Freshwater Invertebrates

Dragonflies and Damselflies

A. Species group description

Common names: dragonflies, damselflies
Scientific names: Order Odonata (dragonflies), Suborder Anisoptera (dragonflies) and Suborder Zygoptera (damselflies)

Few insects inspire as much awe and fascination among the public as do dragonflies and damselflies.

B. Distribution and abundance

Range: Both suborders are widely distributed across Alaska; however, individual species ranges are poorly understood due to limited collection data.
   Global range comments: Worldwide distribution
   State range comments: Ranges vary by species. All species now known to occur in Alaska also occur in other states and/or provinces.

Abundance:
   Global abundance comments: Unknown
   State abundance comments: Unknown

Trends:
   Global trends: Kennedy's Emerald (*Somatochlora kennedyi*), a red-listed species (Canadian designation for endangered or threatened) in British Columbia, may occur in Alaska.
   State trends: Unknown

C. Problems, issues, or concerns for species group

- The primary dragonfly conservation issue in Alaska is the lack of information on geographic distribution, abundance, and species diversity in this large, remote, and undersurveyed state. For example, 10 of Alaska's 31 dragonfly species are known from fewer than 4 locations. During the summer of 2003, a minimal collecting effort by a biologist found 3 new species previously not known to occur in Alaska.
- Dragonflies are an important component of freshwater/terrestrial food webs because they are prey for a large variety of invertebrates and vertebrates and certain carnivorous plants.

Dragonflies are also a top invertebrate predator in both aquatic and terrestrial environments. As such, they are likely to accumulate contaminants and transfer them to predators including migratory songbirds. Dragonflies can serve as barometers of environmental health and change in both the aquatic and terrestrial environments. Dragonfly larvae and adults are both predaceous, relying on diverse and productive

invertebrate communities. Therefore, if the aquatic environment and food web that sustains dragonflies is impaired, dragonflies, and the fishes, amphibians, birds, and mammals that prey on them, will be impacted.

D. Location and condition of key or important habitat areas

Dragonfly larvae live in slow streams and rivers, marshes, lakes, ponds, wetlands, and springs. Adult dragonflies use a variety of terrestrial habitats, both near and far from aquatic habitats. Dragonfly habitat is generally abundant and widely distributed across the state. However, the condition of dragonfly habitat in Alaska is not known. Likewise, the specific habitat requirements of our species are poorly understood.

E. Concerns associated with key habitats

- Dragonflies are sensitive to a variety of stressors, including habitat alteration (e.g., air and water quality degradation, infilling, dams, acidification, pesticides and other chemical pollutants, erosion, eutrophication, and sedimentation), urbanization, shoreline development, collisions with vehicles, heavy metal contamination, fish and domestic duck introductions, commercial peat extraction, and invasive species. An invasive species in Southcentral Alaska, northern pike, feed heavily on dragonfly nymphs after all other prey species have been extirpated.
- Climate change will influence species distribution and habitat quality and quantity through melting of permafrost and drought, both of which eliminate lentic and lotic habitats.
- Dragonfly habitat can be adversely impacted by resource development activities including mining, logging, and oil and gas exploration and production.

F. Goal: Describe and manage dragonfly populations throughout their natural range to ensure sustainable use of these resources.

G. Conservation objectives and actions

Objective: Describe current geographic distribution, abundance within existing range of variation, and species diversity of dragonflies in Alaska.

Target: Survey and map species presence/absence information at 10 sites in each region of Alaska within 5 years (regions correspond to the ADF&G joint board management regions).

Measure: Number of sites surveyed and documented in each region.

Target: Survey larval dragonfly habitat to determine species-specific habitat requirements and the physical, chemical, and biological characteristics of each habitat type within 5 years.

Measure: Develop a list of species-specific habitat requirements for dragonflies in Alaska.

Issue 1: Dragonfly species diversity and distribution data in Alaska are currently insufficient for determining the conservation status of these insects. For example, our limited knowledge of species distributions prevents distinguishing truly rare species from undersurveyed species.

Conservation actions:

a) Conduct a literature review to determine appropriate sampling techniques and protocols and sample sizes.
b) Establish an Alaska Odonata Survey to increase knowledge of dragonfly diversity and distribution.
c) Compile and synthesize existing distribution data and publications into an electronic database (preferably GIS or compatible).
d) Collect immature and adult dragonflies from key habitats and regions not represented in existing collections and literature.
e) Compare dragonfly species lists and distribution data from the Yukon. Territory and British Columbia with available Alaska data to determine what species might occur here.
f) Collaborate with Odonata researchers in neighboring Canadian provinces.
g) Develop a network of volunteer collectors.
h) Train volunteers to sort and label specimens keyed to family level.
i) Use recognized experts to identify specimens.
j) Preserve and archive specimen collections and associated data at the University of Alaska Fairbanks, Museum of the North, for future research and use.
k) Publish a peer-reviewed paper on the distribution of dragonflies in Alaska and present the findings at appropriate state, national, and international meetings.

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

Conservation actions:
a) Use on the ground inventory and GIS technology to determine species-specific habitat availability and health by region over 3–5 consecutive years.
b) Focus on species/habitats that appear rare or have limited distributions.

Issue 3: Understanding dragonfly habitat requirements in Alaska is critical for protecting, conserving, and if necessary, restoring populations.
Conservation actions:
a) Identify species-specific habitat associations during surveys.
b) Use GIS to predict and map habitat.
c) Encourage school districts, Elderhostel, nonprofit organizations, universities, state and federal agencies, and interested individuals to participate in surveys.
d) An annual report including survey locations and maps of new and old distribution records by species and region should be produced.

Conservation actions:
a) Identify species-specific habitat associations during surveys.
b) Use GIS to predict and map habitat.

H. Plan and time frames for monitoring species and their habitats

Presence/absence surveys should begin as soon as funding allows. They should be conducted once per month during the flight season, which varies by area. Surveys should be conducted for 3–5 years.

I. Recommended time frame for reviewing species status and trends

Five years. This interval is necessary because conservation measures may change as data becomes available. Data may show that human development and climate change are affecting dragonfly habitat and populations.

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Other Information

Dragonfly species known from Alaska

Suborder Zygoptera: Common Spreadwing (*Lestes disjunctus)*, Emerald Spreadwing
(*Lestes dryas)*, Subarctic Bluet (*Coenagrion interrogatum)*, Taiga Bluet (*Coenagrion
resolutum)*, Boreal Bluet *(Enallagma boreale)*, Northern Bluet (*Enallagma cyathigerum)*,
Sedge Sprite (*Nehalennia irene)*

Suborder Anisoptera: Lake Darner (*Aeshna eremite)*, Variable Darner (*Aeshna
interrupta)*, Sedge Darner (*Aeshna juncea)*, Paddle-tailed Darner (*Aeshna palmate)*,
Azure Darner (*Aeshna septentrionalis)*, Zigzag Darner (*Aeshna sitchensis)*, Subarctic
Darner (*Aeshna subarctica)*, Common Green Darner (*Anax junius)*, Pacific Spiketail
(*Cordulegaster dorsalis)*, American Emerald (*Cordulia shurtleffii)*, Ringed Emerald
(*Somatochlora albicincta)*, Delicate Emerald (*Somatochlora franklini)*, Hudsonian
Emerald (*Somatochlora hudsonica)*, Treeline Emerald (*Somatochlora sahlbergi)*,
Mountain Emerald (*Somatochlora semicircularis)*, Whitehouse's Emerald (*Somatochlora
whitehousei)*, Boreal Whiteface (*Leucorrhinia borealis)*, Crimson-ringed Whiteface
(*Leucorrhinia glacialis)*, Hudsonian Whiteface (*Leucorrhinia hudsonica)*, Canada
Whiteface (*Leucorrhinia patricia)*, Red-waisted Whiteface (*Leucorrhinia proxima)*,
Four-spotted Skimmer (*Libellula quadrimaculata)*, Black Meadowhawk (*Sympetrum
danae)*, Cherry-faced Meadowhawk (*Sympetrum internum)*; Spot-winged Glider (*Pantala
hymenaea)*

Cladocera (Water Fleas)

A. Species group description

Common name: water fleas
Scientific name: Class: Crustacea; Order: Cladocera; Family: Daphniidae and Bosmina

B. Distribution and abundance

Range:
Global range comments: Order widespread globally, widespread in North America.
State range comments: Widespread where surveys have occurred.

Abundance:
Global abundance comments: Highly variable where documented
State abundance comments: Highly variable where documented

Trends:
Global trends: Unknown
State trends: Unknown

C. Problems, issues, or concerns for species group

- Group is highly sensitive to hydrocarbon, heavy metals, organic pollutant contamination, and turbidity
- Group distribution is limited by temperature and pH constraints
- This group also serves as the primary transfer of aquatic primary production to many vertebrate (waterfowl and fish) species

D. Location and condition of key or important habitat areas

Lakes, ponds, connected wetlands, and sloughs throughout the state. Habitat is mostly in very good or pristine condition. A small and unquantified amount of area damaged by urbanization, road construction, or other development.

E. Concerns associated with key habitats

Specific threats, limited to minor extent of range, are development-specific and include:
- nonpoint source hydrocarbon pollution in urbanized areas
- sedimentation from timber, mineral, or agricultural development
- water quality degradation (changes in pH, organic pollutants, eutrophication, or heavy metals) from industrial or agricultural development
- General threats (statewide) to group are related to water quality degradation (changes in pH, organic pollutants, or heavy metals) through airborne pollutants and water temperature or level changes related to climate change

F. Goal: Conserve and manage *Cladocera* spp. populations throughout their natural range to ensure sustainable use of these resources.

G. Conservation objectives and actions

Objective: Maintain current Cladocera distribution, range of abundance, and species diversity throughout their natural range in Alaska.

Target: Document what species occur in each of Alaska's ecoregions by collecting and identifying specimens from 5 sites within each region over 5 years (regions correspond to the ADF&G joint board management regions).
Measure: Review existing literature and identify the species collected at each site.

Target: Obtain baseline data of normally occurring population densities in typical habitats at up to 5 survey sites in each region of Alaska for 5 consecutive years. (Regions correspond to the ADF&G joint board management regions.)
Measure: The population density estimates for Cladocera populations at selected survey sites within in each region of Alaska.

Issue: Alaska's Cladocera species, distribution, and range of normal abundance are unknown.

Conservation actions:
a) Compile any existing distribution and abundance data into an electronic database (preferably GIS-based).
b) Compare species lists of adjacent areas (Canada, Russian Far East) with available Alaska data to determine what species might occur here.
c) Establish survey protocols and identify possible survey sites.
d) Establish abundance estimation protocols and identify possible study sites.
e) Develop a network of volunteer collectors.
f) Collect individual specimens and document habitat associations.
g) Use recognized experts to identify individual specimens.
h) Create a peer-reviewed paper on the distribution of Cladocera in Alaska.
i) Preserve and archive specimen collections and associated data at the UAF Museum of the North for future research and use.
j) Convene an expert task force to review conservation plans of other jurisdictions.
k) Convene an expert task force to assess trends, critical habitats, threatened species, and to develop a featured species list and a conservation plan for these species.

H. Plan and time frames for monitoring species and their habitats

- Surveying should begin as soon as funding is available and be conducted yearly for 5 years.
- Monitoring for species baseline abundance and variance should begin as soon as funding is available and be conducted at selected sites every year for 5 consecutive years.
- Volunteer organization such as school districts, Elderhostels, nonprofit organizations, state and federal agencies, and interested individuals can collect and share specimen and habitat association information.

- Qualified taxonomists will conduct species identification; data and specimens would be housed at the UAF Museum of the North.
- Review the conservation plans of other jurisdictions concurrently with data and information collection; assessment and preparation of a featured species list would occur after the plan review and the Alaska data review.

I. Recommended time frame for reviewing species status and trends

Five years. This interval is necessary because conservation measures may change as data becomes available. Data may show that human development and climate change are affecting Cladocera habitat and populations.

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Ephemeroptera/Plecoptera/Trichoptera
(Mayflies, Stoneflies, Caddisflies)

A. Species group description

Common name: mayflies, stoneflies, caddisflies
Scientific name: Class: Insecta, Orders: Ephemeroptera/Plecoptera/Trichoptera Alaska endemic mayfly *Rhithrogena n.* sp. (Randolf and McCafferty [in press]) Families: Numerous within each Order.

B. Distribution and abundance

Range:
Global range comments: Order are widespread globally, widespread in North America.
State range comments: Widespread (in flowing waters), where surveys have occurred. Diversity and abundance are higher in lower latitudes, but representatives of each order are found throughout the state.
Rhithrogena n. sp. is currently known only from adults taken at Yukon-Koyukuk region, Birch Creek, 10 miles upstream from mile 147 of the Steese Highway north of Fairbanks. Interestingly, it is most closely related to 2 Siberian species, and not North American species. (Email correspondence from P. McCafferty, 2004).

Abundance:
Global abundance comments: Highly variable where documented
State abundance comments: Highly variable where documented; undocumented in most regions of the state. High levels of abundance are often highly correlated with healthy fish stocks.
Rhithrogena n. sp.: unknown

Trends:
Global trends: Unknown
State trends: Unknown
Rhithrogena n. sp.: unknown

C. Problems, issues, or concerns for species group

- This group is highly sensitive to heavy metals, organic pollutant contamination, and sedimentation and turbidity.
- Ephemeroptera/Plecoptera/Trichoptera (EPT) species are important water quality indicators. The mere presence, abundance, and distribution of these species are indicative of the positive health of waters.
- The distribution of most representatives of the group is limited to flowing waters, and by temperature and pH constraints.
- The group also represents a major transfer of primary production to many vertebrates, including waterfowl and fish species, in flowing waters.

D. Location and condition of key or important habitat areas

Primarily found in flowing waters throughout the state. Habitat is mostly in very good, or pristine condition, although some localized habitat is threatened by water quality problems directly related to mining, logging, or other development.

E. Concerns associated with key habitats

Specific concerns, limited to minor extent of range, are development-specific and include:

- Nonpoint source hydrocarbon pollution in urbanized areas
- Sedimentation from timber, mineral, or agricultural development
- Water quality degradation (changes in pH, organic pollutants, eutrophication, or heavy metals) from industrial or agricultural development

General threats (statewide) to group are related to water quality degradation (changes in pH, organic pollutants, or heavy metals) through airborne pollutants and water temperature or level changes related to climate change.

F. Goal: Conserve and manage Ephemeroptera/Plecoptera/Trichoptera (EPT) populations throughout their natural range to ensure sustainable use of these resources.

G. Conservation objectives and actions

Objective: Maintain current geographic distribution and species diversity of EPT species in Alaska.

Target: Document typical species assemblages (larval stages) that occur in Alaska by collecting and identifying specimens from 5 sites within each region over 5 years. (Regions correspond to the ADF&G joint board management regions.)
Measure: larval species assemblages within each region as determined by site survey and literature review.

Target: Obtain relative baseline data of normally occurring population densities. For example, compare annual densities or densities between habitat sites (Oswood et. al. 2001).
Measure: Obtain statistically valid population density estimates for EPT populations at up to 5 survey sites in each region of Alaska for 5 consecutive years. (Regions correspond to the ADF&G joint board management regions.)

Issue: There is limited information on EPT species in Alaska, their distribution, and their range of normal abundance.

Conservation actions:
   a) Compile existing distribution and abundance data into an electronic database (preferably GIS-based).
   b) Compare species lists of adjacent areas (Canada, Russian Far East) with available Alaska data to determine what species may occur here.
   c) Establish survey protocols and identify possible survey sites.
   d) Establish abundance estimation protocols and identify possible study sites.
   e) Develop a network of volunteer collectors.

f) Collect individual specimens and document habitat associations.
g) Use recognized experts to identify individual specimens.
h) Create a peer-reviewed paper on the distribution of EPT in Alaska.
i) Preserve and archive specimen collections and associated data at the Museum of the North for future research and use.
j) Convene an expert task force of experts to review conservation plans of other jurisdictions.
k) Convene a task force to assess trends, critical habitats, threatened species, and to develop a featured species list and conservation plan for these species.
l) Develop species biological indices within regions.

H. Plan and time frames for monitoring species and their habitats

- Surveying should begin as soon as practical and be conducted yearly for 5 years.
- Monitoring for species baseline abundance and variance should begin as soon as practical and be conducted at selected sites every year for 5 consecutive years.
- Volunteer organizations, such as school districts, Elderhostels, nonprofit organizations, state and federal agencies, and interested individuals can collect and share specimen and habitat association information.
- Qualified taxonomists will conduct species identification; data and specimens would be housed at the UAF Museum of the North.
- Review the conservation plans of other jurisdictions concurrently with data and information collection; assessment and preparation of a featured species list would occur after the plan review and the Alaska data review.

I. Recommended time frame for reviewing species status and trends

Five years. This interval is necessary because conservation measures may change as data becomes available. Data may show that human development and climate change are affecting EPT habitat and populations.

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Karst Cave-dwelling Aquatic Invertebrates

A. Species group description

Common names: scuds, mites, springtails, beetle larvae, proboscis worms, flatworms, seed shrimp, water fleas and possible previously unconfirmed and unknown species
Scientific names: *Stygobromus quatsinensis, Stygobromus n. sp. A, Arrhopalites hirtus, Robustocheles occulta, Hydaticus larvae, Rhynchelmis* spp.*, Polycelis* spp.*, Candona* spp.*, Acanthocyclops* spp.*, Dacyclops* spp.

B. Distribution and abundance

Range:
 Global range comments: Cave adapted invertebrates do not find favorable habitat in all cave systems, but instead occur in environmentally relatively stable cave systems that have a favorable glacial history and are large enough to have true troglobitic habitat. Human accessibility also further limits the systems from which invertebrate samples can be obtained. *Stygobromus* sp. has been described from Vancouver Island caves and may be relict populations from glacial refugial areas. The distributional ranges of many cave-adapted invertebrates are unknown. These species are often associated with cave habitats where subsurface waters are found predominantly within carbonate rock; vadose cave systems that have pirated surface streams and lakes; drip pools in mud and glacial marine outwash sediments, insurgent and resurgent springs, and subsurface groundwater systems.
State range comments: Cave-adapted invertebrate habitats within karst landscapes are scattered throughout Alaska but have been best studied in Southeast Alaska. *Stygobromus quatsinensis* has only been found on the outer islands of Southeast Alaska (Dall, Coronation, Heceta, Baker, and Suemez).

Abundance:
Global abundance comments: unknown
State abundance comments: limited abundance, unquantified

Trends:
Global trends: unknown
- Cavernicole species likely survived *in situ* during the last glaciation but re-radiative and re-immigrative mechanisms may also have resulted in the current distribution.
State trends: unknown
- In Southeast Alaska, one study of caverniculous invertebrate species abundance and diversity indicates that these parameters decrease from north to south; this trend may be an artifact of the sample site locations on the outer islands were also the southernmost islands, which could have been glacial refugia. Trends in distribution could also possibly be due to past glacial events and/or associated sea level changes (Carlson 1997).

- In Southeast Alaska, caverniculous invertebrate migration from the inner islands to the outer islands is represented by a decrease in abundance and diversity from east to west, in the direction of decreasing probability of glacial coverage. (Carlson 1997).

C. Problems, issues, or concerns for species group

There is a very limited amount of information about this group.

Fauna will likely contain cave-adapted taxa that, due to the following characteristics, make them sensitive to anthropogenic impacts.

- Use a very limited habitat type
- Have a low reproductive rate
- Stenothermic
- Highly adapted to unique and harsh living conditions
- Require caves with temperature range equal to the mean annual ambient temperature
- Require low pH range
- Tolerance to contaminants is low
- Recruitment from outside the system is little to none
- Use a specific habitat that is easily degraded, rendering populations highly vulnerable to habitat destruction
- In cave ecosystems, a single species of amphipod may dominate a relatively simple food web based on fine organic particulates (Drost and Blinn 1997).
- Geographic isolation
    a) Chronic population genetics bottlenecks due to glaciation (Carlson 1997)
    b) Endemism, which can be highly localized
- Some populations endemic to a single cave or a small cluster of caves
- Some of the known cave habitats have been degraded by changes in hydrology and nutrient inputs as a result of timber harvest (including road construction, changes in forest structure, and impacts on local hydrology) and other extractive industries. On a global scale, karst landscapes are generally rare. Known karst landscapes exist in Africa, Australia and Oceania, Asia, Europe, North America and South America. Karst landscapes underlying temperate rain forests are even less common, occurring only in Tasmania and Chile.

D. Location and condition of key or important habitat areas

Karst landscapes in Southeast Alaska. Over 600 caves have been inventoried on northern Prince of Wales Island and several westerly islands (Dall, Coronation, Suemez, Heceta, Baker, and Kosciusko). Caves and karst are also present on Kuiu, Long, Etolin, Revillagigedo, Kupreanof and Chichigof Islands, as well as some parts of the mainland near Wrangell, areas of Lynn Canal and Haines, and in Glacier Bay National Park.

Thousands of caves are estimated to exist on Prince of Wales Island (USFS, 2004).

- El Capitan (in Southeast Alaska) is the largest cave in Alaska; over 2 miles of passage have been mapped from the main entrance. The El Capitan pit is the deepest vertical drop in the United States at 598 ft.

- Karst also occurs in Wrangell-St. Elias National Park. Extensive karst occurs in the Brooks Range. Smaller pockets are found in places such as the Lime Hills (Southcentral Alaska), and the White Mountains (Interior Alaska). Some of these karst blocks are similar in geologic age but have been accreted to the North American craton in differing positions due to differences in plate tectonics.

- Karst watersheds: water resources originating from lake or surface waters versus groundwater reserves greatly influence the species composition.

- Aquatic resurgence habitat: aquatic cave dwelling amphipods such as *Stygobromus quatsinensis* are associated with 37.4–46.4 degrees F freshwater cave or resurgence stream and pool habitats (Carlson 1997).

- Terrestrial entrance and deep cave habitats; terrestrial cave-dwelling amphipods such as *Robustocheles occulta* are associated with entrance as well as deep cave drip pools or organic debris. True aquatic "deep cave" habitats characterized by low organic matter, mud-limestone substrate, absolute darkness, a temperature profile resembling ground temperature, and pHs indicative of carbonate buffering host a fairly simple assemblage of invertebrates including: *Stygobromus quatsinensis, Stygobromus n.* sp.*, Arrhopalites hirtus, Robustocheles occulta, Hydaticus larvae, Rhynchelmis* spp.*, Polycelis* spp.*, Candona* spp.*, Acanthocyclops* spp.*, Dacyclops* spp. (Carlson 1997).

Generally the condition of these cave habitats is pristine, although several caves have been degraded due to human visitation, timber harvest, and associated road construction.

E. Concerns associated with key habitats

- Hydrological:
  a) Silting, sediment and debris accumulation, and flooding associated with deforestation and logging, forest fires, and dam structures
  b) Geochemical changes to groundwater pH due to increased tannic acid outwash from runoff due to surface activities
  c) Overpumping of ground water and loss of watershed groundwater storage capacity due to removal of forest canopy and erosion of thin surface soils causing spring failure and dewatering
  d) Poorly planned road drainage causing groundwater contamination from roading outwash and sediment transport into karst systems
  e) Groundwater contamination from industrial sites, logging camps, and the application of pesticides

- Fire:
  Increased susceptibility to silting, changes in pH, loss of watershed storage capacity, increased flashiness of karst systems overlain with thin soils; resultant sedimentation eliminates microhabitats or introduces additional organics that support different epigean invertebrate species

- Land development:
  a) Mineral mining and exploration—copper, gold, silver, zinc, lead, uranium and palladium
  b) Quarrying of caves for limestone, other carbonate rock
  c) Logging and road construction
     - Strong correlation between karst terrain and the presence of large trees; high volume karstland forests have been heavily harvested in the Tongass National Forest.
     - Many roads were originally built for log hauling
  d) Timber industry is still a major employer; high volume karstland forests have been heavily harvested in the Tongass. Meteorological microclimate alterations, such as opening second entrances and sealing caves
- Nutrient stress:
  a) Loss of fine particulate organic matter due to flooding or damming
  b) Enrichment from sewage, slash, and sediments from logging road construction; fuel leakage from pipelines; nonpoint source pollution
- Exotic and pest species:
     Anthropogenically introduced species such as the collembolan *Willowsia* and Formicid ants may prove to have long-term detrimental effects on cavernicole populations.
- Chemical pollution:
  a) Use of pesticides and herbicides, particularly along utility corridors, and more recently logging roads in close proximity to caves (The Associated Press 2003)
  b) Non-point source contamination to the watershed
  c) Hydrocarbon, heavy metal contamination of groundwater from abandoned logging camps
  d) Military and federal toxic waste sites on Prince of Wales (ACAT 1998)
     - Formerly used defense sites
     - Groundwater contamination sites
     - Hazardous substances
- Killing, overcollecting, and disturbance of fauna:
     Most caves have vertical entrances, requiring technical climbing equipment and expertise for entry.
- Show caves:
     1. El Capitan, Prince of Wales Island, Tongass National Forest
        - Longest known cave in Alaska
        - Locked gate guards the cave entrance
        - Guided tours
     2. Cavern Lake Cave, Prince of Wales Island, Tongass National Forest

F. Goal: Conserve and manage karst cave-dwelling invertebrate populations to ensure sustainable use of these resources.

G. Conservation objectives and actions

Objective 1: Describe and maintain species distribution and diversity in karst systems in Southeast Alaska.

   Target: Develop list of species and distribution maps within 5 years.
      Measure: Survey aquatic invertebrates inhabiting karst systems in Southeast Alaska.

   Target: Contact land managers at all Federal Conservation Units and State Special Designated Areas in Alaska within 5 years to provide educational information regarding cave habitats and invertebrate fauna.
      Measure: Number of Federal Conservation Units and State Special Designated Areas in Alaska contacted and provided with educational information.

   Target: Develop list of species and distribution maps within 5 years.

Issue 1: There is little or incomplete information about what species exist in these limited habitats, possibly including new species that have not been identified.

   Conservation actions:
      a) Compile existing data into an electronic database (preferably GIS).
      b) Compare species lists of other karst regions with available Alaska data to determine what species might occur here.
      c) Establish survey protocols and select survey sites.
      d) Partner with the USFS and caving organizations (Glacier Grotto, Alaska statewide chapter of the National Speleological Society, and the Tongass Cave Project, a nonprofit caving organization) to develop a network of volunteer collectors.
      e) Collect individual specimens and document habitat associations and physical and water quality parameters.
      f) Use recognized experts to identify individual specimens.
      g) Develop protocol for estimating densities.
      h) Create a peer-reviewed paper on the distribution of cave-adapted species in Alaska.
      i) Preserve and archive specimen collections and associated data at the Museum of the North for future research and use.
      j) Convene an expert task force to review conservation plans of other jurisdictions.
      k) Convene an expert task force to assess trends, critical habitats, and threatened species, and to then develop a featured species list and a conservation plan for these species.

Issue 2: Karst caves are easily degraded.

Conservation actions:
a) Develop best management practices for karst system watershed protection during land-altering activities.
b) Participate in watershed planning efforts.
c) Review existing management plans to assess provisions to protect invertebrate assemblages in karst caves and their watersheds, and include provisions in revised plans.
d) Identify which cave physical parameters are limiting factors for invertebrate assemblages and are easily degraded.
e) Create pamphlets and a PowerPoint presentation outlining the sensitivity and threats to cave habitats and associated invertebrate communities.
f) Distribute presentation to Public Land Information Centers, school districts, and conservation organizations.

Objective 2: Inventory cave resources throughout Alaska to quantify karst habitats.

Target: Contact land managers at all Federal Conservation Units and State Special Management Areas within Alaska to identify inventoried lands; cooperate with state and federal geologic agencies to identify likely cave-bearing geologic formations.
Measure: Develop a catalog (including maps) of cave resources and geologic formations likely to contain caves in Alaska.

Issue: Cave hydrogeography resources in Alaska are largely unknown.

Conservation actions:
a) Develop a list of persons, organizations, and agencies knowledgeable about cave locations in Alaska.
b) Collaborate with bat researchers and botanists conducting surveys in known karst areas.
c) Develop a GIS database of cave locations and geographic areas likely to contain caves.
d) Work cooperatively with other state and federal agencies and stakeholders to conduct hydrogeologic dye-tracing efforts in karst caves.
e) Produce maps of the karst cave hydrology to identify extent, distribution, flow and characteristics (springs, seeps, streams, etc.) of available aquatic invertebrate habitat.

H. Plan and time frames for monitoring species and their habitats

Objective 1:

Contract collectors, develop sampling protocol in 2005, begin surveys in 2006, and continue for 5 years.

Contact land managers in 2005, develop best practices "white paper" by 2007, distribute by 2007. Review existing land use/management plans by 2006, make recommendations to land managers as part of white paper by 2007.

Objective 2:
Contact land managers in 2005, develop list of caves or likely landforms by 2006.
Develop karst cave dye-tracing plan during 2007.
Implement dye-tracing during 2008–2010.

I. Recommended time frame for reviewing species status and trends

Five years (2011). This interval is necessary because conservation measures may change as data becomes available. Data may show that human development and climate change are affecting cave habitats and cave invertebrate populations.

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Possible Resources:
USFS (Tongass National Forest, Jim Bachtal-Region 1 USFS geologist)
no longer in USFS now in Virginia
Glacier Grotto, statewide chapter of The National Speleological Society
Tongass Cave Project, a nonprofit caving organization
American Academy of Underwater Scientists, Alaska chapter (contact-Seward Sea Life Center)
Alaska bat researchers, UAS and UAF

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Mollusca

A. Species group description

 Common names: freshwater clams/mussels; Western pearl shell, Yukon floater,
Western floater
 Scientific names: *Margaritifera falcata, Anodonta bergiana, Anodonta kennerlyi*
 and possibly previously unconfirmed/unknown species (Baxter [1987] suggested there may
 be 20 species of bivalves in Alaska)

B. Distribution and abundance

 Range:
 Global range comments: Poorly known; northwestern North America and pan-Arctic.
 Generally, mollusks have a widespread distribution but are declining in terms of area
 occupied and number of sites and individuals (NatureServe 2004). Mollusks possess
 limited abilities to disperse with present distributions often reflecting former (Pleistocene)
 drainage linkages.

 State range comments: Poorly known.
 a) *Anodonta beringiana* fairly well documented in many parts of the state, mainly north of
 61 degrees latitude (Smith 2004); Kamchatka to central Alaska and into the upper
 Yukon drainage (Gustafson 1997).
 b) Beringian species endemic to Alaska:
 - *Anodonta kenneryli* and *Margaritifera falcata* are sparingly documented in
 Southeast Alaska (Smith 2004)
 - *Margaritifera falcata* found on Revillagigedo Island (Southeast Alaska) and north
 to Naha Bay at 55 degrees latitude (Gustafson 1997).

 Abundance:
 Global abundance comments: Unknown
 State abundance comments: Unknown

Trends:
 Global trends: Unknown; fish host species are known for only about a quarter of the mussel species in North America (Watters 1994)
 State trends: Unknown; conservation status not yet assessed (NatureServe 2004)

C. Problems, issues, or concerns for species group

As a water quality indicator species:
- Aquatic biomonitors; minute levels of some toxins or chronic environmental stressors can cause catastrophically significant losses in mussel communities long before they are noticed in fish populations
- Presence/absence, spatial distribution, population age structure, tissue and shell chemistry all relative to water quality
- They are bioaccumulator of contaminants with vertebrates (otter, muskrat, fish) relying on them for food
- Live over 100 years
- The spatial and temporal comparison of mussel population age structure may explain timing and causes of species population changes

Large aquatic filter feeder
- Are exposed to toxins or other deleterious environmental conditions at a more acute level than many higher trophic level organisms
- Their nutrient rich biodeposits (feces) provide an important trophic component of benthic community structure
- Easily identified/disturbed by the public
- Complicated biological and reproductive adaptations, requiring a host fish to brood glochidia (obligate parasites)
- Vital components of a number of intact salmonid ecosystems
- Important biomedical research implications for cancer (resistance to tumors)
- Are relatively late at maturing (6≥12 years old)
- Currently one of the most endangered faunal groups in North America
- Distribution and host fish information widely unknown
- Population health and numbers rely on the health of certain, but unknown, fish species and populations
- Can be an important subsistence food

D. Location and condition of key or important habitat areas

- *Anodonta beringiana* associated with slow-moving streams or lakes; prefers sand and gravel substrate
- *Anondonta kennerlyi* associated with lakes, ponds and slow-moving streams; visible in shallow areas
- *Margaritifera falcata* associated with rivers; prefers gravel substrate, often wedged between rocks

Locations of existing populations are limited to certain lakes, ponds, sloughs, slow-moving streams, and rivers. The condition of these habitats is mostly very good or pristine.

E. Concerns associated with key habitats

- Pollution; mussel larvae are more sensitive to pollutants than adults
- Mussels have a mandatory parasitic stage, thus are totally dependent on specific fish species, not all of which are known
    a) *Anodonta kennerlyi*: host fish currently unknown; associated unknown fish habitat closely linked to *A. kennerlyi* habitat
    b) *Anodonta beringiana*: 3 known host fish, sockeye salmon (*Onchorhynchus nerka),* Chinook salmon (*O. tshawytscha*) and threespine stickleback (*Gasterosteus aculeatus*) (Cope 1959; Hart and Fuller 1974)
    c) *Margaritifera falcata*: known host fish include Chinook salmon; rainbow, brook, and brown trout; possibly sockeye salmon

- Fish passage barriers
  Consumption of small mussels by fish and their subsequent elimination from fish's gut unharmed may be an important distribution mechanism; thus mussel populations are even more dependent on the distribution of certain unknown fish populations.

- Siltation
  Juvenile mussels must fall from the host fish onto suitable substrate for their adult life requirements or they will not survive; shifting sands, suspended fine mud, clays, and silt are considered harmful to juveniles and adult mussels.

- Climatic change may result in potentially dangerous falling water levels (due to longer ice-free periods, permafrost melting, and drought)

- Alterations in water temperature
    a) Spawning is stimulated by a change in water temperature.
    b) The duration of the parasitic glochidia stage (generally 5–120 days) is water temperature dependent.

- Water withdrawals due to human activities could threaten populations

- Invasive species: Species such as the zebra mussel (*Dreissena polymorpha)* and New Zealand mud snail (*Potamopyrgus antipodarum)* have driven a number of freshwater mussel species to extirpation in other states.

F. Goal: Conserve and manage freshwater mussel populations throughout their natural range to ensure sustainable use of these resources.

G. Conservation objectives and actions

Objective 1: Maintain current freshwater mussel distribution and species diversity.

  Target: Document what species occur in each of Alaska's ecoregions by collecting adults (preferably shells) from numerous sites over 5 consecutive years (regions correspond to the ADF&G Board of Fisheries management regions); perform DNA and mitochondrial genetic assays.

Measure: The number of species and locations identified should not be increasing significantly by the fifth year of the study.

Issue: Species diversity and distribution in Alaska is unknown.

Conservation actions:
a) Conduct literature search/review of existing references and compile existing data into a database (electronic, preferably GIS or compatible).
b) Compare species lists of adjacent countries with available Alaska data to determine what species might occur here.
c) Establish survey protocols and identify possible survey sites.
d) Develop a network of volunteer collectors.
e) Collect individual specimens and document habitat associations.
f) Recruit recognized experts to identify individual specimens.
g) Create a peer-reviewed paper on the distribution of freshwater mussels in Alaska.
h) Preserve and archive specimen collections and associated data for future research and use.
i) Convene an expert task force to review conservation plans of other jurisdictions.
j) Convene an expert task force to assess trends, critical habitats, threatened species, and to develop a featured species list and a conservation plan for these species.

Objective 2: Maintain and maintain bivalve populations within existing range of variability.

Target: Obtain baseline data of normally occurring population densities at undisturbed key habitat types (for example, lake, pond, river).
Measure: Obtain statistically valid population density estimates for bivalve populations at up to 30 survey sites in each region of Alaska for 5 consecutive years. (Regions correspond to the ADF&G Board of Fish management regions.)

Issue 1: Population variance is unknown for any Alaska bivalve habitats.
Issue 2: Urbanization can create or destroy habitats.
Issue 3: Invasive species introductions may negatively impact habitats and kill individual bivalves.

Conservation actions:
a) Compare urban and undisturbed populations to understand which species benefit from, or are compromised by, disturbance.
b) Survey for invasive species when conducting bivalve fieldwork.

Objective 3: Describe the fish species/subpopulations required for larval obligate parasitic life stage.

Target: 100% of existing currently known whitefish, grayling, and salmon (host species) range information.
Measure: Distribution maps developed by fisheries researchers.

Issue: Variations in obligate fish host populations may affect mussel population maintenance.

   Conservation actions:
     a) Collect individual specimens and document habitat associations.
     b) Survey for present resident and nonresident fish species (and life stages) to aid in identifying specific glochidia host species and life stage of host species.

Objective 4: Educate the public on bivalve conservation issues.

   Target: An informed public that better understands the importance of bivalves and their habitat.
     Measures:
       a) Number of participants in bivalve distribution surveys.
       b) Number of visits to bivalve website.
       c) Number of public presentations and educational seminars including bivalve conservation information.

Issue: The public knows little about freshwater bivalves, thus cannot collaborate in their protection.

   Conservation actions:
     a) Prepare and distribute a general information publication suitable for laypersons and policymakers.
     b) Give presentations to various forums, including symposia, outdoors shows, and conventions in Alaska, the Pacific Northwest, and elsewhere.
     c) Post an article in the ADF&G Division of Wildlife Conservation electronic newsletter and newspapers.
     d) Post information on bivalves on the ADF&G website.
     e) Enlist volunteer organization, such as school districts, Elderhostels, nonprofit organizations, state and federal agencies, and interested individuals, to collect and share specimen and habitat association information.

H. Plan and time frames for monitoring species and their habitats

Surveying should begin immediately both at selected and opportunistic sites. It should be conducted once each year for at least 5 years or until a statistically adequate number of likely habitats have been surveyed, the number of new species found levels off, and all reports of mussel populations are investigated.

I. Recommended time frame for reviewing species status and trends

Five years. This interval is necessary because conservation measures may change as data becomes available. Data may show the need to develop conservations actions if human development, invasive species, and climate change are negatively affecting bivalve habitats and populations.

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