COASTAL BEAR DEN IDENTIFICATION MANUAL

Helen Davis, M.Sc., R.P.Bio.

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Cover photo by Drake Stephens: a female black bear rests with her cub in front of a den in a second growth forest in the Fraser Valley.

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Dens-At-A-Glance

THERE ARE 2 IMPORTANT FEATURES TO LOOK FOR WHEN SURVEYING FOR POTENTIAL DENS:

1) A secure, dry chamber, and,
2) An entrance to the chamber that is just large enough to fit a bear.

WHAT TO LOOK FOR:

→ Chamber ≥60 cm (black bear) or >150 cm (grizzly bear) wide
→ Entrance ≥25 cm (black bear hollow tree den) or >75 cm (grizzly bear excavated den) wide
→ Bite or claw marks at entrance and/or inside tree den cavities
→ Bear hair
→ Bedding (not always present)
→ Lack of scats around den

WHAT TO RECORD:

To assist in collecting and storing relevant information in a consistent manner, a schema for Avenza Maps® has been developed and is available for use in the field (available at: http://artemiswildlife.com/bear-dens. See Appendix 1).

Because current den trees will eventually die and need replacement, it is important to retain a selection of trees with basal or above-ground openings that do not yet fully meet size requirements so that they may become dens in the future.

Purpose of this Manual

This manual is meant to help field crews identify winter dens used by black bears and grizzly bears in coastal British Columbia. Specifically, this manual provides information on types of dens, a brief description of how cavities that produce dens are formed in trees and characteristics of trees or excavations that field staff can use to identify potential dens. The final decision as to whether a tree or excavation is a bear den and worthy of protection should be made by a Qualified Professional whose scope of expertise includes bear ecology and den identification. As such, a great deal of responsibility lies with Qualified Professionals to verify these critical habitat elements.

What Makes a Good Bear Den?

Bears require 2 features from a den:

1) A cavity that provides shelter from the elements (wind, rain, cold temperatures).

This main living area of a den is called the "den chamber". Chambers of dens in hollow trees used by female and subadult black bears are usually ≥60 cm across while adult males are larger, usually ≥80 cm. The height of den chambers can be as low as 60 cm but can be many metres inside hollow trees because it is dependent on how extensive decay is in the centre core of the tree. Dens excavated by grizzly bears are much larger than those of black bears (due to their much larger body size) and may be 150-225 cm in diameter with a height of 125 cm.

2) An opening (entrance) to this chamber that is just slightly larger than the bear's body will fit through.

Den entrances need to be surprisingly small so that the occupant can defend themselves from potential predators (e.g., other bears, wolves) and to reduce heat-loss. Bears likely select dens that have entrances that are just large enough for them to fit through. Entrances to black bear dens may be very small (30 cm tall, 25 cm wide), which can make them difficult to spot. A large adult male black bear can fit through an entrance as small as 42 by 32 cm. Conversely, the entrances of excavated grizzly bear dens are much larger, about 75 cm in diameter and will often have a "porch" of excavated soil.

Any tree that develops these 2 key features (Figure 1) could be used as a den by black bears or grizzly bears.

Figure 1. A typical black bear den in a western redcedar tree on Haida Gwaii. The entrance is approximately 30 cm wide and 50 cm high and leads into a dry cavity. Photo by B. Wijdeven.

Why are Dens Important?

Both black bears and grizzly bears require warm, dry dens to survive and reproduce over the winter (Figure 2). The only way a female bear can produce cubs is inside a den. Cubs are born tiny and helpless and need to grow and develop in dens for around 3 months before they are able to survive outside dens.

Unlike interior regions of BC that get insulating snow cover, black bears in coastal BC need the protection of cavities in large old trees, logs and stumps to survive cold, wet winters with ephemeral snow cover. Grizzly bears in coastal BC may also den inside large old trees, logs or stumps like black bears, but more commonly they dig their dens into deep soils under the roots of tree clumps or shrubs (that provide stability to the den roof). In coastal BC, both black bears and grizzly bears usually begin hibernation by the end of October and can stay in dens into mid-May, although this timing depends on sex, reproductive status and body condition of individual bears. Male bears may occasionally not enter hibernation until December and be in their dens for only a few months, whereas females who have given birth to cubs stay in dens for up to 6 months. Bears may come out of dens during warm spells in the winter, but they rarely move far from their den and generally don't forage. Exceptions include bears accessing late salmon runs or human foods (such as garbage) during the den period.

Figure 2. A natal black bear den in a hollow cedar tree. Notice the bear inside and the polished edges of the entrance from repeated entries by a bear. Photo by D. Vey.

Black Bears

Coastal black bears establish dens almost exclusively in large old trees, logs and stumps that have small entrances. Most den cavities form at the base of trees (particularly in western redcedar and yellow-cedar), but some are located above ground-level (i.e., elevated) and are accessed by climbing the outside of the tree. Grizzly bears do not climb trees as well as black bears so, as far as we know, do not use dens with above-ground entrances. Coastal black bears do not use rock overhangs, caves, or man-made structures likely because they are not as dry and warm as wooden structures.

Dens are associated with trees large enough to house a suitable den cavity rather than any one ecosystem or forest type; dens can occur across widely varying slopes and elevations, ecosystems and forest types. Nevertheless, older forests (structural stages 6 and 7) greater than 300 years old (> age class 9), with tree heights of 30 m or greater, crown or canopy closures greater than 50% with redcedar or yellow-cedar as the leading, secondary or even tertiary tree species are the forests most suitable for systematic sampling for dens. Female bears and young bears do not generally den near concentrated food sources, such as salmon runs, likely due to the risk of predation by other bears.

Grizzly Bears

Unlike black bears, coastal BC grizzly bears are more flexible in the types of sites that they use for dens. This species may also den inside trees like black bears, but more commonly, they dig their dens into deep soils. In areas where grizzly bears occur, dens typically occur on moderately steep mountain slopes in the upper sub-alpine or lower alpine in rugged terrain. Dens are often near avalanche tracks and are usually excavated under the roots of tree clumps or shrubs that provide stability to the den roof because the soils are not deep enough to do so on their own. Den sites generally have good soil drainage, relatively easy digging, seclusion, long-duration insulative snow cover and cavity ceiling stability. Use of rock overhangs and caves by grizzly bears has yet to be documented on the BC coast, but has been documented in coastal Alaska. Forestry field crews are unlikely to frequently encounter grizzly bear dens because they typically occur outside the timber harvesting land base.

Although they prefer older forest stands, grizzly bears do not seem to prefer particular tree species or forest stand characteristics. Grizzly bear dens most often occur at relatively high elevation near tree line, broadly on upper slopes of mountains and on moderately steep slopes and usually at the transition between the Coastal Western Hemlock and Mountain Hemlock biogeoclimatic zones (approximately 600-1000 m elevation, depending on latitude and aspect).

A few coastal grizzly bear dens have been located at lower elevations, sometimes inside tree cavities. It's possible that some lower elevation dens may be associated with use of very late fall salmon spawning runs, known to be fed upon through late December.

Types of Dens

The following are description of the types of structures that produce the 2 features needed by bears from dens.

Figure 3. A den used by a dominant adult male black bear in a 280 cm dbh yellow-cedar tree in coastal BC. This den has been used for >27 years. The chamber was >140 cm wide. The entrance to the den chamber is through a gap in the buttresses of the bole at the base of the tree to the left of the person. Photo by R. Weir.

Figure 4. The smallest diameter hollow tree den used in the Nimpkish Black Bear Study; 110 cm dbh but large enough because of the "butt flare" to the tree. Den entrance is 60 cm wide by 52 cm tall. This den was used by an adult male 3 years in a row. Note all the branches broken off of the little amabilis fir on the right side of the entrance that were used as bedding. Photo by T. Hamilton.

HOLLOW TREES

The best cavities for bears to use as dens are most often found in standing live or dead hollow trees (Figure 1-6). These cavities are the result of fungi and insects decaying and removing woody material from within the bole of the tree. To be large enough to house a bear, cavities take hundreds of years to form and can only develop while the tree is alive and continuing to grow. As a result, hollow trees used by bears for dens are typically hundreds of years old, very large and still alive. Although dead hollow trees are occasionally used, these trees do not persist for a long time because supportive features (e.g., roots) are also dead. Because the cavity within the tree needs to be at least 60 cm across, the diameter of trees that black bears use for denning are typically larger than 100 cm dbh. Hollow trees account for the majority of all known den sites of black bears in coastal British Columbia and make for the highest quality den because of the dryness and defensibility of the den chamber. Most live and dead hollow trees used as dens are in western redcedar (*Thuja plicata*) or yellow-cedar (also called cypress, *Cupressus nootkatensis)* trees. These species tend to tolerate rotting inside while growing and retaining a hard-outer shell, creating a natural cavity in the empty centre. Natural openings often occur in the butts of these trees and some even have entrances through openings created in culturally modified trees. Some Sitka spruce (*Picea sitchensis*), western hemlock (*Tsuga heterophylla*) or mountain hemlock (*Tsuga mertensiana*) trees can form suitable den cavities within the roots structure, often due to growing on nurse logs that eventually rot away (Figure 5).

Figure 5. A grizzly bear den in a Sitka spruce tree on the north coast of BC. Notice the people sitting in the den chamber, showing how much larger the entrance to a grizzly bear den is compared to the black bear den in Figure 6. Photo by G. MacHutchon.

Figure 6. The entrance to a yellow-cedar den used by a subadult male black bear. Diameter at breast height: 118 cm, entrance size: 30x35 cm. Photo by H. Davis.

Figure 7. A grizzly bear den under the roots of a western hemlock tree on the north coast of BC. Photo by G. MacHutchon.

Cavities in trees with above-ground entrances are ideal dens for small black bears (i.e., females and subadults) because they protect occupants from both potentially predatory male black bears (which don't climb trees as well as females and subadults) but also from grizzly bears, where the species co-occur. Both redcedar and yellow-cedar trees can have above-ground cavities (at splits in the tree, branch-hole cavities or at candelabras; Figures 8-11). Black cottonwood trees (*Populus balsamifera*) are important for providing safe dens across BC, including coastal BC (Figure 10). Some hollow western or mountain hemlock trees have above-ground entrances accessed through branch-holes (Figure 11) but these den trees do not have the longevity that is seen with dens in cedar trees.

Figure 8. A den used by a female black bear in a yellow-cedar tree with an above-ground entrance (approximately 19 m above ground), she had cubs in this tree. Photo by T. Hamilton.

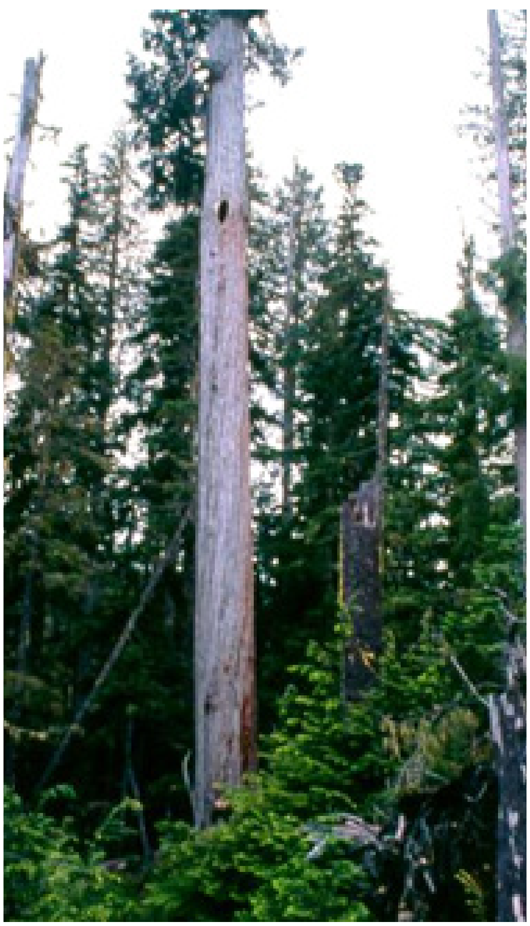

Figure 9. A black bear den with an above-ground entrance. Photo by B. Wijdeven.

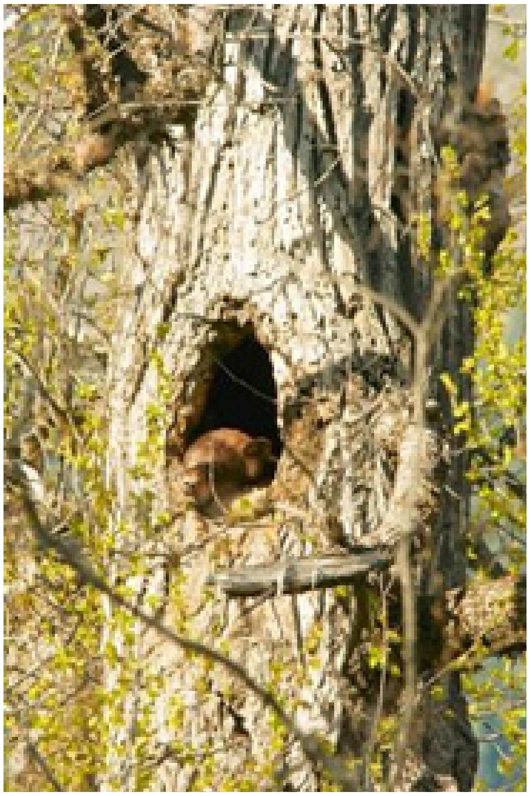

Figure 10. A female black bear rests in the entrance to a den with an above-ground entrance in a black cottonwood tree, she had cubs in this tree. Photo by Connie and Gary Sobchak.

Figure 11. A black bear den with an above-ground or elevated entrance (circled) in a western hemlock tree in coastal BC. Photo by H. Davis.

LOGS

Although used less frequently and of lower overall quality than hollow trees, dens are sometimes located inside (Figure 12), or under (Figure 13), pieces of logs, including unmerchantable wood left behind after logging, as long as the 2 features needed for a den (dry cavity, small entrance) are met. Logs must be quite large in order to provide a cavity large enough to house a bear; generally, den logs are over 130 cm diameter. Cedar logs decay slowly and can be used for decades whereas hollow logs of other species tend to decay much more quickly. These dens in second-growth forests are often not identified and retained in forest development but their protection during subsequent harvesting can be important in areas where the den supply is limited.

Figure 12. A black bear den inside a 146 cm diameter hollow western redcedar log left behind during old growth harvesting in coastal BC. Diameter of opening=50 cm, the chamber was > 4 m down the tube. Photo by R. Weir.

Figure 13. A black bear natal den under a 189 cm diameter Douglas-fir (Pseudotsuga menziesii) log left behind during old growth harvesting in coastal BC. The den chamber was located under and in a pocket of rot in the log. Photo by R. Weir.

ROOT BOLES

Dens are occasionally found under the root wad of overturned trees (Figure 14), typically caused by windthrow. The diameter of the bole of root bole dens can be as small as 75 cm diameter because the cavity is provided by the larger root wad, rather than the tree bole itself. Root boles can be formed by any tree species and can be found in old-growth forests as well as in second-growth forests. However, root bole dens tend to have larger, more open entrances that make occupants more vulnerable to predation.

Figure 14. A black bear natal den under a root bole tree. The very large den entrance is on the left side, the bear travelled down the length of the log to the den chamber under the root wad on the right. Photo by H. Davis.

STUMPS

Dens can also be found inside the base of large, high-cut stumps if a secure dry cavity and small entrance is left behind. These dens in second growth forests are also often overlooked but their protection during harvesting can be important in areas with a limited den supply. Sitka spruce (Figure 15), amabilis fir (also known as Pacific silver fir or balsam, *Abies amabilis*) and western hemlock (Figure 16) stumps are more likely to be used than cedars which, although being hollow, typically lack a “roof” after logging. Stumps of old growth cedar trees that have an open cavity have successfully been turned into useable dens for black bears by capping the open top with wood and cutting an entrance in the base to provide access into the cavity.

Figure 15. A black bear den in a Sitka spruce stump in coastal BC. The tree was cut using spring-boards, leaving a stump over 2 m high. This den has been reused for decades and has large quantities of multi-aged bedding inside. Photo by H. Davis.

Figure 16. A black bear den in a western hemlock stump in coastal BC. Photo by R. Weir.

EXCAVATED DENS (grizzly bears only)

Den excavated by grizzly bears are often obvious features because of the large quantity of soil and rock excavated and deposited downhill from the den. Most grizzly bear dens are dug underneath live or dead trees or clumps of trees or shrubs whose root masses function as a stable ceiling for the required cavity (Figure 17). Excavated dens typically consist of a small entrance and a short tunnel leading to a main chamber up to 2 m diameter and 1.25 m high, often with a “porch” of excavated material on the slope below the entrance. Care should be taken to distinguish actual dens from “test” or collapsed excavations that lack distinct entrances, tunnels or chambers (test diggings may indicate an active den nearby so crews should be careful). Use should be verified by finding hair at the entrance or in the den chamber.

How to Determine if a Cavity is a Den

Dens can often be identified by the presence of claw and bite marks, bear hair, and bedding material (see below) inside the cavity and the absence of scats. It is unusual for a bear to use a den other than during the denning period. If there is recent sign of a bear utilizing a cavity outside the den period, such as multiple scats at a bed, it likely is not a den. The exception is that females with newborn cubs may linger near natal dens until cubs are old enough to leave safely (mid-May) and in some very wet locations black bears may use wooden structures close to salmon-bearing streams to take shelter from the rain while fishing (e.g., Ucluelet, Haida Gwaii).

When conducting surveys to identify dens, all large, dry cavities should be evaluated using the following criteria to determine if it is a potential bear den.

Figure 17. The view looking out of an excavated grizzly bear den showing the large entrance and structural support of roots. Photo by T. Hamilton.

CAVITY SIZE AND ENTRANCE DIMENSIONS

The size of the cavity and dimensions of the entrance leading to it are the key features that should be considered in determining if a tree is a potential den. Den chambers need to be ≥60 cm across for black bears and >150 cm across for grizzly bears. Entrances to cavities are generally ≥25 cm wide for black bears and >75 cm for grizzly bear excavated dens. See photos and dimensions in previous photos.

BEAR HAIR

The presence of hair is one of the best indicators that a cavity has been used as a den. Hair may get caught on a den entrance (Figure 18) from the bear squeezing through the opening, or in the bed where the bear has laid. Check surfaces for hair with a good light and sift handfuls of the bedding over white paper looking for hairs. Hair may be collected and kept dry in paper envelopes and later tested for DNA to determine the bear species and sex and whether the same bear is using a den over multiple years (assuming samples are collected yearly).

Figure 18. Black bear hair caught on the entrance to a den in a hollow tree. Note the bear “carpentry” on the entrance. Photo by H. Davis.

Figure 19. Black bear "carpentry" (bite and claw marks) on the entrance of a black bear den. Photo by H. Davis.

CLAW AND BITE MARKS

Claw and bite marks, or "bear carpentry", both on the entrance (Figure 19) and inside the walls of tree cavities (Figure 20), are strong indicators of use of a tree as a bear den. However, sometimes bite and claw marks are from bears investigating a tree to see if it could be suitable as a den, sometimes the cavity or entrance are not yet large enough (but may become large enough) or lacks suitability in some other way. If in doubt, a Qualified Professional biologist should determine if the tree is actually a den.

The insides of trees are often heavily clawed at, whether to make the den chamber larger or to create bedding. Numerous claw marks that extend up the outside of a tree (Figure 21) may indicate repeated climbing to and from an above-ground black bear den. Trees used for scent-marking and social communication (known as "mark trees") have claw and bite marks, but these trees are usually along trails, have claw and bite marks around 1.5 m high (bears often "mark" while standing next to the tree) and are not usually confused with dens.

Figure 20. Bite and claw marks on the inner chamber of a black bear den. Photo by H. Davis.

Figure 21. Claw marks on the outside of a western redcedar tree from repeated climbing to an above-ground black bear den. Photo by B. Wijdeven.

Figure 22. Measuring the chamber and bed dimensions with a non-flexible measuring tape inside a hollow yellow-cedar den tree. Notice the large quantity of bedding. Photo by R. Weir.

DEN BEDDING

Bears frequently line their den chamber with vegetation. The amount of bedding that bears use in their dens is quite variable. Some bears only use the scrapings of the inside of a tree for bedding, while others will gather large quantities of vegetation and build what looks like a large nest. Tree boughs, shrubs, grass, ferns, mosses and a combination of all of these may be used to create the bed (Figure 22-24). Grizzly bears typically use vegetation as bedding in excavated dens, but concave beds inside the chamber may be simply dug into bare soil and rock.

Figure 23. A mixture of mosses and tree boughs used as bedding in a black bear den. This was a den used the previous winter as evidenced by the greenness of the vegetation and attachment of the needles to branches. Photo by H. Davis.

Figure 24. Grizzly bear den on the north coast of BC with some bedding material pulled out. Photo by G. MacHutchon.

Figure 25. A fecal plug (the first poop after the end of denning) full of hair, internal skin cells and vegetation. This fecal plug weighed about the same amount as a piece of styrofoam. Photo by H. Davis.

BEAR SCATS

Bears do not eat, drink, urinate or defecate while denned. This leads to the major difference between a bear bed and a bear den: the amount of bear "scat" or poop found near the site. When bears are not denned, and are therefore eating, they defecate next to their sleeping beds (often at the base of trees on slopes near food sources such as salmon streams, clearcuts and estuaries). Bears do not defecate around their dens because they are not eating during the den season and likely do not want to attract any attention to their location. The exception is the first "scat" after den emergence, called a "fecal plug" (Figure 25), which may contain hair from grooming, prey, leaves, pine needles, bone chips, soil or salmon bones and may be covered in dried mucous.

Den Reuse

Black bears frequently reuse dens from year-to-year, and individual den trees may be used by multiple generations of bears as long as the den remains safe and dry. Some excavated grizzly bear dens are used more than one year, but they often dig new dens or re-excavate old dens.

A few diagnostic criteria can be used to judge if a den has been reused and time since last use. Presence of a fecal plug indicates use in the previous den season. The greenness of bedding, presence of needles attached to twigs and amount of decay of the vegetation in the bedding material can be used to estimate recent use (see Appendix II for details on ageing den bedding). Comparing photographs of the entrance and bedding inside dens between years (Figure 26) can help determine if a den has been reused since it was last visited, so taking extensive photos of entrances and bedding is important (a selfie stick can assist with taking photos inside cavities if observers can't fit far enough inside).

Determining the age of an excavated grizzly bear den is possible by examining the plant succession on the excavated soil. Recently used dens will look freshly dug, with little or no plant or moss establishment near the entrance or on the downslope material.

Figure 26. Bedding in a black bear den before use (left; created in a hollow cedar stump, swordferns (Polystichum munitum) were added by researchers) and after 3 winters of bedding additions and use by a black bear (right). Much of the bedding is fireweed (Epilobium angustifolium) which does not retain colour and green swordfern added the previous winter. Notice there is less blackened area on the walls of the stump due to the bear scraping down the walls to use as bedding. Photos by H. Davis

Checking Dens for Occupancy

There are a couple of ways to determine if a cavity is occupied by a bear during the den season. Safety is of the utmost concern and anyone approaching a potentially occupied den should be an experienced biologist and carry bear spray. In addition to human safety, causing a bear to abandon its den mid-winter is a potentially life-threatening situation for a bear and should be avoided.

If a den is being monitored in advance of potential disturbance later in the den season (for example, winter forest harvesting), wildlife monitoring cameras or twine (Figure 27) can be utilized. Wildlife monitoring cameras (that are heat and motion sensitive) can be placed at the den and checked quietly before potentially disruptive activities are scheduled. Alternatively, twine placed across the entrance can be useful to detect if a bear has visited or entered a den (use natural twine and aluminum nails placed >5 cm from the entrance edges) since it was last visited by field crews.

Figure 27. A motion-sensitive wildlife camera (left) and twine crossing the entrance to a bear den (right) to determine if the den is occupied or has been reused. Photos by H. Davis.

Collecting Information at Bear Dens

When a potential den tree has been encountered during field surveys, crews should collect a variety of information that will help development and operations foresters work towards retaining the structure within their operations. Once a potential den tree has been identified, the tree should be marked in the field with a permanent Wildlife Tree sign (preferred method), tree paint or flagging tape and a follow-up investigation by a Qualified Professional should be conducted.

Standard measurements should be recorded at potential dens using a den data form or database schema. However, every den will be unique in some way: extra photographs, a careful diagram of both the site and the cavity and comprehensive written descriptions will be helpful. If using a den schema, site drawings can be photographed so that they remain with the den records. Field crews may want to take advantage of den surveys to record information about other cavity-using species including Pacific martens, minks, raccoons, owls or porcupines and to look for culturally significant features.

To assist in collecting and storing relevant information in a consistent manner, a schema for Avenza Maps® has been developed and is available for use in the field (available at: http://artemiswildlife.com/bear-dens. See Appendix 1).

EQUIPMENT NEEDED FOR EXAMINING DENS:

Surveys for bear dens should only be conducted between June 1st and October 1st to avoid displacing bears. Extreme caution should be exercised before June 1 near potential grizzly bear dens because natal dens may be used by adult females with cubs-of-the-year as resting and nursing sites well after initial den emergence. Surprising family groups can be dangerous.

- → *GPS*
- → *Compass*
- → *Tablet with schema or printed field forms*
- → *Headlamp*
- → *Pencils*
- → *Bear spray*
- → *Camera with a flash*
- → *Paper coin envelopes (for hair samples)*
- → *Selfie stick for camera*
- → *Wildlife Tree sign and/or flagging tape*
- → *Tape measure (a stiff metal one works well when you can't fit all the way in the den)*
- → *Hammer and nails for sign and/or placing string across entrance*
- → *Diameter tape*
- → *Natural twine*
- → *Motion sensitive wildlife camera (optional)*

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Appendix I. Data Collection for Bear Dens

The Avenza Maps® schema for collecting den data (available at: http://artemiswildlife.com/bear-dens) has many fields that will aid in future analyses of what coastal bears are selecting for when choosing den sites. The Avenza Maps® schema automatically records the date and coordinates (in latitude and longitude and UTM Easting and Northing, but not Zone) of "den pins" dropped using the schema. The following is a description of the fields that should be collected at each potential den tree that is identified.

1. Project ID: Whatever identifier crews or companies want to use to give some idea of project or location or year, consistency is helpful.
2. Watershed or Development Area: Watershed or development area name.
3. Surveyors names: Provide the surveyor's full names, not initials.
4. Company or client name: Be consistent with company or client names.
5. Detected during?: Was the den found during a reconnaissance walk, block layout, cultural features inventory etc.?
6. Block/setting #: Provide the block or setting number if applicable.
7. Private or public land?: It is important to specify due to data privacy issues.
8. UTM Zone: Enter zone (Avenza Maps only records UTM northing and easting, not zone)
9. Den ID: Unique identifier assigned by company to differentiate from others in the area.

10-13. BEC zone/Subzone/Variant/Site Series: Biogeoclimatic zone, subzone, variant can often be taken off maps after the site visit but site series may be more difficult to identify, so record it if known.

14. Structural Stage: Provide structural stage 1 through 7. There are more detailed stages (for example, "2b Graminoid-dominated") but that level of detail is not required.

Post-disturbance stages, or environmentally limited structural development:

1 Sparse/cryptogam: the initial stages of primary succession; time since disturbance is < 20 years for normal forest succession.

Stand initiation stages or environmentally induced structural development:

2 Herb: Early successional stage or disturbance; generally dominated by herbs; trees and shrubs are usually absent or sparse, time since disturbance is < 20 years for normal forest succession.
3 Low shrub/tall shrub – dominated or characterized by shrubby vegetation < 2-10 m tall; time since disturbance <40 years for normal forest succession.

Stem exclusion stages:

4 Pole/Sapling: Trees > 10 m tall, self-thinning and vertical structure are not yet evident in the canopy; time since disturbance usually < 40 years.
5 Young Forest: Self-thinning has become evident and the forest canopy has begun to differentiate into distinct layers; begins as early as age 30 and extends to 50–80 years, depending on tree species and ecological conditions.

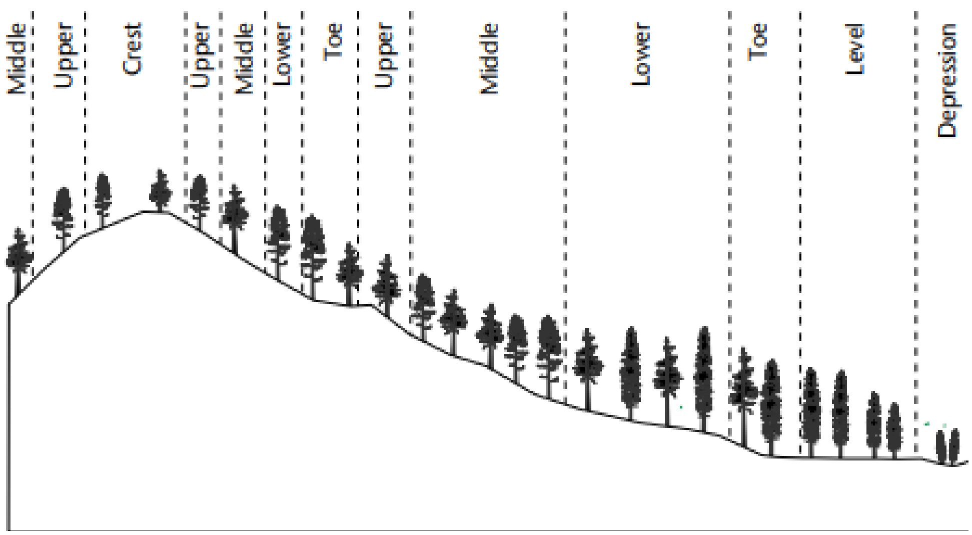
Understorey reinitiation stage:

6 Mature Forest: Trees established after the last stand-replacing disturbance have matured; a second cycle of shade-tolerant trees may have become established; shrub and herb understories become well developed as the canopy opens up; time since disturbance is generally 80–140 years.

Old-growth stages:

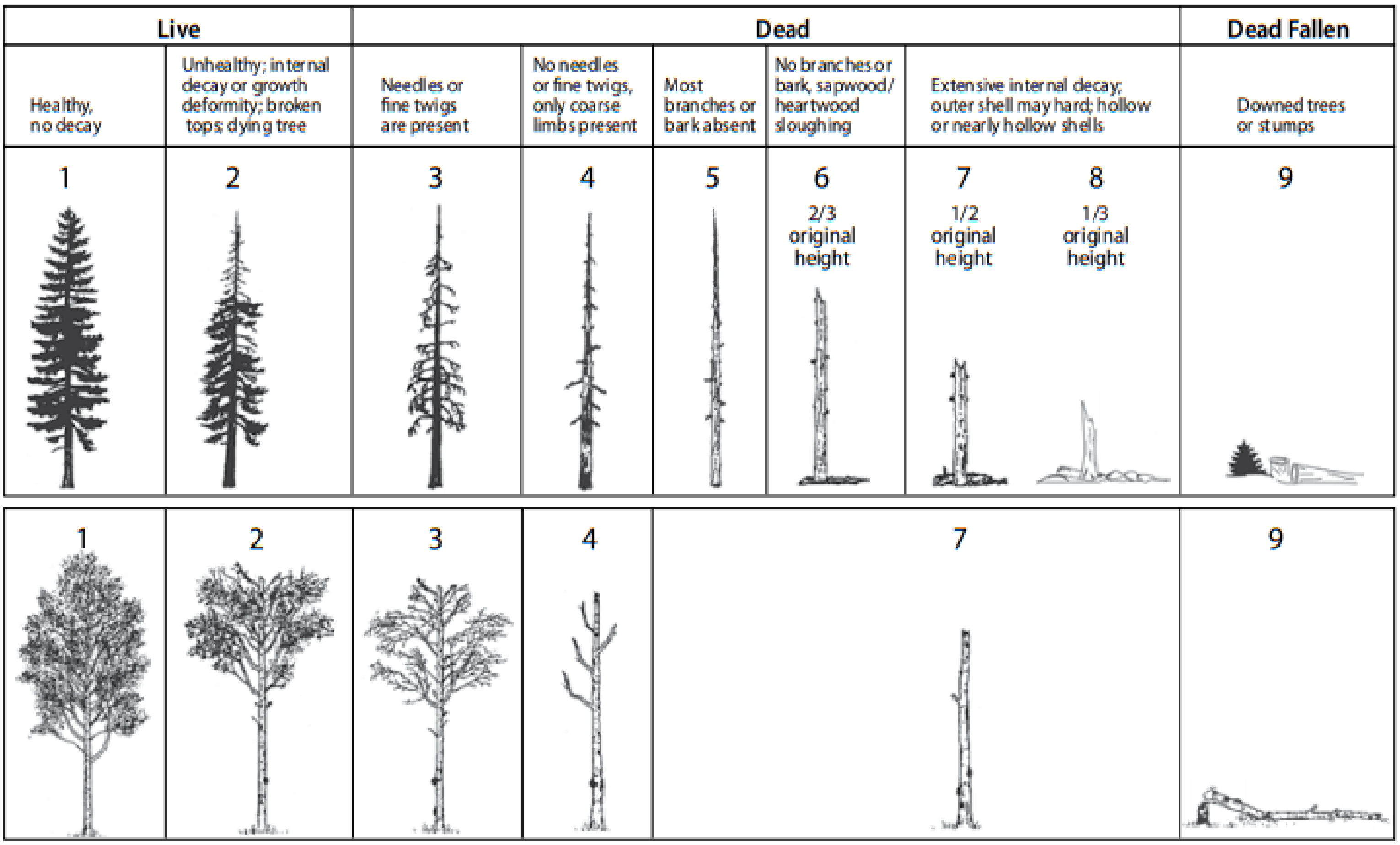
7 Old Forest: Stands of old age with complex structure; patchy shrub and herb understories are typical; regeneration is usually of shade-tolerant species with composition similar to the overstorey; long-lived seral species may be present in some ecosystem types or on edaphic sites. Old growth structural attributes will differ across biogeoclimatic units and ecosystems.

15. Elevation: Determine in the field using an altimeter or GPS. Record in meters.
16. Slope: Record percent (%) slope gradient, measured with a clinometer or similar instrument.
17. Mesoslope position:



18. Aspect: Enter aspect of the general area in degrees.
19. Canopy Closure: Choose from closure categories (0-25, 25-50, >50%).
20. Den type: Choose from categories (log, stump, hollow tree, root wad, excavated, other) and put notes in the comments field if “other” is chosen.
21. Entrance level: Does the bear enter the den cavity from the ground level or does it have to climb up the outside the tree and enter from above ground? Choose the category that fits.
22. DBH: If the den is in a tree, measure the diameter at breast height (dbh; that is, at 1.3 m). On slopes, breast height is measured from the high side of the tree.
    - Measure diameter to the nearest 0.1 cm.
    - Hold the diameter tape tight, making no allowance for missing bark.
    - If it is not possible to measure dbh accurately because of an obstruction or unsafe conditions, enter an estimate.
23. Species: If the den is in a tree, what species is the tree that the den is in or under? Pick one or choose “other” and put what species it is in the comments section or that you can’t tell. Choose N/A if it not in a wooden structure.

24. Alive or dead? If the den is in a standing tree, is the tree alive or dead? Choose N/A if it is not in a standing tree.
25. Appearance code: Choose code (1-9) if the den is in a standing tree, see images below. Choose N/A if it is not in a standing tree.



26. Tree height: Enter the total height of the tree (m) to one decimal.
27. Entrance height: Record the entrance height from the ground to the peak of the opening (Figure 28) in centimetres.

Figure 28. Where to measure the height and width of a den entrance. Photo by H. Davis.

28. Entrance width: Record the entrance width at the widest part of the opening (Figure 28) in centimetres.
29. Entrance aspect: Enter aspect of entrance in degrees.
30. If above-ground entrance: Measure height from the ground to the entrance in metres. Leave blank if not above-ground.

31-40. Tunnel, bed and chamber dimensions: Bear dens are usually considered to have an entrance, a porch (if soil has been excavated), a tunnel (an area they pass through to get to the chamber from the entrance, it may be just the thickness of the tree), a chamber (the main "living area" of the den) and sometimes a bed (some are very distinct cup-shaped beds but sometimes they are not distinguishable from the chamber). Measure the height, width and length (in cm) of the tunnel, chamber and bed (Figures 29-31). Estimate the chamber height if it's very high inside a hollow tree. Leave the bed dimension fields blank if there is no obvious bed.

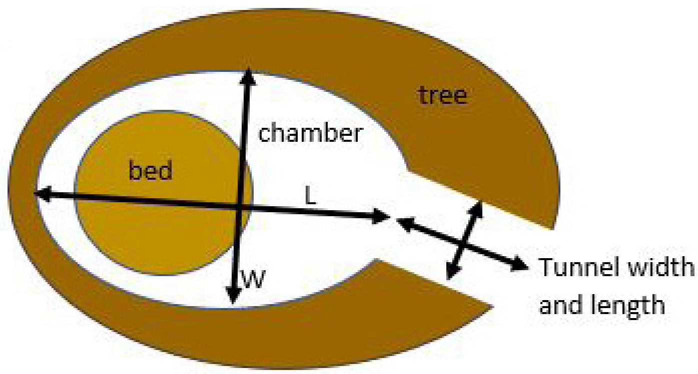


Figure 29. Cross-section of a hollow tree den from above and the measurements to be recorded.

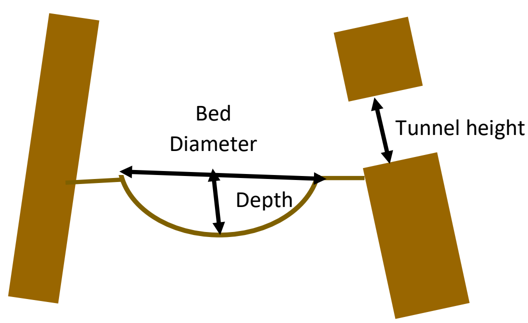


Figure 30. Cross-section of a hollow tree den from the side and the measurements to be recorded.

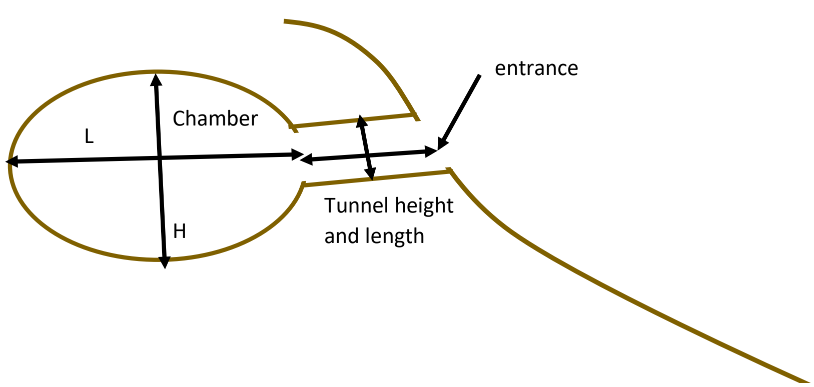


Figure 31. Cross-section of an excavated den from the side on a slope, showing the measurements to be recorded.

39. Bear present? Was a bear seen? Choose from categories (in den, near den, in block, no).
40. Number bears seen? If there was a bear present, record how many were seen. Choose from categories (one, female with cub(s), unknown, N/A).
41. Bear behaviour? If a bear was present, choose its behaviour from categories (indifferent, aggressive, sleeping, abandoned den, N/A).
42. Previous Use? Does it appear the den has been used in the past? Choose from categories (yes, no, maybe, didn't check).
43. Claw or bite marks? Are claw or bite marks present? Choose from categories.
44. Hair on entrance? Was hair evident on the entrance? Choose from categories.
45. Hair in bed? Was hair evident in the bed? Choose from categories (yes, no, didn't check).
46. Bear poops in area? Did you see any bear poops in the area? Choose from categories (yes, no, didn't check).
47. Fecal plug present? Did you see a fecal plug? Choose from categories (yes, no, didn't check).
48. Bedding material present? Is there bedding in the den? Choose from categories (yes, no, didn't check).
49. Bedding material? If there is bedding present, list the types of bedding, including species of plants. This detail is important as future visits may be able to determine reuse by different bedding present in future years.
50. Den status: Choose from categories (active, recently active, not used within last few years, created, unknown). Use "created" for human-created dens in stumps or hollow trees.
51. Bear species: Choose from categories (black bear, grizzly bear, unknown).
52. Signed and flagged? Was the den flagged and marked with a wildlife tree or other type of sign? Choose from categories (yes, no).
53. Monitored by camera? Is the bear den being monitored with a wildlife camera? Choose from categories (yes, no).
54. Photos? Choose from categories.
55. Photo #s: List the photo or file numbers of photos taken at the den.
56. Hair samples taken? Were hair samples taken? Choose from categories (yes, no).
57. Sample ID #s: If hair samples were taken, what are the sample identification numbers? Choose from categories (yes, no).
58. Comments: Comments and any info on any fields marked as "other", location of where sample collections came from (e.g., entrance, bedding). List any data that wasn't entered in other fields, comments on the state and type of bedding, bear sign seen etc.

Appendix II. Photo Guide to Ageing Den Bedding

When trying to determine how long it has been since a bear den was used you can look at the condition of vegetative bedding in the den (Figures 32-40) and bear sign around the den site. Vegetation that is buried within the bed may retain green colouring longer than that nearer the surface of the bed and since most dens are reused, there is likely bedding of multiple ages and states of decay present (Figure 41). Presence of a fecal plug or relatively fresh vegetation on the ground around a den can also indicate use the previous season. Mosses are not good indicators of time since last use because they turn a golden yellow and stay that colour for many years (Figure 42). Regardless, it may not be possible to determine times since last use of dens with above-ground (arboreal) entrances or those that only contain scrapings of the inside of the tree (Figure 43). Note that some of these photos of vegetation are from artificial bear dens that have not been used by bears so are more intact than you would expect (bears tend to tear up the vegetation used in their beds) and the bedding may dry more if there had been the warmth of a bear laying on them in the winter.

One year old bedding:

After one year vegetative bedding appears as follows: fireweed: looks like golden straw (Figure 32); swordfern: dry and green (Figure 33); salal: dry and green; hemlock boughs: green needles attached to boughs; balsam boughs: green needles attached to boughs; cedar boughs: greenish-brown, intact; Douglas-fir boughs: brown needles attached to boughs.

Figure 32. A bear den used the previous winter with fireweed for bedding.

Figure 33. A bear den used the previous winter with fireweed, swordfern and Douglas-fir for bedding.

Two year old bedding:

After two years vegetative bedding appears as follows: swordfern: dry and light green (Figure 34). salal: green leaves, especially buried ones; hemlock boughs: needles greenish and starting to fall off boughs; balsam boughs: needles brown, attached to boughs (Figure 35, not used in a bear den); cedar boughs: brown, intact.

Figure 34. A bear den with swordfern for bedding used two years prior.

Figure 35. A balsam bough 2 years after being placed in an artificial bear den (not used).

Three year old bedding:

After three years vegetative bedding appears as follows: swordfern: green¬ish-brown, retaining structure; salal: many leaves brown but buried leaves may still be greenish (Figure 36); hemlock boughs: needles no longer attached to boughs; balsam boughs: needles brown, attached to boughs; cedar boughs: needles brown, intact.

Figure 36. Three years after being placed in an artificial bear den salal leaves are mostly brown but can still be green underneath.

Four year old bedding:

After four years vegetative bedding appears as follows: swordfern: mostly brown but leaves still attached to stems (Figure 37); salal: most leaves brown but buried ones can still be greenish (Figure 38); hemlock boughs: just bare boughs left (Figure 39); balsam boughs: brown needles attached to boughs; cedar boughs: brown, boughs breaking down.

Figure 37. Swordfern four years after being placed inside an artificial bear den.

Figure 38. Salal four years after being placed inside an artificial bear den, notice the greenness of leaves from underneath.

Figure 39. Salal and hemlock boughs four years after being placed inside an artificial bear den, notice that no needles are left attached to the hemlock boughs.

Five or more year old bedding:

After five years vegetative bedding appears as follows: swordfern: brown, leaves crumbly; salal: brown, leaves still whole; hemlock boughs: boughs present, no needles attached; balsam boughs: needles brown, still attached to boughs (Figure 40); cedar boughs: hard to identify as cedar boughs.

Figure 40. A bear den unused for 5 or more years. Notice the balsam needles are still attached to the boughs.

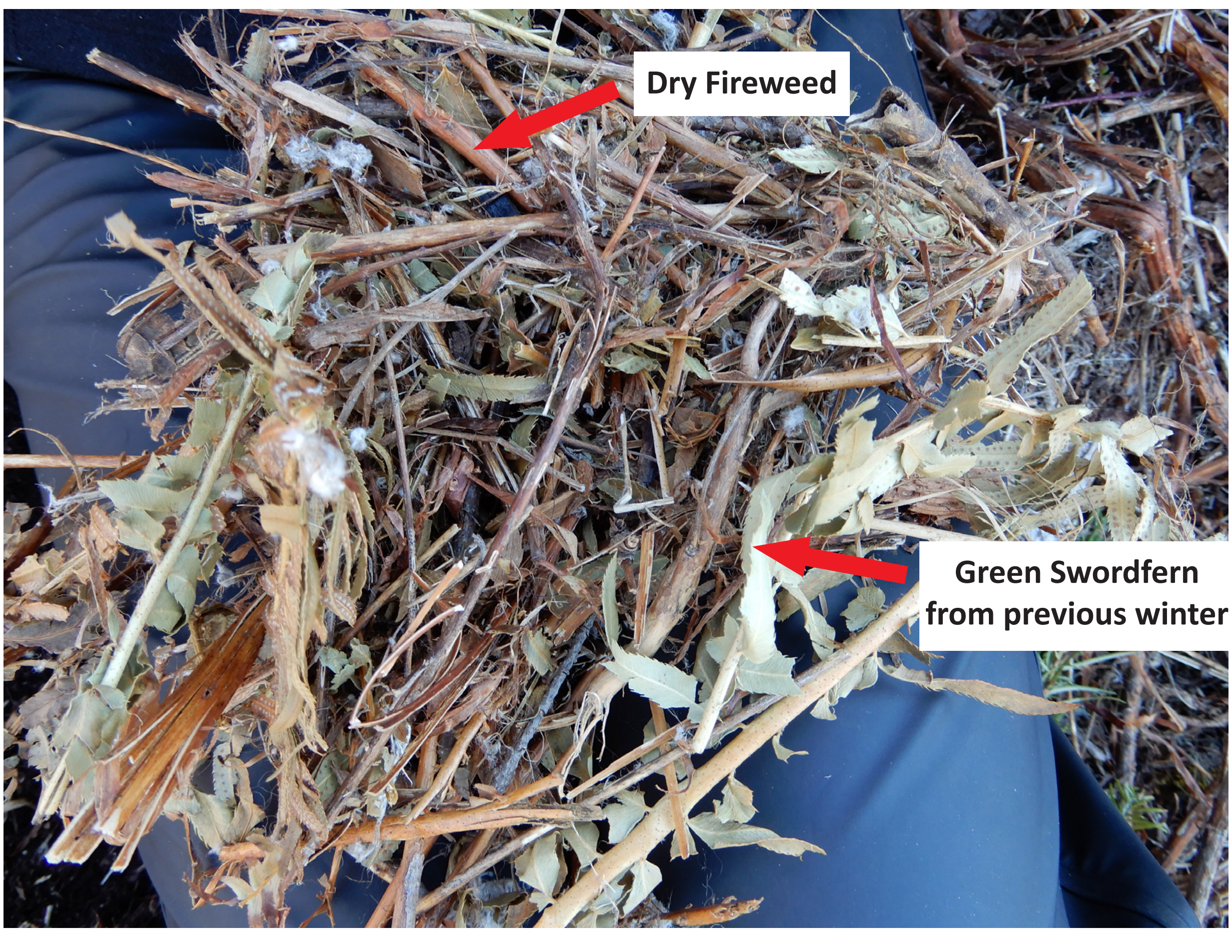


Figure 41. A handful of bedding from a black bear den used the 3 previous winters. Note the multiple ages of the vegetation present including straw-like fireweed and green swordfern added the previous winter.

Figure 42. Step moss 5 years after being placed inside an artificial stump den (not used as a den in that time).

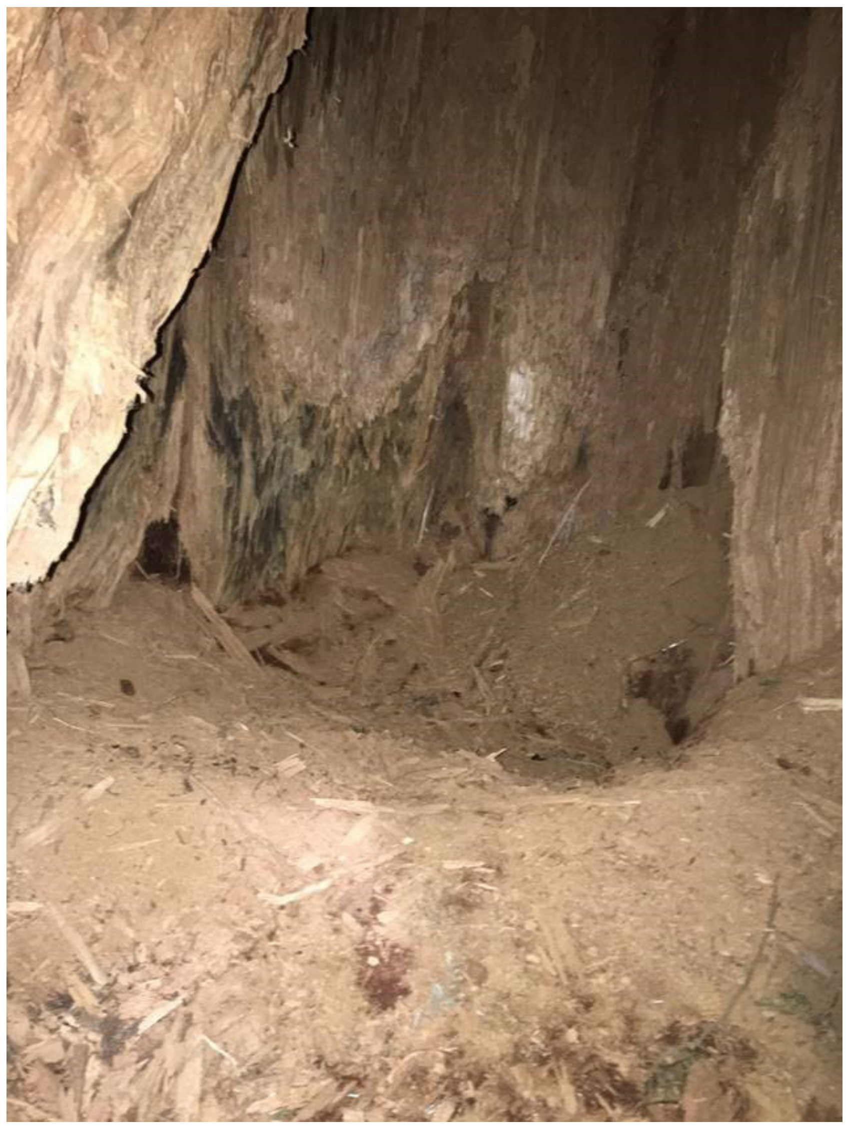


Figure 43. A hollow tree den that only has inner tree scrapings for bedding. It may not be possible to determine the time of last use in these types of dens without monitoring by trail camera or photo monitoring of the site and inside of the tree.