

# Monitoring Black Bear Den Enhancement and Creation in the Jordan River and Campbell River Watersheds: 2016 year-end report

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## Executive Summary

American black bears (*Ursus americanus*) require suitable winter den sites to provide security and thermal cover to successfully survive the critical winter denning period. On Vancouver Island, winter dens used by black bears have only been found in or beneath large diameter (mean = 143 cm) trees or wooden structures derived from trees (i.e., logs, root boles and stumps). During 2014 and 2015, we created a total of 18 potential den structures, 9 artificial structures (3 culverts, 6 den pods) and 9 enhanced natural structures (4 hollow trees, 4 stumps and 1 log) in the Jordan River watershed, north of Victoria, BC. We also created 5 potential den structures in the Campbell River watershed, 4 artificial structures (4 den pods) and 1 enhanced natural structure (1 stump) in 2015 and 2016. The goal of the current year of this project was to monitor these structures and evaluate investigation and use of these sites by bears. Through video-monitoring we have documented multiple visits by bears to den structures, including bears climbing into 5 of our structures, including two enhanced natural stump dens, two culvert dens installed in 2014, and a den pod installed in 2015. We have documented as many as 33 visits by bears to one culvert den and only one of 18 structures that have been video-monitored has not documented a bear visiting the structure. The number of visits to structures and entrances into structures has continued to increase; a number of structures that were not visited by bears in 2015 had repeated visits in 2016. We also documented the first full entrance by a bear into a den pod in 2016. Public and industry interest in the project is high. We propose to continue to monitor the structures into the future to assess their short- and long-term efficacy at providing alternate den sites for black bears in coastal watersheds heavily impacted by forest harvesting and hydro-electric development. This project fulfills the priority action "Second growth harvesting may be impacting den supply... Good candidate area to assess the feasibility of artificial den structures to replace declining levels of natural den site availability in watersheds with various age classes of managed forest" in the Jordan River Watershed Plan (Fish and Wildlife Compensation Program 2011a).

## Introduction

American black bears (*Ursus americanus*) require suitable winter den sites to provide security and thermal cover to successfully survive the critical winter denning period. Female bears may utilize dens for up to 6 months and have additional energy costs associated with gestation, whelping, and nursing of cubs during this period (Lentz et al. 1983). Dens are reused intermittently over decades, if not longer, and are often used by successive individuals (Davis et al. 2012). On Vancouver Island, winter dens used by black bears have only been found in or beneath large diameter (mean = 143 cm) trees (Figure 1) or wooden structures derived from trees (i.e., logs, root boles and stumps; Davis 1996). It is likely that black bears do not use structures other than wooden ones in coastal BC because of the cool and wet climate during the denning period, unlike other parts of North America where they may dig dens in the soil (Beecham et al. 1983) or den in nests on the ground (Martorello and Pelton 2003).

Current and historical land management activities in coastal forests have affected the supply of these critical element-level features. Most prominently, forest harvesting has removed many large trees that are needed to form den structures. Furthermore, the new crop of trees is not allowed to grow to sufficient size for replacement dens to develop in future forest rotations. Further negative impacts come from harvesting of second growth, which may remove or destroy the few residual structures remaining from old growth harvesting. Additionally, flooding of forested land for hydro-electric development removed trees from the potential den supply. Emerging threats include decline syndromes in both redcedar and yellow-cedar trees due to climate change (Woods et al. 2010). Despite the knowledge that these habitat features are critical to the over-winter survival of black bears, the BC government has only recently begun to afford regulatory protection for these critical structures (currently only on Haida Gwaii and in the Great Bear Rainforest). A reduction in the supply of suitable den sites may affect bear populations because using dens with diminished security protection may expose individuals to predation (Davis and Harestad 1996) and using dens with poor thermal properties can result in loss of condition of individual bears. The net effect of this reduction in supply is that suitable den sites may become a factor that limits black bear populations.

The objective of this project is to monitor the efficacy of artificial and enhanced natural den structures (created between 2014 and 2016 in the Campbell River and Jordan River watersheds; Davis 2015, Davis 2016) at providing suitable winter dens for American black bears.

## Study Area

The study spans 2 watersheds, the Jordan River watershed (where artificial and enhanced natural den structures were created and installed in 2014 and 2015; Davis 2016) and the Campbell River watershed (where artificial and enhanced natural den structures were created and installed in 2015; Davis 2015).



Figure 1. A typical coastal black bear den tree (photo by D. Wellwood).

## Jordan River Watershed

The Jordan River watershed (Figure 1) is located on southwestern Vancouver Island, 30 km north of Sooke, BC. It covers 159 km<sup>2</sup> and lies in the Coast and Mountain Ecoprovince, Western Vancouver Island Ecoregion and the Windward Island Mountains Ecosection (Demarchi 1996). The watershed is comprised of 4 different subzones and variants of the Coastal Western Hemlock (CWH) biogeoclimatic zone and one of the Mountain Hemlock (MH) zone (Green and Klinka 1994). The CWH mm1 (Submontane Moist Maritime) and mm2 (Montane Moist Maritime) are found in the valley bottoms and above (respectively) in the eastern half of the watershed whereas the CWH vm1 (Submontane Very Wet Maritime) and vm2 (Montane Very Wet Maritime) are found at the valley bottoms and above in the western half of the watershed. The MH mm1 (Windward Moist Maritime) is at the highest elevations in the western portion of the watershed above the CWH vm2. Elevations within the Jordan River basin range from sea level to 1000 m. At lower elevations, the climatic conditions are typified by moist, mild winters and cool but relatively dry summers (Green and Klinka 1994). Upper elevations experience cooler temperatures, greater snowfall, and a shorter growing season. Heavy precipitation occurs between October and April with an average of 500 mm falling in November (Fish and Wildlife Compensation Program 2011a).

Forests of the CWHmm1 are dominated by western hemlock (*Tsuga heterophylla*), amabilis (balsam) fir (*Abies amabilis*), and Douglas-fir (*Pseudotsuga menziesii*, Green and Klinka 1994). Shrub layers commonly include red huckleberry (*Vaccinium parvifolium*), Alaskan blueberry (*V. alaskaense*), and, to a lesser extent, salal (*Gaultheria shallon*) and dull Oregon-grape (*Mahonia nervosa*). Forests of the CWHmm2 contain more yellow-cedar (*Chamaecyparis nootkatensis*) and mountain hemlock (*Tsuga mertensiana*) and those in the CWHvm1 are dominated by western hemlock and amabilis fir but with a western redcedar (*Thuja plicata*) component rather than Douglas-fir. The understory generally features a well-developed shrub layer also dominated by red huckleberry and Alaskan blueberry. At higher elevations, the CWHvm2 is similar to that of the CWHmm2, with greater amounts of yellow-cedar and mountain hemlock and less Douglas-fir.

The watershed has experienced extensive industrial development since the late 1800's: forest harvesting, mining and flooding for hydro-electricity has occurred. Industrial development continues today with the ongoing harvest of old growth and second-growth forests, a copper mine on the east side of the Jordan River (in production 1919-1977), and hydro-electric power generated from 3 reservoirs. These reservoirs flooded the sites with the highest forest productivity in the valley bottom and thus some of the largest trees in the watershed were likely lost as a result of flooding of the reservoirs. BC Hydro owned-land that was not flooded was logged, which has led to further reductions in den supply in the watershed. The eastern half of the watershed is mostly owned privately by TimberWest Forest Corp (Figure 1) and the western half is Crown land operated as TFL 61 by Pacheedaht Andersen Timber Holdings Ltd. (PATH).

In addition to the direct habitat effects of logging and reservoir development, the industrial history of the Jordan River Watershed has also led to further impacts on local black bear populations through the loss of spawning salmon (*Oncorhynchus* spp.) as a food source during the critical weight-gain period prior to winter denning. The Jordan River once supported spawning but contamination of the lower reaches by copper from the mine has led to spawning salmon being almost non-existent (last known to occur in 1970; Burt 2014) but there are some efforts being made to restore spawning habitat and recreate a sustainable run.

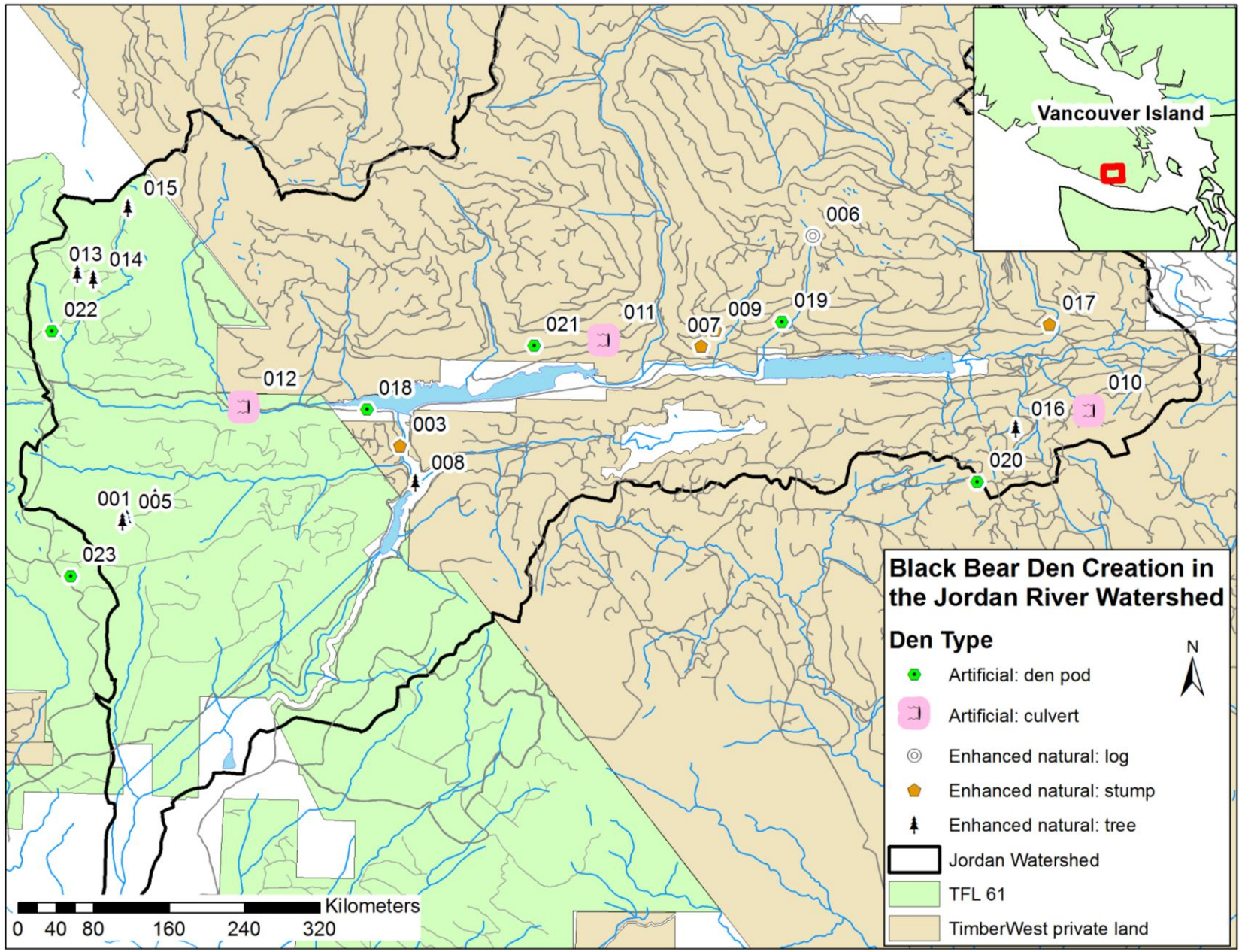


Figure 1. The Jordan River watershed showing land ownership and locations of enhanced natural dens (i.e., logs, hollow trees and stumps) and artificial structures (i.e., culverts and den pods) installed in 2014 & 2015.

## Campbell River Watershed

The study area within the Campbell River watershed (Figure 2) is located west of the town of Campbell River and north of the Strathcona Dam. The Campbell system, including the upper sub-basins of the Heber, Salmon and Quinsam Rivers, straddles the Vancouver Island mountain range. Elevations range from sea level in the Campbell and Salmon River estuaries to rugged peaks with small areas of permanent snowpack over 2200 m. The watershed receives considerable precipitation from October to March with mixtures of snow and heavy rain. The average precipitation in November is 420 mm, but may reach 800 mm (Fish and Wildlife Compensation Program 2011b).

The study area lies within the Georgian Depression Ecoprovince (Demarchi 1996) and Coastal Western Hemlock very dry maritime (CWH xm2) biogeoclimatic subzone (Green and Klinka 1994). The CWH xm1 and 2 have warm, dry summers and moist, mild winters with relatively little snowfall. Growing seasons are long, and feature water deficits on zonal sites. Forests of the CWH xm1 and 2 are dominated by Douglas-fir, accompanied by western hemlock and minor amounts of western redcedar. Major understory species include salal, dull Oregon-grape and red huckleberry (Green and Klinka 1994).

Land ownership in the watershed is a mixture of Crown land and privately owned timberlands (mostly owned by TimberWest Forest Corp.). The study area was selected due to the habitat loss associated with hydro-electric development and large amount of second growth forest created by a forest fire in 1938 (the “Sayward Burn”) that burned for almost 30 days and consumed approximately 35,000 hectares of forests (BC Ministry of Forests 1997). Due to the size of the burn and ongoing forest harvesting, few old growth structures suitable for use as dens by black bears remain in this landscape. In addition to loss of habitat, black bears in the Campbell River watershed have reduced access to a critical fall food supply because salmonids in the watershed have been heavily impacted by the creation of dams and hydro-electric facilities (Fish and Wildlife Compensation Program 2011).

## Methods

In highly modified landscapes, several options exist to create new denning opportunities for bears on a small, element-level scale. First, existing natural structures not currently suitable for denning could be enhanced to create access to cavities that could be used as winter dens. Second, entirely new denning structures that meet the need for thermal and security cover could be engineered and distributed on the landscape for adoption by bears as winter dens. Use of artificial structures for dens by black bears has been documented in the past, for example, dry road culverts have been used (Wyoming, Barnes and Bray 1966; Minnesota, Noyce and Dirks 2012). However, to our knowledge, no one has attempted to intentionally create artificial dens for black bears until this project started in 2014. We applied both enhancement and artificial den techniques using an adaptive management approach to mitigate the impact on black bears of the reduction in den supply resulting from past hydro-electric development and forest harvesting.

Our project is intended as an interim method of addressing shortages of dens at a very fine spatial scale (i.e., element scale) and does not address the larger landscape-scale issue of den supply. Enhanced natural structures and artificial den structures may provide a stop-gap supply of dens that could bridge the period between current and historical forest management (i.e., little or no voluntary retention of suitable structures) and future element, stand and landscape management that takes den supply into account.

## Enhancement of Natural Structures

In 2014 and 2015 we used a variety of spatial data to identify stands within the Jordan watershed that may supply either functioning den trees or those that are precursors to den trees (Davis 2016) which allowed us to identify forest stands that could contain large western redcedar or yellow-cedar trees suitable for enhancement.



Figure 2. The Campbell River watershed showing locations of an enhanced natural den (CR005; created in a stump) and artificial structures (i.e., den pods) installed in 2015 & 2016.



Based on our GIS analyses, we conducted ground searches in identified stands for large hollow cedar trees or large, high-cut stumps that had internal heart rot but no entrance to the centre. These natural structures were enhanced by creating suitably sized openings into the centre with a chainsaw and removing decayed wood when necessary and capping stumps with an open top. Entrances to both enhanced natural and artificial den structures are designed to accommodate female bears, which are the more vulnerable segments of the population (due to their longer time in the den), and exclude adult male bears.

We were not able to search for suitable trees and stumps to modify in the Campbell River watershed but one suitable stump was found while looking for locations to place den pods and it was modified by enlarging the entrance and capping it with plywood.

### **Artificial Den Structures**

In 2014, we installed 3 artificial bear denning structures made out of plastic culverts in the Jordan River watershed and in 2015 we installed 6 den pods in the Jordan River watershed (Davis 2016) and 3 in the Campbell River watershed (Davis 2015). One additional den pod was installed in Campbell River in 2016. In 2016 we covered the den pods with considerably more debris (e.g., logs and branches) than previously to camouflage the pods and improve their thermal protection.

### **Attracting Bears to Den Structures**

We tried to encourage bears to investigate the den sites in 2 ways. A small amount of trapping lure (i.e., anise oil, pulverized beaver castor, commercial fisher lure, skunk oil and glycerin) that attracts Mustelids (weasels) was poured in 2 or 3 spots around the site to create an olfactory interest without providing a food reward. Additionally, we put a small handful of bear hair into a few den pods at the time of installation and a previously installed culvert den to provide another olfactory cue. Subsequent checks of the cameras at these sites with bear hair showed a bear climbing into a culvert den as well as a newly installed den pod; as a result, we put bear hair in nearly all of the dens we are monitoring.

### **Monitoring of Enhanced Natural and Artificial Dens**

We deployed motion-sensitive cameras (Bushnell Trophy Cam HD Max) to monitor wildlife activity at enhanced natural and artificial den structures. Cameras were placed about 5 m from the structure and facing the den entrance. Most of the cameras are configured to record 15-second video clips. Cameras are currently deployed at 19 structures over the 2016-17 winter (3 at culvert dens, 10 at den pods, 3 at hollow trees, and 3 at modified stumps) and will be downloaded in May 2017.

## **Results and Discussion**

We have created a total of 18 potential den structures in Jordan River (Figure 2) over 2 years; 9 artificial structures (3 culverts, 6 den pods) and 9 enhanced natural structures (4 hollow trees, 4 stumps and 1 log). We have also created 5 potential den structures in Campbell River (Figure 3) over 2 years; 4 artificial structures (4 den pods) and 1 enhanced natural structure (1 stump) that can be monitored over time to assess adoption of the structures by coastal black bears. See Appendix I for details on each den structure.

In May 2016, we visited the artificial and enhanced natural den structures and downloaded cameras. No structures were used for denning over the winter. This is not surprising, as we anticipate that it will take a number of years for bears to find the structures and feel comfortable enough with them to begin to use them as dens. The same pattern has been observed with use of artificial dens by fishers (L. Davis, pers. comm. 2016). Despite not being used for overwinter denning, motion-sensitive cameras detected many incidents of bears investigating and marking den structures. Cameras were again downloaded in October 2016.

In 2016, year 1 of the monitoring project, we achieved our stated objectives of continuing to evaluate whether the artificial or enhanced natural dens are utilized by bears for denning.

## Monitoring of Enhanced Natural and Artificial Dens

Motion-sensitive cameras at den structures were operational for 7465 days between 11 July 2014 and 28 October 2016 (Table 1 & 2).

Monitoring structures with motion-sensitive cameras provided invaluable information about the artificial dens and the animals that investigated them. Despite lengthy videos of bears climbing and lolling on den structures there were rarely any obvious signs of investigation by bears; if the structures are not used by bears in the future we would not have known if this was because bears chose not to use them or if they simply had not detected the structures.

Bears have been documented entering some of the enhanced natural structures (two of the enhanced stump dens and a hollow tree) despite these structures have been monitored for the least amount of time. Interestingly, the only potential den structure that has not had a bear recorded at it is a hollow tree at the highest elevation of all the structures (in the MH mm1 biogeoclimatic zone, approximately 913 m elevation).

Notably, we documented a considerable amount of investigation (and entrance) of the artificial dens by bears during the non-denning period of 2016. Bears entered two of the culverts installed in 2014 (one has now had bears enter it 9 times); we have had as many as 33 visits by bears to one of the culverts. A bear also climbed all the way into a den pod (it turned around and came out head first, photo on cover of this report). We repeatedly observed bears rubbing their bodies on the den pods and culverts, as well as biting at the structures while rubbing on them. In cases where we piled debris on top of the dens the bears pushed off the debris to continue marking the dens or switched to marking a tree next to the structure.

Our cameras have also documented the presence of a number of other wildlife species at the den sites. We captured 2 videos of a Vancouver Island ermine (*anguinae* subspecies) at one of the dens. Very little is known about the distribution of this blue-listed species so the location has been submitted to the CDC database. We also documented deer, cougars, squirrels, raccoons, elk (Campbell River only) and mice. We had some strange videos of people finding the den structures, including one hunter who fixed the placement of our camera after a bear had knocked it out of place!

We continued to encounter technical problem with the cameras in 2016; a number of cameras have been replaced under warranty by Bushnell but malfunctions have led to months of lost monitoring opportunities at a few dens. Some cameras got water in them, some took continuous video until batteries lost power (2-3 days), some were not triggering consistently. We may have to explore other camera brands as cameras get replaced during future monitoring.

Our biggest concern with the den pods is the observation of considerable amounts of condensation in several of them. Many structures had quite a bit of moisture on the inner surface when checked in October and some of the bedding in the dens was turning moldy because of it. We had planned on putting small holes with a vent cover on the side of the chamber to increase air flow but we experimented with them on the back of the culvert dens and they were bitten and pulled off by bears fairly quickly. We are currently investigating other fixes for this issue.

**Table 1. Motion-sensitive camera effort and number of video/photo sequences at artificial and enhanced natural dens in the Jordan River Watershed, 2014-16.**

	Den #	Start date	End date	# of camera days	# of video/photo sequences (separated by < 1 hour)								Total	Comments	
					Bears	Deer	Marten	Squirrel	Bird	Mouse	Other	Unknown			
<b>Artificial</b>															
Culvert	10	11/07/2014	25/07/2016	609	9	22	0	3	0	0	3	58	95	Culvert den. Other: cougar and kit and two of people.	
Culvert	11	11/07/2014	11/10/2016	698	33	42	7	101	8	0	0	118	309	Culvert den. Camera had water in it when visited 05/05/2016. One bear has entered structure.	
Culvert	12	11/07/2014	11/10/2016	650	31	26	5	40	5	11	2	89	209	Culvert den. Bears have entered the structure 9 times. Other: cougar and mink or marten.	
Den pod	18	27/10/2015	07/10/2016	346	5	1	3	13	19	58	3	120	222	Den pod. Other: raccoon, people. Most "unknown"s are likely mice.	
Den pod	19	24/07/2015	13/02/2016	352	17	12	0	7	1	0	2	13	52	Den pod. Other: person and possibly raccoon.	
Den pod	20	15/07/2015	26/08/2016	408	4	1	9	10	30	30	1	217	302	Den pod. Most "unknown" sequences are wind+sun.	
Den pod	21	15/07/2015	16/08/2016	398	7	3	2	2	42	58	2	228	344	Den pod. Many of the "unknowns" are likely birds (could hear singing in background).	
Den pod	22	17/07/2015	12/10/2016	453	18	10	1	61	18	6	5	125	244	Den pod. Most of the "unknowns" were weather related (i.e., wind and sun) but also ermine, possibly a mink and people.	
Den pod	23	17/07/2015	12/10/2016	299	24	6	1	25	33	2	2	97	190	Den pod. Other: insect (2).	
<b>Natural</b>															
Hollow tree	14	23/06/2015	12/10/2016	240	5	2	1	1	3	0	0	11	23	Natural hollow tree. Cub of the year showed up and went in tree, only one video taken.	
Hollow tree	4	27/10/2015	30/09/2016	339	2	1	2	3	3	0	1	57	69	Enhanced hollow tree. Other: cougar.	
Hollow tree	15	23/06/2015	12/10/2016	477	0	6	0	2	3	0	0	94	105	Enhanced hollow tree. Most "unknowns" are from sun and wind events (tree is on edge of clearcut).	
Stump	3	24/10/2014	12/10/2016	719	19	46	6	3	1	2	3	53	133	Enhanced stump in second growth. Other: raccoon (2), cougar.	
Stump	17	22/06/2015	24/07/2015	32	1	0	0	0	0	0	0	0	1	Enhanced stump. Extremely skinny bear. Camera removed for logging.	
				<b>Total</b>	<b>5812</b>	<b>170</b>	<b>177</b>	<b>36</b>	<b>270</b>	<b>163</b>	<b>167</b>	<b>24</b>	<b>1270</b>	<b>2277</b>	

**Table 2. Motion-sensitive camera effort and number of video/photo sequences at artificial and enhanced natural dens in the Campbell River Watershed, 2014-16.**

	Den #	Start date	End date	# of camera days	# of video/photo sequences (separated by < 1 hour)								Total	Comments
					Bears	Deer	Marten	Squirrel	Bird	Mouse	Other	Unknown		
<b>Artificial</b>														
Den pod	CR003	21/07/2015	07/10/2016	234	4	1	0	0	0	0	1	5	11	Den pod. At least 2 different bears. Other: Cougar cub. Camera may not always have been working.
Den pod	CR003	21/07/2015	28/10/2016	465	5	9	1	7	26	54	6	66	174	Den pod. Other: cougars (3), person (3). Most unknowns are likely mice.
Den pod	CR003	21/07/2015	06/09/2016	413	5	2	2	17	1	1	0	23	51	Den pod. At least 3 different bears visited in 2016 (none in 2015).
Den pod	CR003	18/05/2016	28/10/2016	163	2	1	0	0	0	0	6	1	10	Den pod. "Other" are all elk.
<b>Natural</b>														
Stump	CR004	16/10/2015	28/10/2016	378	3	0	0	10	1	0	0	7	21	Enhanced stump in second growth. One bear climbed inside.
Total				1653	19	13	3	34	28	55	13	102	267	

## Extension and Communications

Interest in the project continues to be extensive. However, because no dens were used over the 2015-16 winter there was less impetus to disseminate results. Extension and communication activities in 2016 included:

- A presentation was given to the Pacheedaht First Nation at a community luncheon (17 May). There was >40 attendees and a lot of interest and questions
- We provided Western Forest Products with videos of bears at artificial dens to be used in their presentations.
- We posted the best videos of bears investigating den structures on our YouTube channel: <https://www.youtube.com/channel/UCJY3ayUnQCLMkqGGUiBcoHQ> with a short project description and credit was given to FWCP for funding in the description of each video.

A reporter from the Globe and Mail contacted us to do a story about the project; he is scheduled to visit the study area in May 2017.

## Future Work

We have applied for funding from FWCP Coastal in 2017 and have confirmation of continued funding from TimberWest Forest Corp. In 2017, we would like to:

1. Download cameras at den structures in spring (May) and fall (October) to check for use and activity by bears. More debris will be piled on den pods.
2. Retrieve and download temperature data loggers in May.
3. Conduct more social media outreach and deliver den creation workshops to foresters.

## Partner Contributions and Acknowledgements

This Project is funded by the Fish and Wildlife Compensation Program on behalf of its program partners BC Hydro, the Province of B.C., Fisheries and Oceans Canada, First Nations and the public, who work together to conserve and enhance fish and wildlife impacted by the construction of BC Hydro dams.

The project was supported by Helen Jones and Tom Jones (Pacheedaht First Nation) and assistant Michael "Bear" Charlie assisted with spring den checks. TimberWest Forest Corps provided us with \$5000 in funding and access to their private lands. Pacheedaht Andersen Timber Holdings Ltd. provided access to their TFL lands.

Richard Weir (Ministry of Environment) assisted with checking the Jordan River dens in the spring and Laura Chessor (BC Timber Sales) assisted with checking and a den installation in the spring in Campbell River. S. Veit (public) assisted with checking Jordan River dens in the fall and Jeff Hamilton (BCTS), Keiko Arakawa (BCTS) and Dave Vey (contractor for BCTS) assisted with checking Campbell River dens in the fall.

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## Appendix I. Catalogue of artificial and enhanced natural dens

### Structure #1: natural den (tree)

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Diameter: 170 cm dbh

Species: yellow-cedar (splits into 2 boles about 2 m above ground)

Entrance: 95 cm (h) x 22 cm (w)

Habitat: old growth forest, CWHvm2

Modifications: none.

Notes: The only potential natural den structure found in 98 ha of searching high-probability stands in 2014. Heavily chewed and clawed by bears (around entrance, photo below), unsure if it has been used or not because no bedding present. No camera. Located in a proposed Old Growth Management Area (OGMA).



*Structure #3: Enhanced natural structure (stump)*

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Diameter: 255 cm dbh

Species: western redcedar

Entrance: 82 cm (h) x 39 cm (w)

Habitat: second growth forest, CWHmm1

Modifications (2014): entrance already existed, top capped with plywood

Notes: Stump had large hole in top (photo below) and was very wet inside. Inside of stump had dried out considerably by October 2014 after capping in June (much quicker than anticipated). Entrance is a bit too large but overall a very nice den.

Temperature data loggers and motion sensitive camera installed. Bears were recorded entering the structure 4 times between 2015 and 2016.





*Structure #4: Enhanced natural structure (tree)*

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Diameter: 137 cm dbh

Species: western redcedar

Entrance: Before (photo above left): 75 cm (h) x 18 cm (w), after (photo above right): 75 cm (h) x 24 cm (w)

Habitat: old growth forest, CWHvm1

Modifications (2014): entrance widened with chainsaw. Decayed wood inside excavated to create chamber. Bedding added.

Notes: This hollow tree worked out the best of the ones we tried. The chamber is tucked in around to the left of the entrance. However, the chamber has consistently been wet (the tree is mostly dead and there may be cracks high up) which is greatly reducing its suitability. Temperature data loggers installed and motion sensitive camera added Oct. 2015. Located in a proposed OGMA. Bears were recorded investigating the structure twice in 2016.

Structure #5: Enhanced natural structure (tree)

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Diameter: 90 cm dbh

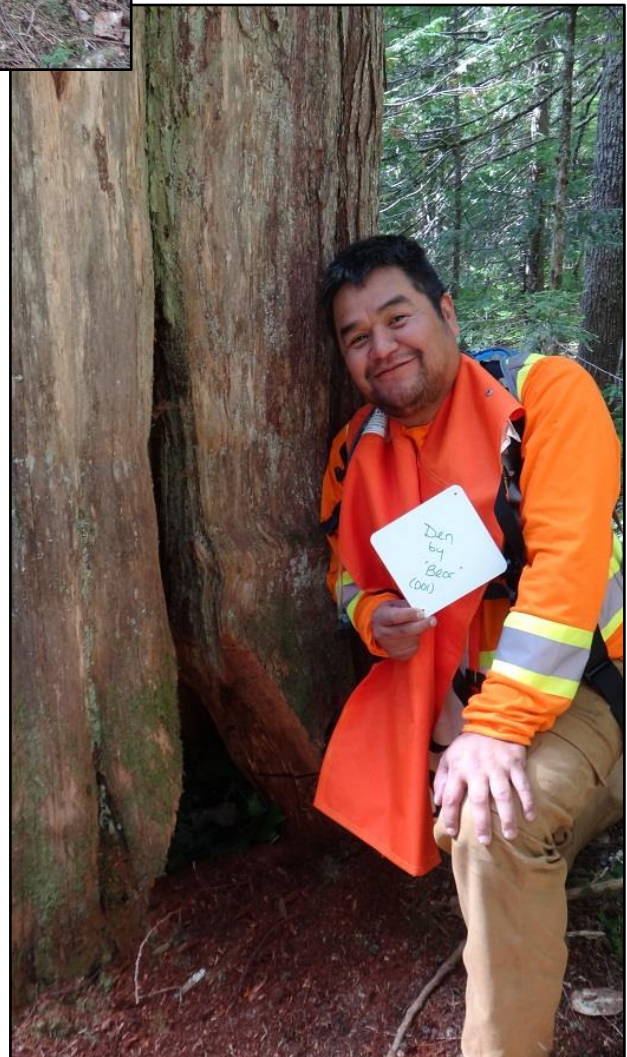
Species: western redcedar

Entrance: Before (photo left:) 45 cm (h) x 10 cm (w), after (photo below): 45 cm (h) x 35 cm (w)

Habitat: old growth forest, CWHvm2

Modifications (2014): entrance widened with chainsaw. Internal decayed wood removed to increase chamber size. Bedding added.

Notes: Resulting effort was not a very high quality potential den, the tree was a bit too small and the chamber ended up being too close to the entrance. No monitoring camera. Near edge of proposed OGMA.



*Structure #6: Enhanced natural structure (log)*

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Diameter: 103 cm diameter

Species: mountain hemlock

Entrance: 57 cm diameter tube, about 5 m long

Habitat: Clearcut, CWHmm2

Modifications (2014): End of log capped with plywood, no other modifications. Debris piled against plywood to hide it (much more than in lower picture).

Notes: Closing off the end of the log created a good quality chamber, however, the log has been very wet inside so it is unlikely it will be used as a den. A cedar log would be far more watertight and suitable as a den. No monitoring camera deployed.



*Structure #7: Enhanced natural structure (stump)*

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Diameter: 140 cm dbh

Species: western redcedar

Entrance: 40 cm (h) x 24 cm (w)

Habitat: Clearcut, CWHmm1

Modifications (2014): Entrance cut into base, top cut off and covered with plywood, lots of inside wood cut out. Bedding added.

Notes: Before (above), after (below). The entrance is nice and small, perfect for a female or subadult bear. Suitability will increase once regenerating trees grow up around it. No visible signs of investigation in 2015 or 2016. No monitoring camera deployed.

*Structure #8: Enhanced natural structure (tree)*

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Diameter: 122 cm dbh

Species: western redcedar

Entrance: 60 cm (h) x 20 cm (w)

Habitat: small old growth patch on edge of Jordan River, CWHmm1

Modifications (2014 & 2015): Entrance cut into tree at split, large amount of decayed wood removed from inside.

Notes: Cutting the entrance to this tree did not work very well. The thickness of solid wood was too wide to create a nice entrance into the cavity. In 2015 we did more cutting to improve the entrance. It will be interesting to see the progression of decay in this structure. No monitoring camera deployed.

*Structure #9: Enhanced natural structure (stump)*



Diameter: 182 cm dbh  
Species: western redcedar  
Entrance: 50 cm (h) x 25 cm (w)  
Habitat: Clearcut, CWHmm1  
Modifications: In 2014, top cut off, covered with plywood. Stump burned so much that there were openings in various places, one large one was filled with debris and covered with plywood. Entrance cut into opening already present on side. Bedding added.

Notes: Before (left), during (middle), after (below). The entrance is a bit large, it was already present except for some cutting away of a piece covering the entranceway. Will likely be more suitable once trees grow up around it. Bear hair found on entrance in Oct. 2015 so a monitoring camera was installed, however its batteries didn't hold charge well so it was only operation for 33 days and no camera was available in 2016 to continue monitoring.



*Structure #10: artificial den (culvert)*

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Diameter: 75 cm dbh

Species: corrugated black plastic culvert

Entrance: 30 cm (h) x 35 cm (w)

Habitat: unharvested, poor-nutrient dry site of the CWHmm2

Modifications (2014): Installed, bedding added, motion sensitive camera installed, temperature data loggers installed (see bottom left of lower photo). Entrance was reduced in size by the addition of a piece of plywood in Oct. 2014. Bears have been recorded at the culvert 9 times but no bears have entered the structure.

Notes: Monitoring camera deployed. Visited by bears 9 times between 2014 & 2016 (top photo). Cougar and cub also photographed at den. In 2016 a hunter repositioned the camera to point at the den after a bear had knocked it out of place!

*Structure #11: artificial den (culvert)*

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Diameter: 75 cm dbh

Species: corrugated black plastic culvert

Entrance: 30 cm (h) x 35 cm (w)

Habitat: second growth, CWHmm1

Modifications (2014): Installed, bedding added, motion-sensitive camera installed, temperature data loggers installed. Entrance was reduced in size by the addition of a piece of plywood in Oct. 2014 but removed in 2015.

Notes: Monitoring camera deployed. The structure has been investigated by bears 33 times between 2014-2016 and **for the first time a bear entered the structure in 2016** (bottom photo)!



**Structure #12: artificial den (culvert)**

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Diameter: 75 cm dbh

Species: corrugated black plastic culvert

Entrance: 45 cm (h) x 35 cm (w)

Habitat: second growth, CWHvm1

Modifications (2014): Installed, bedding added, motion-sensitive camera installed, temperature data loggers installed.

Notes: Monitoring camera deployed. The structure has been investigated by bears 31 times between 2014-2016 there were 9 instances of a bear fully entering the structure.



*Structure #13: potential natural den (tree)*

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Diameter: 153 cm dbh

Species: yellow cedar

Entrance: 114 cm (h) x 23 cm (w)

Habitat: small wildlife tree patch in clearcut, CWHvm2

Modifications: none. Found in 2015.

Notes: Left in very small wildlife tree patch next to road in clearcut. Shows some sign of being investigated by bears but does not look like it has ever been used as a den. Not monitored by camera.

*Structure #14: natural den (tree)*

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Diameter: 89 cm dbh  
Species: yellow cedar  
Entrance: 114 cm (h) x 18 cm (w)  
Habitat: old growth fringe on edge of clearcut along steep-walled creek, CWHvm2  
Modifications: none. Found in 2015  
Notes: A potential natural den, found during searches for trees for enhancement. Entrance is very narrow, quite a bit of bear hair on it. No bedding, don't think it's ever been used as a den, entrance may be too narrow? Sporadically monitored by camera in 2015; photos taken in July 2015 of an old female bear (middle right) investigating the tree. Structure consistently monitored starting in May 2016, 4 bears were recorded at the tree, including a small cub of the year (lower right) when it ran around the side of the tree and down into the cavity.



*Structure #15: Enhanced natural structure (tree)*

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Diameter: 126 cm dbh

Species: yellow cedar

Entrance: before (above left): 110 cm (h) x 5 cm (w), after (above right): 110 cm (h) x 20 cm (w)

Habitat: old growth fringe between clearcut and wetland, MHmm1

Modifications (2015): entrance widened with chainsaw. Decayed wood inside excavated to create chamber. Blueberry shrubs added as bedding.

Notes: Found during searches for trees for enhancement. No bears have ever been photographed at tree despite continuous monitoring 2015-2016. May be too high elevation (~913 m)?

*Structure #16: candidate natural den (tree)*

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Diameter: 85 cm dbh

Species: western redcedar

Entrance: 60 cm (h) x 30 cm (w)

Habitat: old growth, CWHmm2

Modifications: none. Found in 2015.

Notes: found while searching for trees to enhance. Needs to grow larger. The closest to being a natural den tree on land owned by TimberWest.

Structure #17: Enhanced natural structure (stump)



Entrance: 48 cm (h) x 26 cm (w)

Chamber: 150 cm (h) x 135 cm (w) x 150 cm (l)

Habitat: When found was in mature second growth (photo top left) but it was clearcut after creation of den, CWHmm1

Modifications (2015): Entrance cut into base, top cut off and covered with plywood, foam insulation put under plywood edge, bedding added.



Notes: stump was found during search for stumps to enhance. After enhancement the location was sent to TimberWest who discovered the stand was due to be harvested in fall 2015. The harvesting forester chose to only leave short stubs around the enhanced structure (photo left), which effectively reduces the efficacy of this enhancement to zero in the short term.

An extremely malnourished bear investigated the newly created den structure 2 weeks after enhancement (photo right). A camera was installed at the stump in May 2016 but malfunctioned so no data was recorded in 2016. The camera was replaced in November 2016.



*Structure #18: artificial den (den pod)*

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Type: polyurethane molded den pod

Entrance: 35 cm (h) x 30 cm (w)

Chamber: 75 cm (h) x 110 cm (w) x 110 cm (l)

Tunnel: 50 cm (h) x 65 cm (w) x 70 (l)

Habitat: second growth, CWHmm1

Notes: Installed 2015, camera at site malfunctioned and had to be replaced so very little monitoring data in 2015. However, one bear was filmed July 25<sup>th</sup>, 8 days after installation. In 2016, 5 bears were recorded at the structure, including sticking their head inside.



*Structure #19: artificial den (den pod)*

---



Type: polyurethane molded den pod

Entrance: 35 cm (h) x 30 cm (w)

Chamber: 75 cm (h) x 110 cm (w) x 110 cm (l)

Tunnel: 50 cm (h) x 65 cm (w) x 70 (l)



Habitat: second growth, CWHmm1  
Notes: Installed 2015. Purnima Govindarajulu (Ministry of Environment, above left) and Rachelle Shearing (TimberWest, above right) assisted with installation. A large bear was photographed investigating the den pod 4 Sept. 2015 but that was the only bear at the structure in 2015. In 2016, there was 16 sequences of >2 different bears at the structure! One small bear enjoyed standing on the den during repeated visits (photo to left).



*Structure #20: artificial den (den pod)*

---



Type: polyurethane molded den pod

Entrance: 35 cm (h) x 30 cm (w)

Chamber: 75 cm (h) x 110 cm (w) x 110 cm (l)

Tunnel: 50 cm (h) x 65 cm (w) x 70 (l)

Habitat: second growth, CWHmm2

Notes: Installed 2015. Monitoring captured many photographs of deer, mice, squirrels and marten. One bear was photographed in 2015 and 3 in 2016. The camera was triggered hundreds of times by wind and sun events.



*Structure #21: artificial den (den pod)*

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Type: polyurethane molded den pod

Entrance: 35 cm (h) x 30 cm (w)

Chamber: 75 cm (h) x 110 cm (w) x 110 cm (l)

Tunnel: 50 cm (h) x 65 cm (w) x 70 (l)

Habitat: second growth, CWHmm1

Notes: Installed 2015. Michael “Bear” Charlie and Brent Jones installing den (above). The motion-sensitive camera at this site was poorly positioned and did not detect any bears investigating the den pod in 2015. However, in 2016 there were 7 visits by bears, including one that went right inside and turned around and came out head first (photo on report cover).



*Structure #22: artificial den (den pod)*

---



Type: polyurethane molded den pod

Entrance: 35 cm (h) x 30 cm (w)

Chamber: 75 cm (h) x 110 cm (w) x 110 cm (l)

Tunnel: 50 cm (h) x 65 cm (w) x 70 (l)

Habitat: second growth, CWHvm2

Notes: Installed 2015. This structure had a flaw in the hood covering the entrance, bears pulled it off within the first 2 weeks but we left it without one to see how wet it would get inside. There were 9 visits to this den pod by bears in each of 2015 and 2016, the first visit was 8 days after installation; **13 days after installation a bear climbed ¾ of the way in 3 times over a 7 minute period**. A female with 2 cubs visited the structure in 2016. This den has been covered with debris which is our intent for all of the artificial structures in 2017.



*Structure #23: artificial den (den pod)*

---



Type: polyurethane molded den pod

Entrance: 35 cm (h) x 30 cm (w)

Chamber: 75 cm (h) x 110 cm (w) x 110 cm (l)

Tunnel: 50 cm (h) x 65 cm (w) x 70 (l)

Habitat: second growth, CWHvm1

Notes: Installed 2015. There were 11 visits to this den pod in 2015 (starting 20 days after installation) including a bear climbing all over it and biting at it (photo below) and 13 visits in 2016.



Structure #CR001: artificial den (den pod)

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Watershed: Campbell River

Type: polyurethane molded den pod

Entrance: 35 cm (h) x 30 cm (w)

Chamber: 75 cm (h) x 110 cm (w) x 110 cm (l)

Tunnel: 50 cm (h) x 65 cm (w) x 70 (l)

Habitat: second growth forest (burn), CWHxm2

Notes: Installed 2015. Bedding and bear hair added. Motion sensitive camera installed but has not worked consistently (replaced Nov. 2016). Investigated 4 times by

bears (at least 2 different bears). Bear hair on entrance in Oct. 2016 but no accompanying video.



*Structure #CR002: artificial den (den pod)*

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Watershed: Campbell River

Type: polyurethane molded den pod

Entrance: 35 cm (h) x 30 cm (w)

Chamber: 75 cm (h) x 110 cm (w) x 110 cm (l)

Tunnel: 50 cm (h) x 65 cm (w) x 70 (l)

Habitat: second growth

forest (burn), CWHxm2

Notes: Bedding and bear hair added. Motion sensitive camera installed. More debris added in 2016 (photo above). No bears were detected investigating structure in 2015 but 5 bears were detected in 2016. In photo, Jeff Hamilton (BCTS), biologist Dave Vey and Keiko Arakawa (BCTS).



*Structure #CR003 artificial den (den pod)*

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Watershed: Campbell River

Type: polyurethane molded den pod

Entrance: 35 cm (h) x 30 cm (w)

Chamber: 75 cm (h) x 110 cm (w) x 110 cm (l)

Tunnel: 50 cm (h) x 65 cm (w) x 70 (l)

Habitat: second growth forest (burn), CWHxm2

Notes: Installed in 2015. Bedding and bear hair added. Motion sensitive camera installed. No bears were detected investigating structure in 2015 but 5 bears were detected in 2016.



*Structure #CR004: Enhanced natural structure (stump)*

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Watershed: Campbell River

Diameter: 140 cm

Species: western redcedar

Entrance: 34 cm (h) x 27 cm (w)

Habitat: second growth forest (burn), CWHxm2

Modifications: entrance slightly enlarged, stump levelled, top capped with ¾" plywood. A 1-2" lip of plywood was left where it hung over so ensure the rain stayed off the stump. The plywood was held in place with 6 lag bolts (4", 6", 8") with washers and a couple of 10" spikes. One soft side/crack of the stump was filled in with slabs and shavings. A

thick layer of moss was added for bedding.

Notes: Motion-sensitive camera (on loan from COS) installed. Stump is about 20 m from CR001. No bears were detected investigating structure in 2015 but 3 bears were detected in 2016 including one who climbed inside (photo on cover of report, bottom right). Top photo: Rob Martin (BCTS) in stump before modification. Middle photo: stump levelled before plywood installation. Bottom photo: Laura Chessor (BCTS) at finished stump.





*Structure #CR005: artificial den (den pod)*

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Watershed: Campbell River

Type: polyurethane molded den pod

Entrance: 35 cm (h) x 30 cm (w)

Chamber: 75 cm (h) x 110 cm (w) x 110 cm (l)

Tunnel: 50 cm (h) x 65 cm (w) x 70 (l)

Habitat: second growth forest (burn), CWHxm2, elk winter range.

Notes: Installed May 2016, 2 bears investigated the structure in 2016. Bears removed the debris piled on the structure (photo, above) but more debris was piled on it in Oct. 2016 (photo, below)! In photo, Jeff Hamilton (BCTS), biologist Dave Vey and Keiko Arakawa (BCTS).

