Habitat suitability/capability modeling for Pacific water shrew

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Executive Summary

Habitat suitability/capability modeling is a useful method for identifying habitat that is potentially suitable for a species. During modeling, the suitability or capability of habitat types is rated based on known habitat associations of the species, typically in a 4 (such as High, Moderate, Low or Nil) or 6-ratings scale. Such information can assist in prioritizing areas for research, stratifying research effort, landscape level planning (such as corridors), and identifying habitat essential for the survival of a species at risk.

Two habitat suitability/capability models have been created for the Endangered Pacific water shrew (*Sorex bendirii*). One is based on Terrestrial Ecosystem Mapping (TEM) data, the other on Sensitive Habitat Inventory Mapping (SHIM) data. TEM is the provincial standard for habitat suitability modeling, but its emphasis on the terrestrial environment, and its coarse scale may result in habitat suitability or capability being incorrectly assigned for Pacific water shrew (PWS; e.g. in areas where there are no watercourses). SHIM is a riparian-based system of assessing habitat which is useful for PWS, but its limited scope minimizes its usefulness in landscape planning with non-riparian corridors. Both of these models can be complementarily used when assessing habitat for PWS.

Additional research is required to refine both of these models. Collection of both TEM and SHIM-type data when surveying locations for PWS (such as when conducting environmental assessments) is important to provide feedback to the models. In addition, it is important to ground-truth the models by surveying for PWS in areas identified by the models as High, Moderate, Low or Nil suitability habitats. Prior to large-scale surveys, the efficiency of the current surveying methodology should be assessed to determine if it is adequate to reasonably indicate the presence of PWS when they are indeed present.

Recommendations include:

1) The environmental assessment model should continue to be based on TEM data, because it is a simple model based on a well-established Ministry protocol with which most consultants are familiar;
2) Any trapping permits for PWS should include as a requirement that contractors collect TEM and SHIM-type data and submit these records to the Ministry whether or not a PWS is captured during the survey. An excel data sheet is included which has the variables that should be collected;
3) The current methodology used to assess presence/absence of PWS (pitfall trapping for 7 days with multiple trap checks per day) should be assessed to determine whether it is adequate to reliably detect the presence of PWS when it is present;
4) The models should be ground-truthed by surveying for PWS in areas identified as High, Moderate, Low and Nil suitability habitat for PWS;
5) Stewardship groups should be surveyed to determine if additional SHIM data are available;
6) Obtain funding to enter SHIM data that have been collected along streams in Chilliwack and North Vancouver, but have not yet been entered in digital format;
7) Any accidental mortalities of Pacific water shrew should be necropsied to determine their sex and reproductive status. This information will provide important feedback to the models about habitat suitability.

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Introduction

The ability to identify habitat essential for the survival and recovery of Pacific water shrew (PWS) will rely on the ability to accurately map habitat suitability across its range. Two habitat suitability/capability models have been created for Pacific water shrew (Craig 2006a and b). One is based on Terrestrial Ecosystem Mapping (TEM) data, the other on Sensitive Habitat Inventory Mapping (SHIM) data. This document describes the two models, provides recommendations for changes to the environmental assessment protocol for Pacific water shrew so that more data is provided to the Pacific water shrew Recovery Team from any assessments, and makes recommendations about activities to assist in the refining and implementation of these two models.

Terrestrial Ecosystem Mapping (TEM) habitat suitability/capability model

The habitat suitability/capability model for Pacific water shrew for use with Terrestrial Ecosystem Mapping (TEM) data (Craig 2007) follows standards established by the BC government (Resource Information Standards Committee; RISC standards). TEM is currently the provincial standard for habitat capability/suitability models. TEM is a process that assigns an ecological site series classification to an area based on site indicators such as soil moisture, soil nutrient status, and plant communities. For each ecological site series/seral stage combination present in the lower mainland I rated the potential habitat suitability as High (1), Moderate (2), Low (3) or Nil (4). In addition, I also created a habitat capability ratings table where the rating for each site series reflected the maximum attainable within that site series (for example, if a young seral stage within a site series was rated Moderate whereas an older seral stage within the series was rated High, the overall habitat capability was rated High).

Unfortunately, TEM mapping in the Lower Mainland is sparse and is expensive to complete, so the model can not be widely applied. The model is primarily used during Environmental Assessments to assist in assessing habitat capability, and to provide guidelines for activities within Low, Moderate and High quality habitat (Craig 2007, Craig and Vennesland 2007).

Benefits to using the TEM model:

- TEM modeling is currently the provincial standard;
- Most consultants are familiar with the protocol for collecting TEM data;
- The province has established guidelines for collecting TEM data;
- The relative simplicity of the TEM model (compared to the SHIM model). Based on one piece of information (site series) the habitat capability of the area for PWS can be assessed, and based on 2 pieces of information (site series and seral stage) habitat suitability can be assessed.

Potential drawbacks to using the TEM model:

1) The emphasis on the terrestrial habitat. The TEM model may not accurately reflect the habitat suitability for PWS because it does not incorporate information about watercourses. Best habitat for Pacific water shrews is considered to be intact riparian habitat (structural stages 4-7) associated with permanent, intermittent or ephemeral small to moderate sized streams (typically <10 m wide). In some situations, TEM mapping may rate habitat as suitable that is not associated with a stream, or is associated with an unsuitable watercourse. Additionally, where water is present, the site may be more suitable for PWS than indicated with TEM ratings (for example in a dry site series). Assessments of habitat capability for PWS based on TEM data should apply the protocol of increasing Nil ratings by 1 to Low within 100 m of water;

2) The TEM model works in conjunction with TRIM to identify the presence of water; however, TRIM does not identify many smaller or non-permanent watercourses or small wetlands meaning that the model will not always accurately identify suitable habitat. This drawback does not apply during on-the-ground site assessments;

3) The relatively coarse scale of TEM may not distinguish potentially suitable habitat. For example, the presence of riparian habitat retained streamside in a clear-cut area, or a site series that is considered to be too dry to provide suitable habitat except where water exists, may provide suitable habitat but may not be recognized on TEM maps (e.g. Figure 1). This can be at least partially addressed by using the protocol of increasing the habitat capability/suitability rating by 1 within 100 m of water so that these sites are sampled for PWS during environmental assessments;

4) TEM is only suitable for assessing suitability/capability of natural forested sites, and is not useful for assessing anthropogenic (modified) areas such as agricultural areas;

5) The expense of conducting TEM will limit the widespread collection of data, thereby limiting the usefulness of the model.

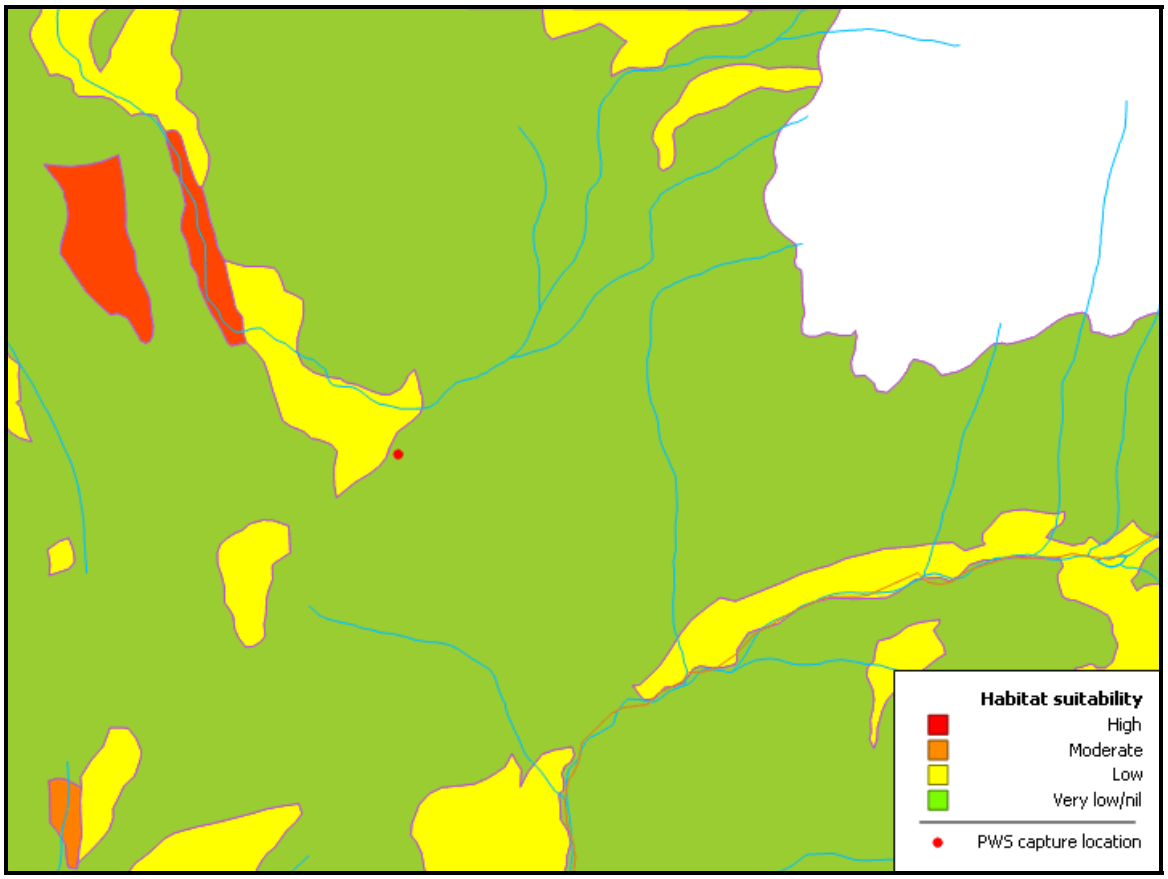

Figure 1. Close-up view of TEM ratings in the Coquitlam watershed. The Nil suitability area in the figure (green) is site series CWHvm1 site series 01, which is rated Nil by the habitat capability model because it has almost no moist/wet site indicators. By increasing TEM ratings from Nil to Low within 100 m of streams the suitability of the site would be assessed through trapping.

Sensitive Habitat Inventory Mapping (SHIM) habitat suitability model

To generate habitat suitability maps for additional areas of the Lower Mainland, I developed an additional habitat suitability model that uses SHIM (Sensitive Habitat Inventory Mapping) data (Craig 2006). The SHIM method was developed as a standard for measuring the attributes of freshwater watercourses and their associated riparian habitats (Mason and Knight 2001). The emphasis of SHIM is on the suitability of the site as fish habitat. Stream data are summarized along stream segments, and occasionally detailed cross-sectional data are collected across the entire riparian zone. Data such as the presence of barriers to fish passage, areas of concern (such as the presence of degraded habitat), presence of wildlife trees or wildlife sightings are also noted.

Based on the data available from SHIM, I created a Bayesian Belief Network (BBN) which classified habitat suitability as High, Moderate, Low or Nil. I focused the BBN on data collected along stream segments. Emphasis was placed on selecting variables that would not vary widely between seasons (*ie*. using Bankfull width instead of wetted width).

The model was originally applied to the SHIM dataset available from the Community Mapping Network (CMN), which includes data collected from 1999 to 2003 in areas around the province. I was able to collect additional SHIM data to add to the database (Table 1), which is included in the updated model (Craig 2006).

Potential benefits of the SHIM model:

1) Modified habitats (such as agricultural areas or areas of pavement) can be modeled using the model;

2) The model can easily be modified to incorporate new information about the suitability of specific habitat types for PWS (e.g. the suitability of narrow ditches or channelized watercourses with abundant surrounding shrub cover). Currently this habitat would be rated Low by the model; as additional data are collected about the use of modified habitats by PWS the model can easily be updated;

3) The SHIM model can incorporate uncertainty and missing variables. For example, where data are missing for 1 or more variables, the model output reflects the probability that the stream rating will fall within a given category. Updated information can be easily incorporated to give updated stream classification probabilities;

4) The flexibility of the model. As additional information becomes available about important habitat characteristics for PWS, additional variables may be included in the model;

5) SHIM data are often collected by Municipalities as part of their efforts in stream mapping and fisheries stewardship. Therefore, these data are more accessible than TEM data.

Table 1. Status of SHIM mapping in Municipalities within the range of Pacific water shrew as of March 2006.

Jurisdiction	Contact Information	Telephone	Email/Web address	Contact	SHIM status
Village of Anmore	2697 Sunnyside Road, Anmore, B.C., V3H 3C8	(604) 469 9877	village.hall@anmore.com www.anmore.com/	Linda Tremblay Linda.Tremblay@anmore.com	No mapping data
Village of Belcarra	4084 Bedwell Bay Road, Belcarra, B.C. V3H 4P8	(604) 937-4100	mcgregor@belcarra.ca www.belcarra.ca/index.htm	Connie Scherk cscherk@belcarra.ca	Connie will check and get back
Bowen Island Municipality	981 Artisans Lane, Box 279, Bowen Island, BC V0N 1G0	(604) 947-4255	www.bowen-island-bc.com/Council/		No PWS on Bowen Island
City of Abbotsford	32315 South Fraser Way, Abbotsford B.C. V2T 1W7	(604) 853-2281 Toll-free: 1-866-853-2281	www.abbotsford.ca/	Tanya Bettles Tbettles@abbotsford.ca, Darren Brown 604-864-5510 Dbrown@abbotsford.ca	Have begun SHIM mapping priority areas – high development pressure areas. Have begun on Sumas Mountain, - have mapped McKee Peak and are working on the Clayburn watershed. Data should be available in a few months. Will be charging for access to data.
City of Burnaby	4949 Canada Way, Burnaby B.C. V5G 1M2	(604) 294-7944	www.city.burnaby.bc.ca/Home.html	Robyn Wark (604) 294-7297	Have SHIM data done by BCIT students in all of Brunette watershed (may have errors). Also, Robyn did a strategic level analysis of streams in the Still Creek watershed to classify potential suitability for PWS.
City of Coquitlam	3000 Guildford Way, Coquitlam, B.C. V3B 7N2	(604) 927-3000	feedback@coquitlam.ca www.coquitlam.ca/default.htm	Erin Ferguson (Enviro Mapping Technician) 604-927-3463; eferguson@coquitlam.com	Provided SHIM data for Riverview Lands in Coquitlam (collected NAD27 in 2002). The rest of Coquitlam SHIM data is on the CMN.

Jurisdiction	Contact Information	Telephone	Email/Web address	Contact	SHIM status
City of Chilliwack	8550 Young Road, Chilliwack, B.C. V2P 8A4	(604) 792-9311	info@chilliwack.com www.chilliwack.com/main	Rod Sanderson 604-793-2944; sanderson@chilliwack.com	Chilliwack has SHIM data for all of its streams, but it is in paper form (approximately 9 volumes).
Corporation of Delta	4500 Clarence Taylor Crescent, Delta, B.C. V4K 3E2	(604) 946-4141	www.corp.delta.bc.ca/	Mike Brotherston 604-946-3282 mbrotherston@corp.delta.bc.ca	Have conducted streamside mapping for fish
Electoral Area A	Gary Gibson, Director	(604) 224-0699	www.gvrd.bc.ca/growth/ElectoralAreaA.htm		
City of Langley	20399 Douglas Crescent, Langley, B.C. V3A 4B3	(604) 514-2800	www.city.langley.bc.ca/		
Township of Langley	4914 - 221st Street, Langley, B.C. V3A 3Z8	(604) 534-3211	www.township.langley.bc.ca/		Langley has SHIM mapping for its streams, held by the Langley Environmental Partnership Society, which charges for access to the database.
Village of Lions Bay	Box 141, Lions Bay, B.C. V0N 2E0	(604) 921-9333	office@village.lions-bay.bc.ca www.civicnet.bc.ca/members/municipalities/lionsbay.shtml		Email, no response
District of Maple Ridge	11995 Haney Place, Maple Ridge, B.C. V2x 6A9	(604) 463-5221	www.mapleridge.org/	Jim Sheehan 604-467-7499 Rod Stott 604-467-7390	Have modified SHIM along all watercourses in District (450-500 km of watercourses)
City of New Westminster	511 Royal Avenue, New Westminster, B.C. V3L 1H9	(604) 521-3711	Postmaster@city.new-westminster.bc.ca www.city.new-westminster.bc.ca/	Claude Leduc (Parks and Rec) 604-830-6962	No SHIM data for New Westminster. No streams in New West – has the Burnett River and some ditches in Queensborough
City of North Vancouver	141 West 14th Street, North Vancouver V7M 1H9	(604) 985-7761	info@cnv.org www.cnv.org/	Michael Hunter (Enviro Coordinator); Mhunter@cnv.org	City of North Vancouver has not conducted SHIM mapping, and are unaware

Jurisdiction	Contact Information	Telephone	Email/Web address	Contact	SHIM status
					of any consultants collecting data in the area
District of North Vancouver	355 West Queens Road, North Vancouver, B.C. V7N 4N5	(604) 987-7131	infoweb@dnv.org www.district.north-van.bc.ca	Ken Bennett	Creeks are mapped on GIS. Also have data (not SHIM) from 1993 survey of 38 creeks, but not in electronic format. Data have been recorded from Hastings and Roche Ck which are locations of previous PWS captures.
District of Pitt Meadows	12007 Harris Road, Pitt Meadows, B.C. V3Y 2B5	(604) 465-5454	www.pittmeadows.bc.ca/	Kim Grout	No SHIM mapping, might be revisited by Council in 2007
City of Port Coquitlam	2580 Shaughnessy Street, Port Coquitlam, B.C. V3C 2A8	(604) 927-5411	info@city.port-coquitlam.bc.ca www.city.port-coquitlam.bc.ca/	Alan Jensen jensena@city.port-coquitlam.bc.ca	There is a rumour that SHIM mapping was conducted in POCO but they don't know the location of the data. The data might be out of date because it would be approx. 10 years old.
City of Port Moody	100 Newport Drive, Box 36, Port Moody, B.C. V3H 3E1	(604) 469-4500	info@cityofportmoody.com www.cityofportmoody.com/default.htm	Rick Saunier Rick.Saunier@cityofportmoody.com; 604-469-4572; Julie Pavey (Mgr Enviro Services) 604-469-4570; Julie.Pavey@cityofportmoody.ca	SHIM available for all streams in Port Moody
City of Richmond	6911 No. 3 Road, Richmond, B.C. V6Y 2C1	(604) 276-4000	www.richmond.ca/home.htm		
City of Surrey	14245 - 56th Avenue, Surrey, BC, V3x 3A2	(604) 591-4011	http://www.city.surrey.bc.ca/default.htm	Carrie Baren,	Have completed SHIM collection along the Little Campbell River Basin and the Upper Serpentine, are currently collecting data

Jurisdiction	Contact Information	Telephone	Email/Web address	Contact	SHIM status
					along Highland Creek
City of Vancouver	453 West 12th Avenue, Vancouver, B.C. V5Y 1V4	(604) 873-7011	info@city.vancouver.bc.ca www.city.vancouver.bc.ca/		Email, no response
District of West Vancouver	750 – 17th Street, West Vancouver, B.C. V7V 3T3	(604) 925-7000	info@westvancouver.net www.westvancouver.net/	Steve Jenkins 604-925-7192	Left message
City of White Rock	15322 Buena Vista Avenue, White Rock, B.C. V4B 1Y6	(604) 541-2181	www.city.whiterock.bc.ca/		

Drawbacks to using the SHIM model of habitat suitability:

1) For habitat suitability classification of wetlands, SHIM data must be carefully entered into the BBN to avoid erroneously classifying the wetland as Nil habitat (based on the large size of the area);
2) The focus of SHIM on the riparian area means that SHIM modeling is less useful than TEM for assessing habitat suitability far from water (potentially a useful exercise for planning corridors if PWS can move across moist forested habitat);
3) SHIM is not the provincial standard;
4) SHIM data often are collected by volunteers (in many cases without specific training) which may influence the accuracy and thoroughness of the data, and often not all variables are collected which reduces the certainty with which habitat suitability ratings can be assigned;
5) The model incorporates many variables which increase the potential accuracy of the model; however, the complexity of the model means that it cannot easily be used by consultants in the field to classify habitat suitability. Once the necessary stream data are collected the variables can be input into the model on a computer and the habitat suitability can be assessed.

Use of TEM and SHIM habitat suitability models

Where habitat data are collected such as during environmental assessments, data for both TEM and SHIM models should be collected (Appendix I). Because the focus of SHIM is on the stream, it is more likely to provide directly applicable habitat suitability information than TEM for now; as additional data are collected to refine the TEM model this might change. The collection of TEM data will enable the refinement of the TEM model, which is the provincial standard. TEM is currently the only model that can be used to rate habitat capability.

The SHIM model is applicable to assess habitat suitability of the stream or wetland. All watercourses, whether permanent, intermittent or ephemeral should be considered potential habitat for Pacific water shrew. Note that in areas of larger watercourses there may be tributaries (potentially intermittent or ephemeral) or wet areas that may provide suitable habitat. In addition, wetlands and ponds of all sizes should be considered as potential habitat.

The TEM model should be applied to habitat within 100 m of watercourses, ponds or wetlands. Habitat capability rankings of Nil should increase by 1 to Low within 100 m of water (as indicated by TRIM data or by onsite reconnaissance). TRIM data do not include many smaller watercourses, and may not accurately reflect habitat suitability in some areas. Many Municipalities have their own TRIM data which is more accurate, and often includes alternate water sources such as ditches. Where possible, access watercourse data from Municipalities to increase the watercourse coverage.

The relative simplicity in assessing habitat capability in the field with the TEM model compared to the SHIM model means that the TEM model should remain the primary model for environmental assessments.

Recommended changes to the environmental assessment guidelines

I recommend changes to the current environmental assessment guidelines (Craig and Vennesland 2003). The changes will increase the number of sites requiring an environmental assessment and/or water shrew sampling which will increase the amount of information available for the Pacific water shrew Recovery Team. In addition, requiring consultants to collect additional standard habitat variables (such as canopy closure, % shrub cover, stream width etc.) will provide very useful information on habitat associations of PWS and will also permit the refining of the models. The collection of additional habitat data at sites assessed for PWS will entail a little additional work for consultants. However, the variables included are easily and quickly estimated, and sampling is only recommended at 2 sites which limits the additional work required. See Appendix I for a sample data sheet; an excel spreadsheet is also available that can be customized by consultants to fit their requirements.

See Figures 1 and 2 for a revised environmental assessment protocol. Changes include:

- Only recent PWS capture records (<20 years) trigger automatic implementation of guidelines. Habitat at the site of older records will need to be assessed. This has the benefit of requiring additional habitat collection in areas that might have been modified since the original capture. It is unlikely that previous capture locations would be ranked as Low or Nil unless heavily modified, and so would still qualify for implementation of guidelines;
- To gain additional data, environmental assessments should also be conducted at sites classified as Nil capability (in practice Nil ratings increase to Low close to water so this would rarely happen in a project being assessed for its impact to Pacific water shrew). Currently the guidelines indicate that no further action is required on Nil habitat. If this is considered too onerous for consultants, then separate surveys (funded by MoE) should be conducted as soon as possible. Sites should be surveyed from all classification ratings (High, Moderate, Low and Nil) with additional emphasis on sampling Nil sites;
- The change in the TEM ratings so that all Nil capability habitat will be rated Low within 100 m of water means that these habitats will be sampled for PWS;
- TEM and SHIM data should be collected at <u>all</u> sites and submitted to MoE (see Appendix I for a list of data to collect), even if initial TEM models indicate the site is Moderate/High and does not require further sampling;
- The elevation range included within the guidelines was increased to 1000 m.

Recommended activities

Additional research and data collection is required to further refine the two models (Table 2).

1) It is possible to increase our information on habitat associations of Pacific water shrew with minimal cost by:

i) requiring consultants conducting environmental assessments to collect habitat data in a standardized form and to submit these data to the Recovery Team. This should be a requirement of obtaining a trapping permit for this species. These data should be collected at all assessment sites regardless of habitat ratings. Currently, data are collected in a haphazard manner and a general description of habitat is usually provided only where a shrew is captured;

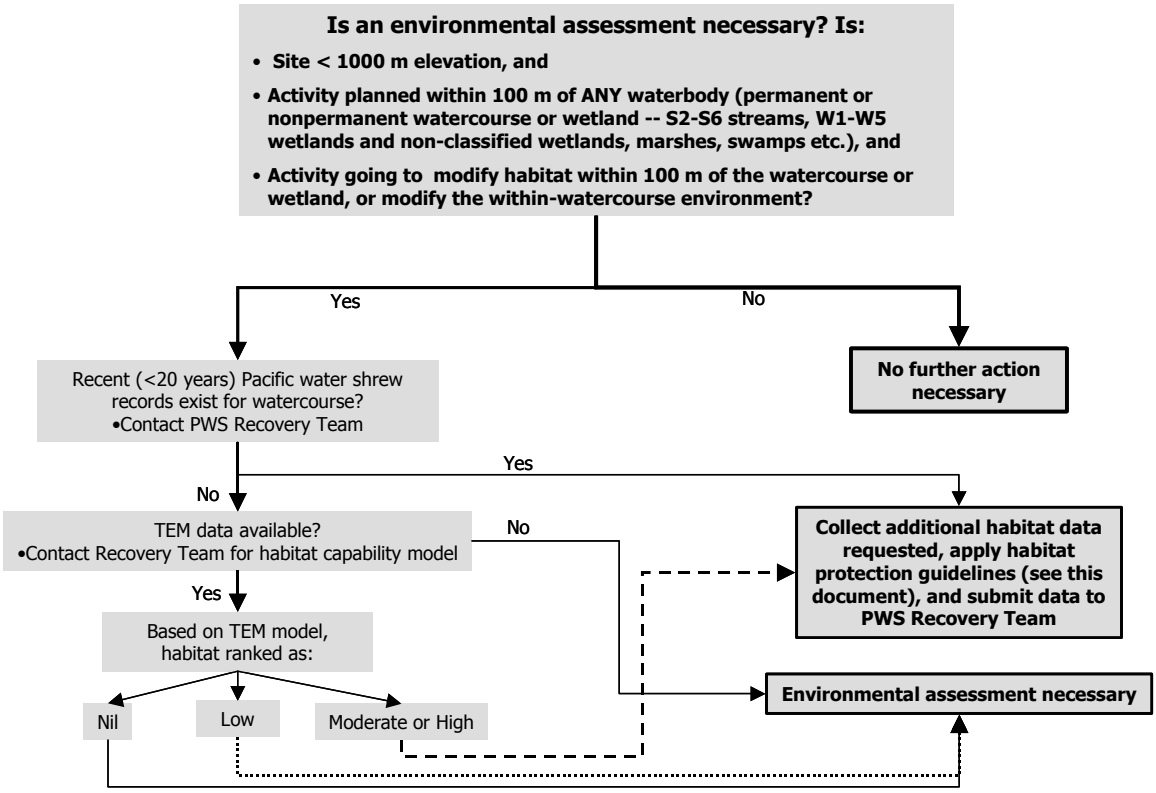

Figure 2. Modified decision support flowchart for assessing whether an environmental assessment is necessary. The included range of elevation has been expanded, a recent PWS capture is necessary to qualify for automatic application of deadlines, and habitat ranked as Nil now requires an environmental assessment instead of requiring no further action.

ii) conducting a necropsy on all mortalities of PWS to establish the sex, reproductive condition, and age of the shrew. This will provide useful information about the population characteristics at the site, and provide feedback on the suitability/capability ratings;

iii) collecting TEM and SHIM data at previous capture locations that can be identified with reasonable accuracy, where these data are not currently available.

2) Research should be conducted investigating the efficiency of the current recommended trapping protocol (trapping for 7 days, traps open 24 hours a day, repeated checks) for identifying the presence of Pacific water shrew when the shrew is actually present. Options include a study where alternate trap types are used in addition to the pitfall traps (e.g. modified minnow traps or live-traps), and/or extending the trapping period or adding additional traps. Another option is the development of a high-efficiency lower-cost assessment option (such as the bait-tube method);

3) Once an efficient reliable method of identifying the presence of the PWS is developed, sample areas rated High, Moderate, Low and Nil to ground-truth the models and update the ratings;

4) Additional SHIM data are available, but they either are not in electronic format (as in Chilliwack), or the Municipalities are charging a fee for access (as in Langley and Abbotsford). Accessing these data will increase the coverage of the SHIM model in the Lower Mainland.

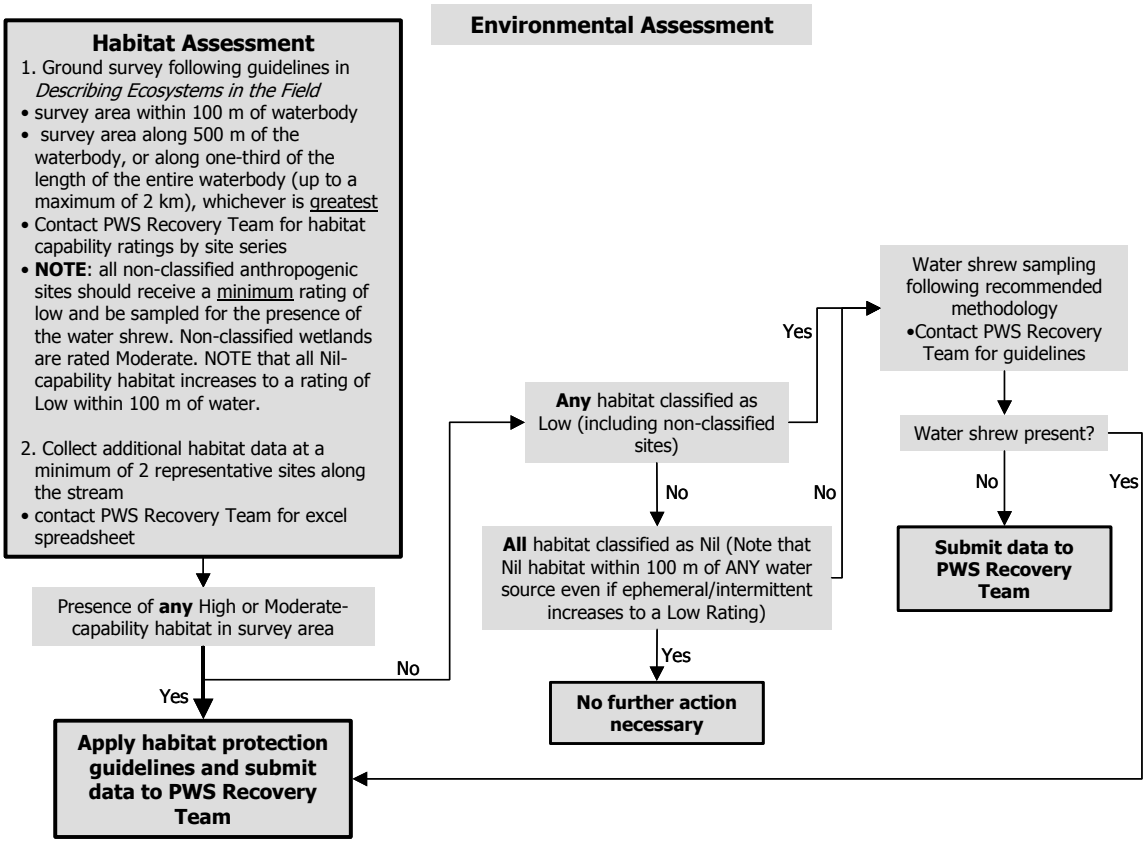

Figure 3. Modified decision support flowchart for assessing whether sampling for Pacific water shrew is necessary. The flowchart is modified to recommend that all Low and Nil rated habitats be sampled, and that additional information on stream characteristics be collected and submitted.

4) It is possible that additional SHIM data may be held by stewardship groups. Contacting these groups will be a low priority

5) Research should be conducted on the usefulness of channelized watercourses (ditches) to PWS. Are these sink habitats for dispersing juveniles or less successful individuals or are they suitable habitat for PWS? If they are used as dispersing habitat/corridors or represent suitable habitat, what are the characteristics that make them useful? (ie. presence of a certain amount of shrub cover, bank slope and condition, or water characteristics)? This should be a high priority for research.

Table 2. Recommended actions and start dates for addressing knowledge gaps in the PWS habitat suitability/capability models

Priority	Description of Activity	Start Date	Completion Date
1	TEM and SHIM habitat data collection at previous capture locations, or sampling locations where PWS not captured, where data not already available	2007	2007
1	Require contractors to collect and submit TEM and SHIM habitat data to MoE when conducting EAs (see Appendix I)- data should be collected and submitted for all surveys whether or not a PWS is captured – a condition of obtaining trapping permit	2006	2009
1	Conduct research to determine trapping efficiency of current trapping protocol. Is current design adequate? (number of traps, type of traps, number of days open)	2006	2007
1	Where PWS are captured in habitats rated Low or Nil, conduct research to determine whether the habitat should receive a higher rating (ie. the use of channelized watercourses by PWS). Are these dispersal habitats? Sink habitats? Or suitable living habitats?	2007	2009
1	Necropsy all mortalities to assess reproductive status, age	2006	2009
2	Using TEM and SHIM models, survey for PWS in habitats classified as High, Moderate, Low and Nil (must use efficient method that has high degree of success when PWS are present)	2007	2009
3	Optional: design alternate cost-effective and efficient method of sampling for PWS	2006	2009
3	Obtain funds to allow computer input of Chilliwack SHIM data, and potentially stream data for District of North Vancouver	2007	2008
3	Obtain funds to access Langley and City of Abbotsford SHIM data (likely approximately $2000)	2007	2007
3	Contact Municipalities to determine if improved watercourse coverage exists for the area.	2008	2009
4	Contact stewardship groups to determine if additional SHIM data are available	2007	2007

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Mason, B., and R. Knight. 2001. Sensitive habitat inventory and mapping. Community Mapping Network, Vancouver, British Columbia. 315 pp + viii. M. Johannes, editor.

Appendix I. Habitat sampling at PWS sampling locations

Please record the following site characteristics at sampling locations of PWS. Please complete at least 2 plots per area, and characterize habitat on both banks. Pick a representative portion of habitat to characterize. If two distinct habitats are sampled please collect data for both habitat types. Data are collected on both the upland and watercourse characteristics, and represent standard habitat measurements. The sheet is included as an example of the types of data collected. An excel spreadsheet is available that can be formatted to be suitable for use.

Please conduct sampling for terrestrial characteristics immediately beside the watercourse in the same location stream characteristics are recorded. If a water shrew is captured please indicate habitat characteristics at or near to the capture site if possible.

For habitat collected along the 2 banks at one location, use the same record number and indicate L or R (or N/S, E/W or 1 or 2 or whatever you want) under the bank category.

Under the dominant structural stage of bank category please enter one of the following 7 stages by number or title: 1-bryophytes, 2-herb/grass, 3-low shrub, 4-tall shrub, 5-young forest, 6-mature forest, 7-old-growth.

Under the Site Condition column please indicate whether the site was in a natural, rural, agricultural, urban residential, or disturbed state (or some other condition descriptor such as paved parking lot, or dirt road).

Any comments you can provide on the habitat (e.g. approx. distance to nearest development, approx. distance to nearest forest) are useful.

See the recommended habitat variables on the next page (also available in excel spreadsheet format).

Habitat sampling at Pacific water shrew sampling locations

Terrestrial habitat

Record	Zone	UTM N	UTM E	NAD 27 or NAD 83?	Capture? (Y/N)	Site series	Elevation (m)	Bank (L or R, N or S, E or W etc.)	Dominant structural stage of bank	% Canopy cover	Dominant canopy spp	% Tall shrub cover (>2m)	% Short shrub cover (<2 m)	Dominant shrub spp	% Herb cover	Dominant herb spp	% Grass cover	Approx. width of current buffer	Site condition

Stream habitat

Record	Zone	UTM N	UTM E	NAD 27 or NAD 83?	Bankfull width (m)	Wetted width (m)	Bankfull depth (m)	Wetted depth (m)	Bank height (m)	Stream Gradient (degrees)	Stream substrate	% cover by overhanging veg	Stream condition	**Comments**