**Jiigwul awGa**

**Haida Gwaii Dusky Shrew**

**(*Sorex monticolus*)**

Management Plan for Haida Gwaii

horizontal line

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**Preface**

The dusky shrew is a staple in the diet of the Haida Gwaii ermine. The ermine on Haida Gwaii are part of a subspecies endemic to the islands and are listed as “threatened”   
under COSEWIC (Government of Canada, 2015). The population of dusky shrew on Haida Gwaii is not listed as threatened but their population is affected negatively by predation and competition from invasive rats. The aim of this management plan is to provide a strategy for increasing the population of dusky shrew by eradicating Norway and Black rats, thereby increasing the population of ermine.

**1.0 Background**

1.1 Geographic Range

The dusky shrew (*Sorex monticolus*) also known as the montane shrew, is a small mammal that can be found in a wide range in North America. They are found along the west coast (including Haida Gwaii and Vancouver Island) from Alaska down to Mexico, and as far east as Manitoba (Mt.Gov).

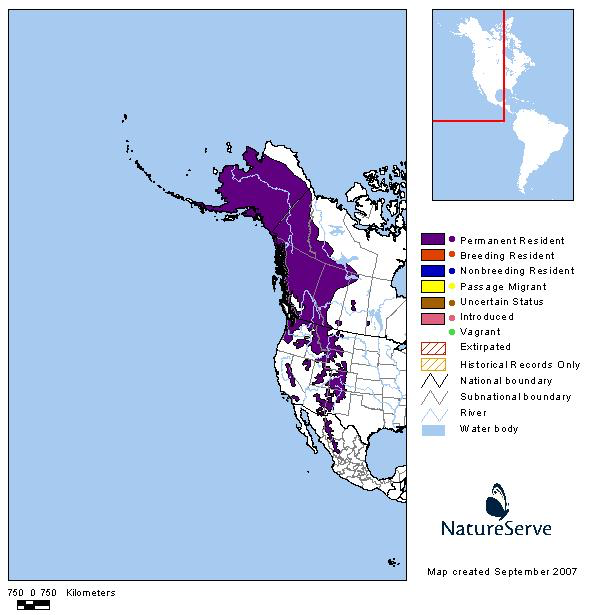


Figure 1. Geographic Range of Dusky Shrew (Mt. Gov).

1.2 Habitat

Dusky shrews have a wide habitat range. They can be found in tundra, alpine meadows, forests and prairies (Banasiak, 2001). The shrews do not often burrow and usually inhabit areas with a lot of ground cover and woody debris, such as clearcuts. During the colder seasons, the shrews will inhabit areas with fallen logs, or cover under aspen, and during the warmer seasons spread out through fields and meadows under the cover of grass. They prefer wet/moist areas with acidic soils that reside near streams/rivers and forests (Smith & Belk, 1996). Dusky Shrews make dens in decaying logs with a bundle of grasses (Eder & Kennedy, 2011).

1.3 Physical Description

The dusky shrews are small and mole-like mammals. Shrews are distinguishable from their long snouts and long tails, but it is difficult to tell shrews apart without observing their teeth (Eder & Kennedy, 2011). In the upper jaw, they have one incisor with two cusps, five unicuspids, and four molars. In the lower jaw they have one incisor, 2 unicuspids, and 3 molars (Smith & Belk, 1996). Dusky shrews are considered medium-sized shrews. Their size ranges between 103-144mm and have long tails that are approximately 40-62mm (Smith & Belk, 1996). They are a pale brown, with a grey-light brown underside. In the winter they are darker in colour (Eder & Kennedy, 2011). They shed twice yearly, in the fall and in the spring (Smith & Belk, 1996).

1.4 Life Cycle

The dusky shrews mating season is between March-August (Eder & Kennedy, 2011) as their time of mating differs depending on geographic range (Banasiak, 2001). The litter size is between 2-9 young, which need to be nursed for a three week period until they are able to survive on their own (Eder & Kennedy, 2011). The females go into a postpartum estrus, and will usually have 3-4 litters per season (Smith & Belk, 1996). The life expectancy of the dusky shrew is 12-18 months (awd).

1.5 Behaviour

Dusky shrews are unsocial and rarely territorial. Young shrews may be territorial to maintain their winter habitat, but breeding shrews do not display territorial behaviour (Smith & Belk, 1996). Female shrews will stay in the home range their whole lives whereas male shrews usually leave their original home range. Males may choose a new home range near the home ranges of 5 or so females home range (Banasiak, 2001). Shrews are active 24/7, they have three peak times of activity a day, twice during the night and once during the day. Their daytime activity is limited and they do not hibernate (Banasiak, 2001).

1.6 Food

Shrews are insectivores. Their diet consists of adult and larval insects, spiders, snails, slugs, earthworms, and some vegetation. They will also scavenge for carrion and eat small salamanders (Eder & Kennedy, 2011). The majority of a shrews life they are scavenging for food. They need to keep up their metabolic rate to keep warm due to their small sizes; they are prone to losing body heat quickly (Banasiak, 2001).

1.7 Ecological Role

Dusky Shrews roles in the ecosystem consist of eating prey that many would consider “pests” (as shown in 1.6) and feeding predators. Regular predators of the shrew include; snakes, owls, cats, weasels, and even larger fish such as trout or bass. The predators of the Haida Gwaii shrew include; ermine, saw whet owls, pine martens, and other large birds.



Figure 2: General Food Web of Dusky Shrew on Haida Gwaii

1.8 Population Density

Dusky shrews are very common and have a wide geographic range, and there is not much information on the status of the shrew However, on Haida Gwaii the population size is not worrisome, they are fewer shrews due to invasive rats out competing them (Towns, Atkinson, & Daugherty, 2006).

**2.0 Ermine on Haida Gwaii**

The Haida Gwaii ermine (Mustela erminea haidarum), also known as the short-tailed weasel, is a subspecies of ermine. Ermine are small and skinny with long bodies. They are brown in colour during the summer, and white during the winter with year-round black tails (Government of Canada, 2015). The ermine prefer to live in low-elevation forested areas that are close to streams, rivers or lakes. Areas with a high coarse woody debris are also preferred as it offers protection from predators and their main prey (dusky shrew) is often found in CWD (Ermine, 2009). Ermine breed during the months of May-July. Female ermine reach sexual maturity early in life (2-3 months), while males reach sexual maturity after a year. It takes 10-11 months for the litter to be born, as there is a 9 month delay in the fertilization of the egg. A litter usually consists of five to nine young. Males will continually mate with as many females as possible (Government of Canada, 2015). The biggest threat to Ermine is the habitat changes, as the introduced sitka black tail deer have decreased a lot of understory vegetation which previously served as a protection for the ermine (Ermine, 2009). Other threats include invasive rats, racoons, as predators as well as the pine marten both is a predator and a competitor with the ermine (Government of Canada, 2015).

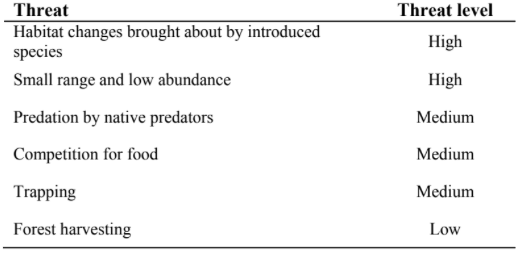


Figure 3. Threats of Haida Gwaii Ermine (Ermine, 2009)

**3.0 Rats on Haida Gwaii**

Rats first appeared on Haida Gwaii in the 1700s when they arrived on ships. Since that time they have caused a lot of disturbances on Haida Gwaii. Both Norway and Black rats have invaded 18 islands in the archipelago. They are threatening many native species to Haida Gwaii such as seabirds, songbirds, dusky shrew, and ermine. There has been an ongoing attempt to eradicate rats on some of the islands, but some of the islands that have had eradications, have had the rats re-establish themselves (ISC, 2019). Both black and norway rats are excellent swimmers and climbers which helps them be skillful invaders. They can hold their breath for a long time and tread water for up to three days. They also have great memories which helps them find their way around the islands. Though they only live for approximately 2-3 years they are avid breeders (Western Exterminator Company, 2019). Norway rats reach sexual maturity at 2-5 months and can have 2-12 litters a year, with 4-22 young in each litter (Orkin). Black rats reach sexual maturity at 3-5 months. They can have up to 5 litters a year, with approximately 8 young per litter (Gillespie, 2004). These high rates make total eradication difficult, and make it more difficult to keep the rats from coming back.

**4.0 Limiting Factors of Dusky Shrew**

|  |  |  |
| --- | --- | --- |
| Magnitude | Threat | Impact |
| Low | Habitat Degradation | Habitat is mainly in riparian areas which are threatened by human activities (logging, recreation, etc.) |
| Low | Reproduction | Need specific habitat for optimal reproduction conditions |
| High | Rats | Predation and Competition for food |

Table 1. Summary of Threats to Dusky Shrew on Haida Gwaii Including Estimated Impact

4.1 Rats

Rats are the most direct risk to Dusky Shrew populations on Haida Gwaii as there are two species of rat present, Norway Rat (*Rattus norvegicus*) and Black Rat (*Rattus rattus)*, that are considered invasive species. Black rat has been associated with the decline or extinction of the largest amount of native vertebrate species (sixty), which includes small mammals such as shrews (Towns, Atkinson, & Daugherty, 2006). There have been numerous rat eradications on Haida Gwaii over the last few decades, and each one has provided more information into the ecology of rats on the islands and the impacts of eradication on other species. During the 1993-1997 eradication of Norway Rats from Langara and Lucy Islands (Smith & Belk, 1996), shrews were also monitored in relation to the rat traps and to establish population estimates. It was observed that while shrew populations at the beginning of the campaign first decreased by way of non-target poisoning from the traps, the population decline was brief. It was noted that shrews likely benefited from the removal of the rats due to reduced competition for prey (insects) and decreased predation. Shrews had nearly returned to pre-eradication levels by May 1995 on Lucy Island after eradication ended in August 1994 (Smith & Belk, 1996).

In Night Birds Returning: Feasibility Study for Removal of Black Rats from Murchison and Faraday Islands (Parks Canada Agency, 2012), It is stated that Dusky shrews are unlikely to be present on Murchison or Faraday islands due to direct predation and resource competition by black rats. They note that while Dusky shrew is not considered at risk provincially or federally, they recommend further studies to confirm the absence of Dusky shrew on these islands. It is noted that through an aerial eradication approach on Murchison and Faraday islands, it is likely that shrew populations will suffer, but it would be possible to reintroduce shrews to the islands if they are fully extirpated due to the pressure from rat predation as well as non-target poisoning from the eradication (Parks Canada Agency, 2012).

As evidenced in (Drever, 1997), shrew populations can likely return to pre-eradication densities even after non-target poisoning of shrews occurs. Drever goes on to comment that it is possible, however, to decrease the amount of non-target poisoning that results in small, native mammals. Modifications to bait stations were tested throughout the project but failed to produce evidence of significant differences in shrew captures. However, Drever also states that the techniques tested show promise and more research is necessary in rat-targeted traps.

A study on Norway rat eradications on five islands off the coast of France (Pascal, Siorat, Lorvelec, Yésou, & Simberloff, 2005) demonstrated that after the eradication of the rats, two species of shrew recovered markedly. It was also found that the distribution of the lesser white-toothed shrew, that had been restricted to two areas with few rats before, spread to encompass nearly the whole island four years after rats were eradicated. These results are valuable as a case study indicating a strong detrimental association between Norway rats and shrew species. As well, these reports were only available due to the rigorous sampling process that took place, showing that eradications can have many important contributions for scientists and managers if strategic research is also conducted. The need for better research on native species is also noted by (Pascal, Siorat, Lorvelec, Yésou, & Simberloff, 2005) “Deficiencies in our knowledge would be reduced by documenting distribution and abundance of indigenous species before and after eradications”. Better assessments of the extent of the impacts rat eradications have on native species would help to create models that could be used to determine the effects of invasive rat species.

2.2 Reproduction and Habitat Degradation

Dusky shrews have been found to have higher reproductive rates in areas with a high amount of Coarse Woody Debris (CWD) (Lee, 1995). Due to this and their proclivity for nesting in riparian areas and near streams (Smith & Belk, 1996), it should be argued that riparian areas be protected for the increase of their populations.

**5.0 Benefits to the Haida Gwaii Ermine**

5.1 Haida Gwaii Ermine Prey

The species of ermine *(Mustela erminea haidarum)* found on Haida Gwaii is an endemic species to Haida Gwaii. This brings some possible challenges to their population. Based off of other research conducted on other ermine subspecies found on the mainland and other island ecosystems we can infer its diet. The ermine has adapted to predate on arvicoline rodents as their main source of prey, such as voles and lemmings (Edie, A. 2001). But neither of these species are found on Haida Gwaii. This results in the ermine being forced to prey on other, smaller prey that is found on haida Gwaii. Because of the absence of voles on Haida Gwaii, the importance of other, lesser preferred prey is increased and can even make the species more vulnerable to disturbance (Ermine, 2009). These species include the Keen’s mouse *(Peromyscus keeni)* and dusky shrews *(Sorex monticolus)* (Edie, A. 2001). Because of these species smaller size (compared to voles or lemmings) it has been found that they are insufficient prey for the ermine. As Haida Gwaii islands are ample in many different habitats, it is hard for the ermine found on the islands to find and catch these smaller types of prey that they aren’t as well adapted to. Based on this researchers of the ermine suggest that these small rodent species and their inability to provide ermine with the food source that they need, may be a reason why the Haida gwaii ermine limits the sub-species to relatively low densities and can also limit the sub-species population growth (Edie, A. 2001). Outlined in the COSEWIC status report update of the ermine *haidarum* subspecies it says directly that a potential threat to the ermine includes the poor supply of food that is present on Haida Gwaii (Edie, A. 2001).

5.2 Predator-prey link

In numerous other studies conducted on short-tailed and least weasel species that are closely related to ermine, a link between prey density and predator (weasel) density can be found (Edie, A. 2001). The link shows that when arvicoline prey is richer, reproduction of the weasels is more successful, causing populations of weasels to increase. There is also a link when prey is less abundant as well, but weasel reproduction decreases or even fails completely. This cases the populations to decline and possibly disappear entirely (Edie, A. 2001). Because of these connections and the already poor small mammal community on Haida Gwaii puts the ermine found here at a possibly severe disadvantage. With Haida Gwaii ermine being naturally bound to prey availability it can be argued that this factor has a larger impact on ermine populations over possible predation of ermine by marten (Ermine, 2009). Another link that was also found isn’t between ermine and prey, but between prey and food supply. It was stated in the ermine recovery strategy that prey abundance is more likely to be linked to food supply over physical habitat features (Ermine, 2009). This is because of the vast span of habitats that prey such as the Keen’s mouse and the dusky shrew can cover, with the mice being found in all terrestrial sites (from shoreline to alpine) and the shrew being found in moist, riparian habitats that contain dense undergrowth (Ermine, 2009).

5.3 Haida Gwaii Prey Disadvantages

But as stated before, these arvicolines aren’t found on Haida Gwaii, and this causes a disadvantage to female ermine specifically, as their prey is limited to the Keen’s mouse and the dusky shrew. Other studies conducted outside of Haida Gwaii in North America found that deer mouse *(Peromyscus maniculatus)* and dusky shrews are a part of other weasel species, with dusky shrew being found to be a more common prey compared to deer mice in three different studies (Lisgo, 1999; Simms, 1979a; Fitzgerald, 1977) (Edie, A. 2001). The COSEWIC status report update of the ermine *haidarum* subspecies also briefly outlined the possible extent that the small mammals found on Haida Gwaii actually contribute to ermines diet. It said that deer mice may be more challenging to catch compared to the ermines usual arvicoline prey that the ermine are best adapted for, and that because of this there may even be possible avoidance of selection of deer mice as prey. The report also stated that Keen’s mouse may even be more arboreal then deer mice, which makes the likelihood that ermine prey on them even lower than deer mice. When it comes to the dusky shrew their small mean body mass (about 6 grams) makes them a feeble alternate prey compared to the larger prey that ermine are adapted for (Edie, A. 2001). But even so it is more likely that the dusky shrew is a more important food resource as ermine are more likely to prey on them over the Keen’s mouse because the climbing habit of the mice makes them harder to catch (B.C. Conservation Data Centre). Covered in the Ermine Recovery plan, it was found that the abundance of Keen’s mouse and the dusky shrew can shift widely from year to year (Ermine, 2009). There is also evidence of smaller species of birds being present in ermine diets but as this management plans focuses on the links between the dusky shrew and ermine the presence of those species in ermine diet aren’t covered in this plan.

5.4 Overlap of Ermine and Marten Prey

It is believed that marten and ermine diets have always overlapped. But even though marten are adapted to prey on larger, introduced species that the ermine cannot prey on, there is still overlap of some prey species between the two (Edie, A. 2001). Before introduced species the Keen’s mouse would’ve been the exceeding choice of prey for marten historically and presently when compared to the dusky shrew presence in marten diet. But the Keen’s mouse is also importantly historically and currently to the ermine as well. Before introduced species were brought to Haida Gwaii it is assumed that food supply was a large limitation for both predators, and with the Keen’s mouse being more important to ermine it’s possible that high exploitative and interference competition existed between the predators (Edie, A. 2001). But even with this competition present it is more likely that it was more on marten as ermine are a more adequate predator of Keen’s mouse as they could pursue the mice through smaller escape refuges then the marten would be able to because of the ermines smaller body size and the fact that it would be less of an energy expenditure for the ermine (Edie, A. 2001).

5.5 Introduced Species

Studies have found that introduced species such as squirrels, rats and muskrats aren’t a food resource to female ermine specifically and that any food resources that they could potentially provide play a minimal role in the population dynamics of the ermine. Male ermine could prey on introduced red squirrels when they are in their juvenile phase as ermine found in Alberta have been found to prey on squirrels and that they make up a significant part of the male ermine diet (Edie, A. 2001). But male ermine found in Alberta have a mean winter weight of 150 grams compared to the 110 gram mean winter weight of ermine found in Haida Gwaii, meaning ermine on Haida Gwaii could be less successful in catching squirrels compared to their mainland relatives (Edie, A. 2001). Because of this weight difference this also means that Haida Gwaii ermine are less likely to be successful in predating on introduced species such as rats and muskrats, as they are all larger than squirrels (muskrats being the least likely to be predated on because of their aquatic habitats) (Edie, A. 2001).

**6.0 Knowledge Gaps**

There are a couple of knowledge gaps that must be taken into consideration in order to properly develop and implement a successful management plan. Research of native species during rat eradications only occurs after an eradication has taken place. In order to properly visualize the impacts that come out of invasive eradications research needs to be conducted before, during, and after eradications. This would allow researchers to fully realize the impact that eradications have on native species. Before eradications a population estimate of dusky shrew should be developed along with identifying possible negative effects of the eradication. During the eradication monitoring must be done in order to determine if the dusky shrew are casualties of the eradication. Once an eradication has occured long-term monitoring of dusky shrew populations should be conducted in order to gauge the benefits, if there are any, that the eradication has. There is also no definitive estimate of the dusky shrew population on Haida Gwaii or they’re direct effects to ermine populations. Further research in this area would allow for a better focused management plan. Collaboration between dusky shrew and ermine research teams could be a straightforward way of closing this knowledge gap. Finally, more research should be conducted in order to learn more about the dusky shrews overall effect in the ecosystems it is present within.

**7.0 Management Strategy**

7.1 Management Goal

To increase Dusky Shrew populations on Haida Gwaii by further eradications of rats and protection for critical habitat in order to provide a larger amount of prey for Ermine which are endangered on Haida Gwaii.

7.2 Management Objectives

1. Provide current population estimates of Dusky Shrew on Haida Gwaii through monitoring and research.
2. Identify critical habitat of Dusky Shrew and determine if protection of these areas is necessary.
3. Determine the extent of threat Norway Rat (Rattus norvegicus) and Black Rat (Rattus rattus) have to populations of Dusky Shrew.
4. Eradication of rats and further research on rat baiting that will not attract shrews.
5. Further monitoring of Dusky Shrew, rat, and ermine populations to determine impacts of rat eradication and establish new population estimates.

7.3 Objectives

Table 2. Objective 1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Objective 1: Determine current population estimates of Dusky Shrew** | | | | | |
| **Priority** | **Broad Strategy** | **Recommended Approach to Meet Recovery Objective** | **Action** | **Knowledge Gap Addressed** | **Timeline** |
| High | Research | Produce current population estimate | Conduct surveys using live traps and wildlife cameras | Current Haida Gwaii population estimates | Long-term monitoring |
| Medium | Outreach | Use local resources such as ermine researchers and rat managers to record sightings | Start line of conversation with local scientists to discuss population size of dusky shrew | Continuous information source of shrew sightings | Long-term |
| Medium | Outreach | Use public resources | Use citizen science through public apps/social media such as iNaturalist to add to research | Gathering data on population size and location | Long-term |

Table 3. Objective 2

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Objective 2: Identify Critical Habitat of Dusky Shrew and Determine if Protection of Habitat is Necessary** | | | | | |
| **Priority** | **Broad Strategy** | **Recommended Approach to Meet Recovery Objective** | **Action** | **Knowledge Gap Addressed** | **Timeline** |
| High | Research | Determine the extent of shrew habitat | Survey riparian areas and areas of CWD throughout Haida Gwaii and setup live traps and wildlife cameras in diverse habitat types | Determine critical shrew habitat and extent of distribution on Haida Gwaii | Short-term intensive monitoring |
| High | Research | Determine extent of human impact on shrew habitat | Survey critical habitat for human impact (logging, fishing, etc) | Impact of human activities on shrew habitat | Mid-term monitoring - Intensive surveying at first then monitor as human disturbances occur to determine relation |
| Medium | Research and Mapping | Identify range of both sexes of shrew | Trap individuals and use micro-GPS receivers to track movement | Variation in home range size and seasonal changes (eg. breeding season) | Mid-term monitoring- A couple months seasonally |

Table 4. Objective 3

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Objective 3: Determine the extent of the threat of Norway Rats** | | | | | |
| **Priority** | **Broad Strategy** | **Recommended Approach to Meet Recovery Objective** | **Action** | **Knowledge Gap Addressed** | **Timeline** |
| High | Research | Record interactions between rats and shrews | Determine presence of shrew in rat diets | Extent of predation of rats on shrews | Long-term monitoring |
| High | Research | Identify common resources used by both rats and shrews and assess competition | Assess overlap between niches- determine extent of resource competition | Extent of competition for resources between rats and shrews | Long-term monitoring |

Table 5. Objective 4

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Objective 4: Eradication of rats and further research on rat baiting that will not attract shrews** | | | | | |
| **Priority** | **Broad Strategy** | **Recommended Approach to Meet Recovery Objective** | **Action** | **Knowledge Gap Addressed** | **Timeline** |
| High | Research & Management | Determine overlap between shrew critical habitat and areas of high rat density | Survey areas with high rat populations and identify shrew critical habitat within | Determine where shrew populations are most threatened by rats | Short-term intensive monitoring |
| High | Management | Eradicate rat populations in critical shrew habitat | Use baiting and traps to eradicate rat populations | Rat populations are managed through eradication | Medium-term- On a seasonal basis to avoid shrew breeding season |
| Medium | Research and Management | Research and implement new traps to avoid shrew capture | Throughout eradication research and test new traps that target rats specifically to avoid non-target capture and poisoning of shrews | Implement new traps that target rats and prevent shrew mortality | Long-term - throughout eradication process |

Table 6. Objective 5

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Objective 5: Further monitoring of dusky shrew, ermine, and rat populations to determine impacts of rat eradication and establish new population estimates** | | | | | |
| **Priority** | **Broad Strategy** | **Recommended Approach to Meet Recovery Objective** | **Action** | **Knowledge Gap Addressed** | **Timeline** |
| High | Research and Management | Monitor dusky shrew populations before, during, and after rat eradications | Monitor shrew populations through live traps and wildlife cameras previously set up for up to 3 years after eradication | Assess long-term effects of rat eradication on shrew populations | Long-term |
| High | Research and Management | Monitor ermine populations before, during, and after rat eradications | Monitor ermine populations through live traps and wildlife cameras for years after eradication | Assess long-term impact of rat eradications on ermine and provide insight into food web | Long-term |
| High | Research and Management | Monitor rat populations before, during, and after rat eradications | Monitor rat populations through baited traps throughout process of the eradication and for years after | Determine effectiveness of eradication on rat populations and assess areas of population rebound | Long-term |

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**All**- 7.1 Management Goal, Preface