Snover. 2003. Preparing for climate change: The water, salmon and forests of the Pacific Northwest. Climatic Change 61:45–88.

Price, D., D.W. McKenney, I.A. Nalder, M.F. Hutchinson, and J.L. Kesteven. 2000. A comparison of two statistical methods for spatial interpolation of Canadian monthly mean climate data. Agricultural and Forest Meteorology 101:81–94.

Spittlehouse, D.L. 2005. Integrating climate change adaptation into forest management. Forestry Chronicle 81(5):691–695.

Spittlehouse, D.L., R.S. Adams, and R.D. Winkler. 2004. Forest, edge, and opening microclimate at Sicamous Creek. BC Ministry of Forests, Research Branch, Victoria, BC. Research Report 24.

Spittlehouse, D.L. and R.D. Winkler. 2004. Snowmelt in a forest and clearcut. Proceedings of the 72nd Western Snow Conference, Richmond, BC. pp.33-43.

Wang, T.L., A. Hamann, D.L. Spittlehouse, and S.N. Aitken. 2006. Development of scale-free climate data for western Canada for use in resource management. International Journal of Climatology 26:383–397.

Winkler, R., D. Spittlehouse, T. Giles, B. Heise, G. Hope, and M. Schnorbus. 2004. Upper Penticton Creek: How forest harvesting affects water quantity and quality. Streamline 8(1):18–20.

World Meteorological Organization. 1989. Calculation of monthly and annual 30-year standard normals. Geneva. WCDP-No. 10, WMOTD/No. 341.

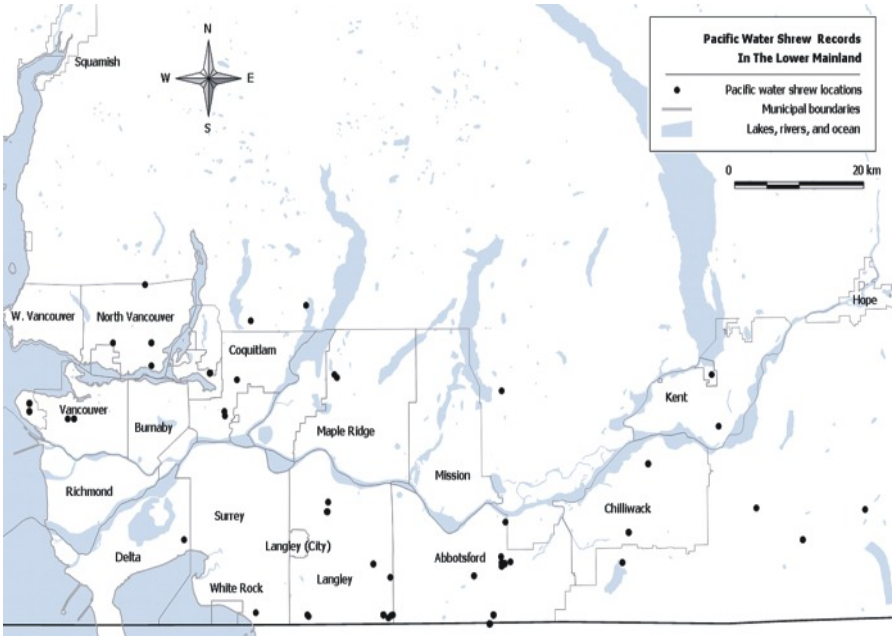
Fish Traps Threaten Pacific Water Shrew Recovery

Kym Welstead and Ross Vennesland

The Pacific Water Shrew Recovery Team has learned of several water shrews being killed in minnow traps during fisheries surveys. The many fisheries-related studies on the South Coast of British Columbia could therefore threaten this species at risk. The objectives of this article are to introduce this species at risk and its related conservation issues to fisheries practitioners; to request information on past and future mortalities or observations; and to recommend methods to mitigate this potential source of mortality to facilitate recovery of the species.

Species Biology

The Pacific water shrew (*Sorex bendirii*), also known as the marsh shrew, is a curious creature that feeds on invertebrates in aquatic and riparian areas of streams, wetlands, estuaries, lakes, beaches, and anthropogenic watercourses (Nagorsen 1996). It occurs from sea level to about 700 m elevation (Craig and Vennesland, in review). Currently, the species is known to occur in the lower Fraser River valley and associated watersheds from Hope to West Vancouver (Figure 1). However, the boundaries of this species' range in BC are not well documented, even with extensive surveys conducted in the early 1990s (Zuleta and Galindo-Leal 1994). The North American range stretches south to northern California. Only 38 observations of this rare species have been documented in Canada in the past 30 years.



V. Craig map, EcoLogic Research

Figure 1. Location of Pacific water shrew captures and sightings current to 2003. Contact the BC Conservation Data Centre for up-to-date information about water shrew capture locations.

Compared with other shrews, the Pacific water shrew is large. Its total body length is about 15 cm, almost half of which is tail (Figure 2; Nagorsen 1996). The waterproof outer coat and insulated undercoat keep shrews warm and help to trap air bubbles that aid in their buoyancy while swimming and diving (Figures 2 and 3). These bubbles give the fur a metallic appearance underwater. The water shrew's feet are fringed with stiff hairs, a characteristic unique to this type of shrew (Figure 3; Nagorsen 1996). Fringed feet give the water shrew its impressive swimming and diving abilities, allowing it to dive as deep as 2 m for up to 48 s and run across the water surface for several seconds, appearing to walk on water (Nagorsen 1996). The fringe hairs may also aid in detecting prey underwater. Both

Continued on page 22

Continued from page 21

aquatic (e.g., insect larvae) and terrestrial (e.g., earthworms, slugs) invertebrates are prey for the Pacific water shrew. Due to their high metabolism, the water shrews require near-continuous access to food (Nagorsen 1996; Craig and Vennesland, in review).

Relatively little is known about Pacific water shrews because they are very rare, difficult to trap, and declining across their range. In 1992, the BC government sponsored extensive surveys across the Lower Mainland to assess this species' status (Zuleta and Galindo-Leal 1994). Results were disappointing — only 3 Pacific water shrews were captured during more than 19,000 trap-nights of effort at 55 locations.

D. Knopp

Figure 2. The Pacific water shrew (Sorex bendirii) is the largest shrew in British Columbia.

The common water shrew *(Sorex palustris)* is a similar but more abundant species that is generally found at higher elevations and in faster water on the South Coast of BC. However, recent evidence suggests these species occur sympatrically in some locations. The Pacific water shrew is distinguished from the common water shrew by its uniform dark brown coat (Figures 2 and 3). The common water shrew is bicoloured with the belly and underside of its tail a silvery-grey. Several other species of shrews occur in the range of the Pacific water shrew, but they are considerably smaller than the two water shrew species (average less than 12 cm total length) and are therefore easily distinguished from the larger water shrews.

Threats and Conservation

The Pacific water shrew is a species at risk as a result of habitat loss and fragmentation from urban development and forest harvesting; direct mortality from fisheries surveys; introduced predators (especially domestic cats); and water pollution from agricultural, urban, and forestry sources (such as pesticide use or urban runoff that can impact prey populations). The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has listed this species as Threatened, meaning it is likely to become endangered in Canada if the factors affecting its vulnerability are not reversed (Galindo-Leal and Runciman 1994). Craig and Vennesland (in review) have produced a recovery strategy to ensure the species is maintained and restored, where possible.

It is not known exactly how vulnerable this species is to fisheries traps, but biologists have reported several incidents of water shrews being caught in minnow traps (6 reports in 3 years; R. Vennesland, unpublished data). The Pacific Water Shrew Recovery Team therefore hopes that fisheries practitioners can supply information on incidental captures to assist with assessing this threat while taking steps to prevent this type of mortality in the future (Craig and Vennesland, in review). The following information provides some guidance on what to do if you capture a Pacific water shrew and how to avoid drowning water shrews while surveying fish.

Note that although this article relates primarily to the Pacific water shrew, this potential threat is relevant to other animals across the province, some of which are species at risk. For instance, the threatened sub-species of common water shrew on Vancouver Island, *Sorex palustris brooksi*, has a similar life history to the Pacific water shrew (Lindgren and Craig 2002) and therefore may also be at risk to minnow traps.

C. Schmidt

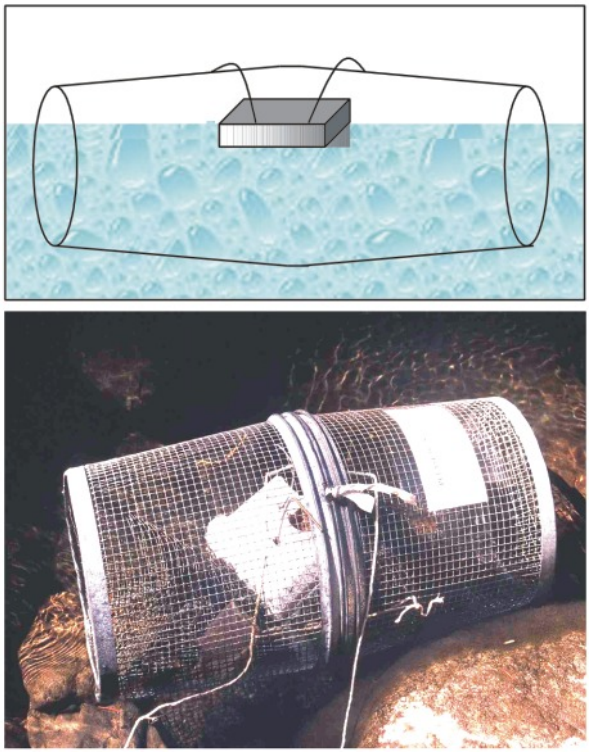
Figure 3. Close-up views of Pacific Water Shrew showing uniform fur colour (left) and stiff hairs on rear foot (right).

Reporting a Sighting or Mortality

Reporting incidental captures (or any other sightings) of Pacific and common water shrews on the South Coast and Vancouver Island of BC can help the Ministry of Environment and the Pacific Water Shrew Recovery Team learn more about the range and biology of, and threats to, these unusual creatures.

If you capture, or have captured, a live water shrew or find one accidentally drowned, report this information and submit any dead specimens. If the shrew is dead, place it in a zip-lock bag and freeze the body. Send the carcass or have the BC Ministry of Environment collect it (see contact information for Ross Vennesland). Record the date and time the water shrew was seen or captured; describe the size and colouration of the shrew; and, most importantly, include a detailed description of the location including GPS co-ordinates and photos of the habitat. For Pacific water shrews, document the capture location using a BC Conservation Data Centre rare vertebrate animal observation form (available from: http://srmwww.gov.bc.ca/cdc/contribute.html). Finally, for any live animals that you release, take photos showing the top and bottom of the water shrew (with scale if possible) so that the species description can be confirmed.

Making minor alterations to trap placement and trap design will reduce mortality.



V. Craig, EcoLogic Research

Figure 4. Minnow trap diagram and photo showing preferred water depth and Styrofoam shrew floatation device.

Methods to Decrease Trap Mortality

A live shrew released unharmed is obviously preferable to a drowned one. When working on the South Coast or Vancouver Island of BC, fisheries practitioners should first assess the potential of using survey methods with a lower risk to water shrews than minnow traps. Other standard fisheries trapping methods, such as seine netting or electrofishing, might be options.

If you must use minnow traps, making minor alterations to trap placement and trap design will reduce mortality (Figure 4; V. Craig, pers. comm., EcoLogic Research).

To reduce shrew mortality, place minnow traps at a shallow depth, so that air space is left at the top of the trap to enable the shrews to come up for air (Figure 4). However, shrews are still likely to succumb to the effects of long exposure to cold water and will eventually drown. To prevent this, add a PFD to the trap by simply tethering a piece of Styrofoam in the trap to prevent drowning (Figure 4). The Styrofoam block should be about 2 × 2 × 7 cm for ideal buoyancy. Secure it using two wires so that the platform can move up and down with any changes in water level. Leave a 2.5-cm air gap above the Styrofoam so that the shrew can sit out of the water. Furthermore, because these animals will die within several hours without food, use a large amount of bait in the trap and check the traps regularly (at least every 8 hours). Place bait in nylon netting (e.g., pantyhose) to ensure fish cannot access food from outside of the trap — any captured shrews will be able to tear this fabric.

Here are some other options to decrease water shrew mortality. Provide an escape route out the top of the trap by cutting a 5-cm square out of the wire mesh with a pair of tin snips and using 4 plastic-coated twist ties as hinges. If surveys are required in deeper water, use larger minnow traps that will maintain freeboard while still allowing the trap to reach deeper water. Alternatively, place the trap more than 2 m below the water surface (i.e., below the maximum depth recorded for diving water shrews). If you must use traps away from shore, use Styrofoam on the exterior of the trap to create a floating minnow trap that can be tethered to shore (although this may be difficult to achieve in waterbodies that are large or have high current). Finally, using traps designed for other organisms, such as "funnel traps" for sampling amphibians in aquatic environments (e.g., Mushet *et al.* 1997), may reduce risk to air-breathing animals.

These suggestions may be difficult to implement for some fisheries objectives (e.g., if traps must be located fully under the water surface); however, you can avoid some mortality by considering and implementing the methods suggested above. We would appreciate feedback on this question from fisheries practitioners. Learning about the frequency and location of mortalities will help the recovery team document the significance and locations of this threat.

To learn more about water shrews, please refer to reference material at the following links:

- South Coast Conservation Program (home of the Pacific Water Shrew Recovery Team): http://www.sccp.ca
- BC Ministry of Environment brochure: www.env.gov.bc.ca/wld/documents/shrew.pdf

Continued on page 24

Continued from page 23

- Identified Wildlife Management Strategy account for Pacific water shrew: http://www.env.gov.bc.ca/wld/identified/accounts.html
- BC Species and Ecosystem Explorer search tool: http://www.env.gov.bc.ca/atrisk
- Federal species at risk Web site: http://www.sararegistry.gc.ca/default_e.cfm

For further information, contact:

Ross Vennesland
Species at Risk Biologist

BC Ministry of Environment
10470 152 Street
Surrey, BC
V3R 0Y3
Tel: (604) 582-5279
Email: ross.vennesland@gov.bc.ca

Literature Cited

Craig, V.J. and R.G. Vennesland. In review. National recovery strategy for the Pacific water shrew in Canada. Report prepared for the Pacific Water Shrew Recovery Team and BC Ministry of Environment, Victoria, BC.

Galindo-Leal, C. and J.B. Runciman. 1994. Status report on the Pacific water shrew (Sorex bendirii) in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.

Lindgren, P. and V. Craig. 2002. Identified Wildlife Management Strategy for Vancouver Island water shrew (Sorex palustris brooksi). BC Ministry of Environment. Available from: http://srmapps.gov.bc.ca/apps/eswp/ (search by species).

Mushet, D.M., N.H. Euliss, B.H. Hanson, and S.G. Zodrow. 1997. A funnel trap for sampling salamanders in wetlands. Herpetological Review 28:132–133. Available from: http://www.npwrc.usgs.gov/resource/herps/funnel/funnel.htm

Nagorsen, D.W. 1996. Oppossums, shrews and moles of British Columbia. Volume 2: The mammals of British Columbia. Royal BC Museum, Victoria, BC.

Zuleta, G.A. and C. Galindo-Leal. 1994. Distribution and abundance of four species of small mammals at risk in a fragmented landscape. BC Ministry of Environment, Lands and Parks, Wildlife Branch, Victoria, BC. Wildlife Working Report WR-64.

UPDATE

Recent Publications (2005–2006)

Beaudry, L.J., J. McConnachie, P.G. Beaudry, and R.G. Pike. 2006. **Appendix 1 – Glossary of hydrologic and geomorphic terms** [online]. *In* Compendium of Forest Hydrology and Geomorphology in British Columbia. R.G. Pike *et al.* (editors). BC Ministry of Forests and Range, Research Branch, Victoria, BC, and FORREX Forest Research Extension Partnership, Kamloops, BC. Land Management Handbook (TBD). In preparation.
Available from: http://www.forrex.org/program/water/compendium.asp

Beaudry, L.J., J. McConnachie, R.G. Pike, and P.G. Beaudry. 2006. **Appendix 2 – Acronyms, symbols, and conversion factors** [online]. *In* Compendium of Forest Hydrology and Geomorphology in British Columbia. R.G. Pike *et al.* (editors). BC Ministry of Forests and Range, Research Branch, Victoria, BC, and FORREX Forest Research Extension Partnership, Kamloops, BC. Land Management Handbook (TBD). In preparation.
Available from: http://www.forrex.org/program/water/compendium.asp

Beaudry, L.J., J. McConnachie, P.G. Beaudry, and R.G. Pike. 2006. **Appendix 3 – Watershed Data and Information Resources** [online]. *In* Compendium of Forest Hydrology and Geomorphology in British Columbia. R.G. Pike *et al.* (editors). BC Ministry of Forests and Range, Research Branch, Victoria, BC, and FORREX Forest Research Extension Partnership, Kamloops, BC. Land Management Handbook (TBD). In preparation.
Available from: http://www.forrex.org/program/water/compendium.asp

Guthrie, R.H. 2005. **Geomorphology of Vancouver Island [electronic resource]: Extended legends to nine thematic maps.** BC Ministry of Environment, Victoria, BC. Research Report No. RR02.
Available from: http://wlapwww.gov.bc.ca/wld/documents/techpub/rr02/VIextlegends.pdf

Guthrie, R.H. 2005. **Geomorphology of Vancouver Island [electronic resource]: Mass wasting potential.** BC Ministry of Environment, Victoria, BC. Research Report No. RR01.
Available from: http://wlapwww.gov.bc.ca/wld/documents/techpub/rr01/VImasswaste.pdf

Moore, R.D. and D.F. Scott. 2005. **Camp Creek revisited: Streamflow changes following salvage harvesting in a medium-sized, snowmelt-dominated catchment.** Canadian Water Resources Journal 30(4):331–344.
Available from: http://ginkgo.cisti.nrc.ca/ppv/RPViewDoc?_handler_=HandleInitialGet&journal=cwrj&volume=30&articleFile=cwrj3004331.pdf

Pike, R.G. and J. Ussery. 2006. **Pre-planning for post-wildfire rehabilitation: Key points to consider.** FORREX Series 19.
Available from: http://www.forrex.org/publications/FORREXSeries/FS19.pdf

Teti, P.A. and R.G. Pike. 2005. **Selecting and testing an instrument for surveying stream shade.** BC Journal of Ecosystems and Management 6(2).
Available from: http://www.forrex.org/publications/jem/ISS31/vol6_no2_art1.pdf

Tripp, D.B., P.J. Tschaplinski, S.A. Bird, and D.L. Hogan. 2005. **Protocol for evaluating the condition of streams and riparian management areas.** FRPA Resource Evaluation Program, BC Ministry of Forests and BC Ministry of Water, Land and Air Protection, Victoria, BC. 53 p.
Available from: http://www.for.gov.bc.ca/ftp/HFP/external/!publish/FRPA%20Evaluation%20Program/repository/rip_protocol.pdf

VanDine, D.F., R.F. Rodman, P. Jordan, and J. Dupas. 2005. **Kuskonook Creek, an example of a debris flow analysis.** Landslides 2(4):257–265.
Available from: http://dx.doi.org/10.1007/s10346-005-0017-9

Wilford, D.J., M.E. Sakals, and J.L. Innes. 2005. **Forest management on fans: hydrogeomorphic hazards and general prescriptions.** BC Ministry of Forests, Research Branch, Victoria, BC. Land Management Handbook No. 57.
Available from: http://www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh57.htm

Wilford, D.J., P. Cherubini, and M.E. Sakals. 2005. **Dendroecology: A guide for using trees to date geomorphic and hydrologic events.** BC Ministry of Forests, Research Branch, Victoria, BC. Land Management Handbook No. 58.
Available from: http://www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh58.htm

Winkler, R.D., D.L. Spittlehouse, and D.L. Golding. 2005. **Measured differences in snow accumulation and melt among clearcut, juvenile, and mature forests in Southern British Columbia.** Hydrological Processes 19:51–62.
Available from:http://www3.interscience.wiley.com/cgi-bin/jhome/4125