NO.

15a. PLACE ISSUED | 15b. DATE

Under Sections 411, 412, and 414 of the Plant Protection Act (7 USC 7711, 7712, and 7714) and Sections 10404 through 10407 of the Animal Health Protection Act (7 USC 8303 through 8306), you are hereby notified, as owner or agent of the owner of said carrier, premises, and/or articles, to apply remedial measures for the pest(s), noxious weeds, and or article(s) specified in Item 12, in a manner satisfactory to and under the supervision of an Agriculture Officer. Remedial measures shall be in accordance with the action specified in Item 16 and shall be completed within the time specified in Item 17.

AFTER RECEIPT OF THIS NOTIFICATION, ARTICLES AND/OR CARRIERS HEREIN DESIGNATED MUST NOT BE MOVED EXCEPT AS DIRECTED BY AN AGRICULTURE OFFICER. THE LOCAL OFFICER MAY BE CONTACTED AT:

16. ACTION REQUIRED

☐ TREATMENT:

☐ RE-EXPORTATION:

☐ DESTRUCTION:

☐ OTHER:

Should the owner or owner's agent fail to comply with this order within the time specified below, USDA is authorized to recover from the owner or agent cost of any care, handling, application of remedial measures, disposal, or other action incurred in connection with the remedial action, destruction, or removal.

17. AFTER RECEIPT OF THIS NOTIFICATION COMPLETE SPECIFIED ACTION WITHIN (Specify No. Hours or No. Days):

18. SIGNATURE OF OFFICER:

ACKNOWLEDGMENT OF RECEIPT OF EMERGENCY ACTION NOTIFICATION

I hereby acknowledge receipt of the foregoing notification.

SIGNATURE AND TITLE: | DATE AND TIME:

19. REVOCATION OF NOTIFICATION

ACTION TAKEN:

SIGNATURE OF OFFICER: | DATE:

PPQ FORM 523 (JULY 2002) Previous editions are obsolete.

Figure B-3 Example of PPQ 523

Temperate Terrestrial Gastropods

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