Terrestrial Invertebrates – Introduction

Invertebrates, or animals without backbones, are a diverse group occupying marine, freshwater, and terrestrial habitats. Terrestrial invertebrates include all of the groups listed at the end of this introduction, in order from most primitive (worms) to highly evolved (insects). The list illustrates the incredible diversity of species represented by this group.

Currently, there are no federal or state listed terrestrial invertebrates in Alaska. Information from the coterminous United States indicates that invertebrate populations of concern—like many declining bird, mammal and amphibian populations—are affected by habitat degradation and habitat loss 87% of the time, and by pollution 45% of the time, among other factors (Stein et al. 2000). This is important because it tells us that the factors that cause species to become rare often operate in similar fashion for invertebrates as for the vertebrate species that humans tend to be more aware of and to value more highly. By the same token, management efforts that benefit an important bird species, for example, could also have positive benefits for the invertebrate species that share its habitat.

Invertebrates are often keystone components of the habitats and ecosystems of the more familiar vertebrate species that we value. It is perhaps difficult to appreciate the importance of microbes and worms, which are essential for the improvement of soil fertility. In the Arctic, large populations of mites, collembolans (springtails), enchytraeid worms, and insect larvae assist in decomposition by breaking down plant and animal material (CAFF 2001). Decomposition helps determine the amount of organic matter accumulated in the soil. Thus, it is essential to soil fertility and plant growth upon which all terrestrial animals ultimately depend.

Less difficult perhaps is some appreciation for bees, which are known to pollinate a wide diversity of domestic and wild plants. In the late 1980s, the value of insect- (that is, mostly bee-) pollinated crops in the United States was estimated as ranging between $4.6 billion and $18.9 billion (Daily and Ellison 2002). Plants that rely on pollinators include potatoes, almonds, soybeans, onions, carrots, and many greenhouse crops. The decline of native pollinators in many areas has had significant economic impacts on cash crops (Kevan and Phillips 2001). Therefore, it is no surprise that farmers and gardeners whose crops rely on native pollinators have begun to incorporate some common-sense conservation practices, including protecting natural habitat where native bees and other beneficial insects can thrive; leaving enough wildland to provide a functioning habitat; buffering these important areas from areas where pesticides are being used; mixing crops where possible and maintaining weedy borders, ground cover, and hedge-rows; and aiming for sequential flowering so that there will be nectar and pollen year-round for the beneficial insects. Many of these practices are intended to mimic what intact natural ecosystems already provide.

In Alaska, where farms are relatively few in comparison to the Lower 48, the economic importance of pollinators is best illustrated by their usefulness in natural systems and their vital role in maintaining sport and subsistence hunting. Most insect pollination in the Arctic is done by flies and by bumblebees (Pielou 1994). Many of the plants that benefit from their activity, such as the arctic willow (*Salix arctica*), are highly important to caribou, which in turn are highly important to humans for their meat and hides.

Invertebrates are important food sources for other species. A wide-ranging Alaskan species such as the Blackpoll Warbler, for example, eats aphids, flies, beetles, gnats, mosquitoes, wasps, ants and spiders (Hunt and Eliason 1999). The breeding seasons for many birds occur when insect populations are at their highest levels. Little is know about bats in Alaska, but elsewhere their diets depend heavily on both terrestrial and aquatic invertebrates. Spiders composed 15% of the estimated diet volume of the little brown bat (*Myotis lucifigus*) in Southeast Alaska (Parker 1996) and 16% in central Alaska (Whitaker and Lawhead 1992).

Many recent studies have considered the potential of invertebrates as reliable indicators of disturbance or degradation in terrestrial systems (Holliday 1991; Niemela et al. 1993; Anderson 1997; Blair and Launer 1997; Rodriguez et al. 1998). Terrestrial invertebrates are prevalent, have high species diversity, are easy to sample, and are important in ecosystem function (Rosenberg et al. 1986). They respond to environmental changes more rapidly than vertebrates and can provide early detection of ecological changes (Kremen et al. 1993). They also have diverse roles in natural environments that include functioning as decomposers, predators, parasites, herbivores, and pollinators, and these roles are affected by various perturbations.

Some studies have examined the responses of various taxa, including ground beetles (family Carabidae), ants (family Formicidae), and butterflies, to urbanization, logging, agricultural practices, and fire. More recently, studies have attempted to examine terrestrial invertebrate assemblages across a range of disturbance events, with the goal of selecting groups that respond in a consistent manner to various types of disturbance, and using those for developing a terrestrial index of biological integrity. Similarly to the aquatic indices now in use, terrestrial indices would provide an objective way to assess the biological condition of various sites, which is the ultimate key to successful restoration, mitigation, and conservation efforts.

Traditional management has taken a single-species perspective focusing on the activities that directly threaten declining species. It is not likely that we can successfully conserve invertebrate diversity if we try to survey, study, manage, and monitor invertebrates one by one. The loss of species interactions and their ecological functions may be of even greater consequence than the loss of one or more individual species (Levin and Levin 2002; Soule et al. 2003). Management that takes a broad multi-species and -systems perspective may be essential to the conservation of invertebrate species and the ecosystems of which they are a part. We are hampered by our lack of specific information about the various ecosystem functions of terrestrial invertebrates. As an ideal, however, we strive toward holistic and adaptive ecosystem-based management of Alaska’s terrestrial systems to maintain functioning landscapes and natural communities.

Our knowledge of the status of terrestrial invertebrates is less than that of any other taxonomic group. For this reason, it is virtually impossible to come up with a list of species of invertebrates of concern that would be at all comparable to lists for vertebrates. In addition, vertebrate groups are split out much more finely than the tremendous and diverse group of animals lumped together here as “terrestrial invertebrates.”

One logical starting point for terrestrial invertebrate conservation efforts would be to focus on the habitats for terrestrial invertebrates within the 7 general habitat types identified by the planning team: forests, tundra, freshwater aquatic, wetlands, marine aquatic and coastline, sea ice, and karst caves. Appendix 5 describes each of these complex habitat types and subtypes, associated species ecological importance, status, and recommendations for conservation. Table 34, Section VI, lists these types and the standard subtypes for which experts identified concrete information regarding species' habitat requirements. Forest (boreal, coastal temperate rain forest), tundra (alpine, arctic, maritime), wetland (grass, sedge, bog, salt marsh), and karst cave (entrance zone, twilight zone, deep cave zone) habitats would be especially important for terrestrial invertebrates.

In May 2003, a number of invertebrate experts participated in a Candidate Conservation Workshop, organized by USFWS (Judy Jacobs, pers. comm.). They identified a number of high priority activities; many of these are captured in the Terrestrial Invertebrates Template below. The group also identified several areas and specialized habitats that require survey. The potential to identify new and habitat-limited invertebrates, as well as plants and mammals, is high in these places. They include the isolated Nogahabara Dunes and Great Kobuk Dunes of northwest Alaska; the steppes and south-facing slopes of the southern Yukon River, which include rare plants and vegetation similar to western Beringia during the last glaciation; the 3000 feet of south-facing slopes associated with Castle Mountain; the Kenai Peninsula with its mix of maritime and continental climates; and the Aleutian Islands and the Seward Peninsula with its associated coastal islands, which were all connected at one time to Asia and the Russian paleoarctic as part of the Bering Land Bridge. Urbanizing areas, such as Anchorage, the Matanuska-Susitna valleys, and Fairbanks, also may require immediate study.

Based on limited information, we have included 2 groups of potentially rare invertebrates in Alaska: the western bumblebee and land snails. Concerns for their status are presented next.

The western bumblebee (*Bombus occidentalis*) once ranged from northern California northward along the Pacific Coast; it has declined precipitously from northern California to British Columbia. Very few if any specimens have been collected in California, Oregon, and Washington in the last few years. More recently, bees in British Columbia seem to be declining dramatically as well. The decline may be associated with a pathogen introduced by nonnative bees. We do not know if this species is waning in Alaska, or if it is already extirpated. There are two morphologically different forms of this bumblebee, an interior form, and a Pacific coastal form. Biologists speculate that the interior form is still abundant, but status of the coastal form is unknown.

Similarly, little information is available for the land snails of the Arctic and boreal habitats of North America. Baxter (1983) summarized the few earlier reports of Alaskan land snails at 31 species. Additional work by Brian Coles (2002, University of Arkansas for Medical Sciences, unpublished) in the Anchorage region added 10 species for the state, showing that some wetlands contain an undescribed (and perhaps endemic) *Vertigo* species, and that other species also are highly restricted in range and/or habitat, with a striking cline of species from Anchorage to Girdwood (boreal-Pacific north-west). Arctic Alaska is almost unexplored for land snails, yet they can be a common component of the Arctic tundra (e.g., *Vertigo hannai* is abundant in the tundra of Churchill, Manitoba; Jeff Nekola, University of Wisconsin – Green Bay, and Brian Coles, University of Arkansas for Medical Sciences, 2003, unpublished). Further work needs to be done to determine whether these snails are endemic to their type localities or more widely distributed.

Terrestrial Invertebrates

"Animals Without Backbones"

(Note: The following information was derived from BIOSIS; it is based on a simplified and somewhat abbreviated classification scheme for the animal kingdom following the Zoological Record indexing service.)

Phylum **Nematoda**: includes round, thread (some), whip, lung, hook, and eel worms
Many nematodes are free living and play critical ecological roles as decomposers and predators on microorganisms; also include parasitic species. One study reported around 90,000 individual nematodes in a single rotting apple. Another reported 236 species living in a few cubic centimeters of mud. The number of described species is around 12,000, but too little attention has been paid to these animals and the true number may be closer to 500,000 (Myers 2001).

Phylum **Annelida**: includes leeches, earthworms, terrestrial bristle worms
Currently, more than 830 species of annelids representing 27 families, 12 orders, and 5 classes (Oligochaeta, Aphanoneura, Branchiobdellae, Acanthobdellae, and Hirudinea) are recognized as occurring in the U.S. and Canada; these include both native and introduced species (Coates et al. 2003). Many species function as decomposers, and enhance soil properties.

Phylum **Mollusca**: includes slugs, land snails, and their relatives (gastropods)
Gastropods are by far the largest group of molluscs. Their 40,000 species comprise over 80% of living molluscs. Gastropod feeding habits are extremely varied. Some graze, some browse, some feed on plankton, some are scavengers or detritivores, and some are active carnivores (Myers and Burch 2001).

Phylum **Arthropoda**: includes crustaceans, arachnids, and insects; easily the largest phylum of all animals and of great economic importance

- Class **Malacostraca**: includes many marine, freshwater species; also terrestrial isopods
  - Order **Isopoda:** isopods, pill bugs, woodlice
- Class **Arachnida:** spiders, mites, ticks, scorpions
- Class **Pentastomida:** tongue worms, parasitic group
- Class **Chilopoda:** centipedes
- Class **Diplopoda:** millipedes
- Class **Entognatha:** minute arthropods mostly found in leaf litter and soil
  - Order **Collembola:** springtails
  - Order **Protura:** proturans
  - Order **Diplura:** diplurans
- Class **Insecta:** insects
  - Order **Anoplura:** sucking lice, true lice
  - Order **Coleoptera:** beetles
  - Order **Dermaptera:** earwigs
  - Order **Dictyoptera:** cockroaches, mantids
  - Order **Diptera:** true flies

Order **Hemiptera:** true bugs, aphids, plant lice, cicadas, mealy bugs, scale insects, jumping plant lice
Order **Hymenoptera:** wasps, ants, bees, sawflies
Order **Isoptera:** termites, white ants
Order **Lepidoptera:** butterflies and moths
Order **Mallophaga:** bird lice, biting lice
Order **Mecoptera:** scorpionflies
Order **Neuroptera:** dobsonflies, doodlebugs, lacewings
Order **Orthoptera:** leaf insects, stick insects, crickets, grasshoppers, groundhoppers, katydids, locusts
Order **Psocoptera:** bark lice, book lice
Order **Siphonaptera:** fleas
Order **Strepsiptera:** twisted wing insects
Order **Thysanoptera:** thrips
Order **Thysanura:** bristletails, silverfish

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Terrestrial Invertebrates

A. Species group description

Common name: terrestrial invertebrates
Scientific name:

B. Distribution and abundance

Range:
<u>Global range comments:</u> Ranges vary; many are only partially described or completely unknown.
<u>State range comments:</u> Ranges vary; many are only partially described or completely unknown.

Abundance:
Global abundance comments: Mostly unknown
State abundance comments: Mostly unknown

Trends:
Global trends: Mostly unknown
State trends: Mostly unknown

C. Problems, issues, or concerns for species group

- The primary issue for terrestrial invertebrates in Alaska is the lack of information on geographic distribution, abundance, habitat use, and species diversity in this large, remote, and under-surveyed state.
- Many common habitats and most unique habitats are under-surveyed. Little work has been conducted off the existing road system.
- Insects associated with rare plants need additional study.
- In many cases, the ability to identify species with appropriate taxonomic keys and species descriptions is lacking.
- Existing information is scattered and not compiled in a consistent, accessible fashion. Many specimen collections are outside of Alaska.
- Coordination of efforts could be improved. Communication among experts, interested managers, and general public also could be enhanced.
- The important roles of terrestrial invertebrates, even when known, are not appreciated and are undervalued by most people.
- Endemic species need to be identified and conservation status assessed.
- Response of various groups to climate change is uncertain.
- Establishment of baseline information on populations would permit proactive management.

D. Location and condition of key or important habitat areas

Habitat for many terrestrial invertebrates generally is assumed to be abundant and widely distributed across the state. The specific habitat requirements of many species, however, are poorly understood. An evaluation of habitat locations and conditions is needed.

E. Concerns associated with key habitats

- Unknown at present; since habitat loss and degradation are the most common causes of species' declines, it will be important to identify key, important, and unique habitats for future conservation efforts.
- Climate change will influence species distribution, habitat quality, and habitat quantity.

F. Goal: Ensure terrestrial invertebrates remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

State conservation and management objectives and actions:

Objective: Assess and describe current geographic distribution, abundance within existing range of variation, and species diversity of terrestrial invertebrates in Alaska.

Target: Survey unique, threatened, or representative habitats (at least 2 sites) for key or priority terrestrial invertebrates in each Alaska state region in the next 10 years.

Measure: Spreadsheet documenting baseline species presence/absence information, current state rank (SRANK) for priority species, and GIS distribution and range maps for priority species.

Target: Survey and assess habitats of 10 priority species to determine species-specific habitat needs, and the physical, chemical, and biological characteristics of each habitat type in the next 10 years.

Measure: Description of species-specific habitat requirements for priority species; maps of key, important, and unique habitats.

Issue 1: Terrestrial invertebrate species diversity and distribution data in Alaska are currently insufficient for determining their conservation status. For example, our limited knowledge of species distributions prevents distinguishing truly rare species from under-surveyed species.

Conservation actions:

a) Compile and synthesize existing distribution data and publications into an electronic database (preferably GIS).
b) Work with experts and managers to identify information gaps.
c) Compare species lists and distribution data from the Yukon Territory and British Columbia with available Alaska data to determine what species might occur here.
d) Establish survey priorities to target rare, unique, threatened, or representative habitats.
e) Establish survey priorities to target rare, declining, keystone, or representative species, including species associated with rare plants.
f) Conduct a literature review to determine appropriate sampling techniques and protocols, and sample sizes.
g) Conduct inventories.
h) Establish an Alaska invertebrate survey, and employ bio-blitz or rapid bioassessment technology to increase knowledge of terrestrial invertebrate diversity and distribution.

i) Train observers in species identification and collection of unknown species for taxonomic identification (including using molecular methods); use recognized experts to identify specimens.

j) Develop a network of volunteer collectors. Encourage school districts, Elderhostels, nonprofit organizations, universities, state and federal agencies, public schools, and interested individuals to participate in surveys.

k) Collaborate with terrestrial invertebrate researchers in Canadian Provinces and Russia.

l) Develop a series of manuals to provide current information on the identification, distribution, and habitat of Alaska's rarer terrestrial invertebrate species.

m) Develop a general guide to Alaskan insects to raise public awareness and perhaps spur additional insect observations and reports.

n) Preserve and archive specimen collections and associated data at the University of Alaska Museum as feasible for future research and use.

Issue 2: Maintaining healthy terrestrial invertebrate populations throughout Alaska requires baseline information on natural spatial and temporal variation in species' abundance.

Conservation actions:

a) Use on-the-ground assessments, modeling and GIS technology to determine species-specific habitat availability and quality.
b) Focus on species/habitats that appear rare or have limited distributions.

Issue 3: Understanding species' habitat requirements in Alaska is critical for protecting and conserving populations.

Conservation actions:

a) Identify species-specific habitat associations during surveys.
b) Use GIS to predict and map habitat.
c) An annual report including survey locations and maps of new and old distribution records by species and region should be produced.

H. Propose plan and time frames for monitoring species and their habitats

Presence/absence surveys should begin as soon as funding allows and continue until all priority species and habitats have been addressed.

I. Recommended time frame for reviewing species status and trends

Five years. This interval is necessary because conservation measures may change as data become available.

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