Black Bear Den Enhancement and Creation in the Jordan River Watershed

Prepared by

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Introduction

American black bears (*Ursus americanus*) require suitable winter den sites to provide security and 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 bears (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).

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

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. Despite the knowledge that these habitat features are critical to the over-winter survival of black bears, the BC government has not provided any regulatory protection for these critical structures. A reduction in the supply of suitable den sites may impact bear populations through predation on denned bears (Davis and Harestad 1996) and loss of condition of bears utilizing unsuitable dens. The net effect of this reduction in supply is that suitable den sites may become a factor that limits black bear populations.

The objectives of this project are three-fold. First, this project aims to mitigate losses of denning opportunities in the Jordan River Watershed by creating potential dens in existing old growth trees or large legacy stumps. Second, this project will install and evaluate the efficacy of artificial den structures for black bears. Third, this project aims to educate forestry companies, government personnel and the public about the need for suitable winter den sites for black bears. The augmentation techniques that we develop may be useful for other areas in which forest harvesting and hydroelectric development have diminished the supply of dens for black bears.

Study Area

The study area is within the Jordan River Watershed (Figure 2) on southwestern Vancouver Island, 30 km north of Sooke, BC. It covers 159 km² 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

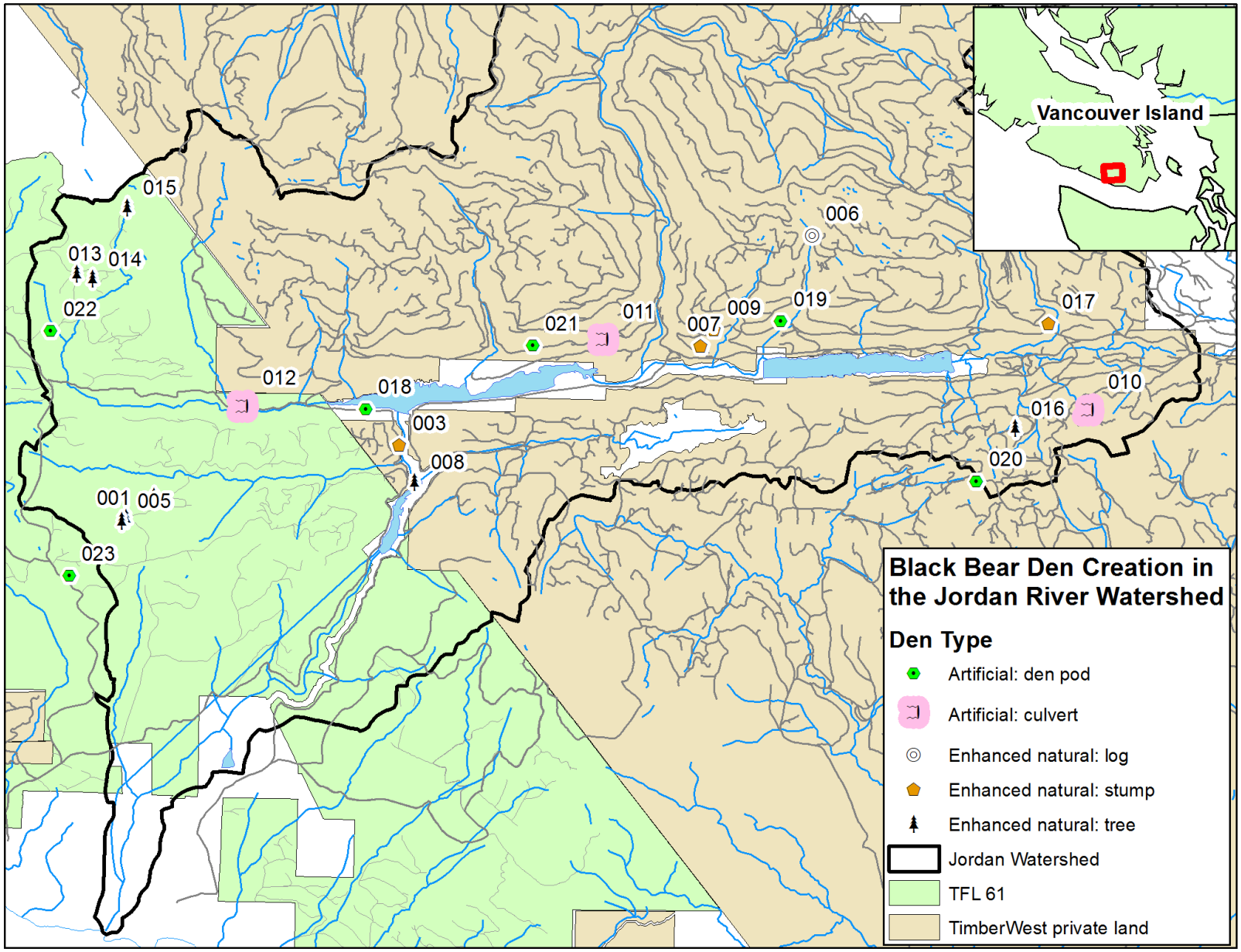

Figure 2. The Jordan River watershed showing land ownership and locations of enhanced natural dens (logs, hollow trees and stumps) and artificial structures (culverts and den pods) installed in 2014-2015.

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 2011).

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 hydroelectricity 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; currently for sale), 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 2) 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 is some efforts being made to restore spawning habitat and recreate a sustainable run.

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; 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 hydroelectric 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

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. TimberWest conducted GIS analyses as per our criteria and provided us with results while PATH provided us with their forest cover GIS data that allowed us to identify forest stands that could contain large western redcedar or yellow-cedar trees suitable for enhancement.

We created a query of spatial vegetation data to identify stands with the greatest likelihood of containing potential dens based upon structural attributes. Where data was available, the query identified stands with the following attributes:

- Site series 01, 03, 06 (zonal and one drier and one wetter than zonal)
- Site index >15
- Seral stages 6 and 7
- Age >300 years
- Height >28 m (height class >4)
- Crown closure >46% (class 5-7)
- western redcedar or yellow-cedar as the leading, secondary or tertiary species (less than half the time cedar is leading in stands used for denning)
- Basal area >40 m^2/ha

We targeted sampling in stands with western redcedar and yellow-cedar trees because these tree species are the most likely to have hollow centres, unlike amabilis fir, Douglas-fir, western hemlock or mountain hemlock which do not have decay patterns that produce large basal cavities.

Based on our GIS analyses, we conducted ground searches in identified stands (Figure 3) for large western redcedar or yellow-cedar trees or large, high-cut stumps that had internal heart rot but no entrance to the centre. We applied enhancement techniques to either stumps left over from previous old-growth harvesting or trees that had existing cavities but which were currently not suitable for use as dens due to a lack of a large enough entrance into the cavity. These were enhanced by creating suitably sized openings into the centre with a chainsaw and removing decayed wood when necessary. Entrance sizes were based on those found in natural den trees used by female bears on northern Vancouver Island (Davis 1996) and by structural limitations of the tree or stump being enhanced. 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 sealed stumps that had an open top and hollow centre with a “roof” of ¾” plywood affixed by lag bolts. Injectable foam insulation was added in 2015 between the stump and the plywood to better-seal the top from wind. See Appendix I for photos and descriptions of each den.

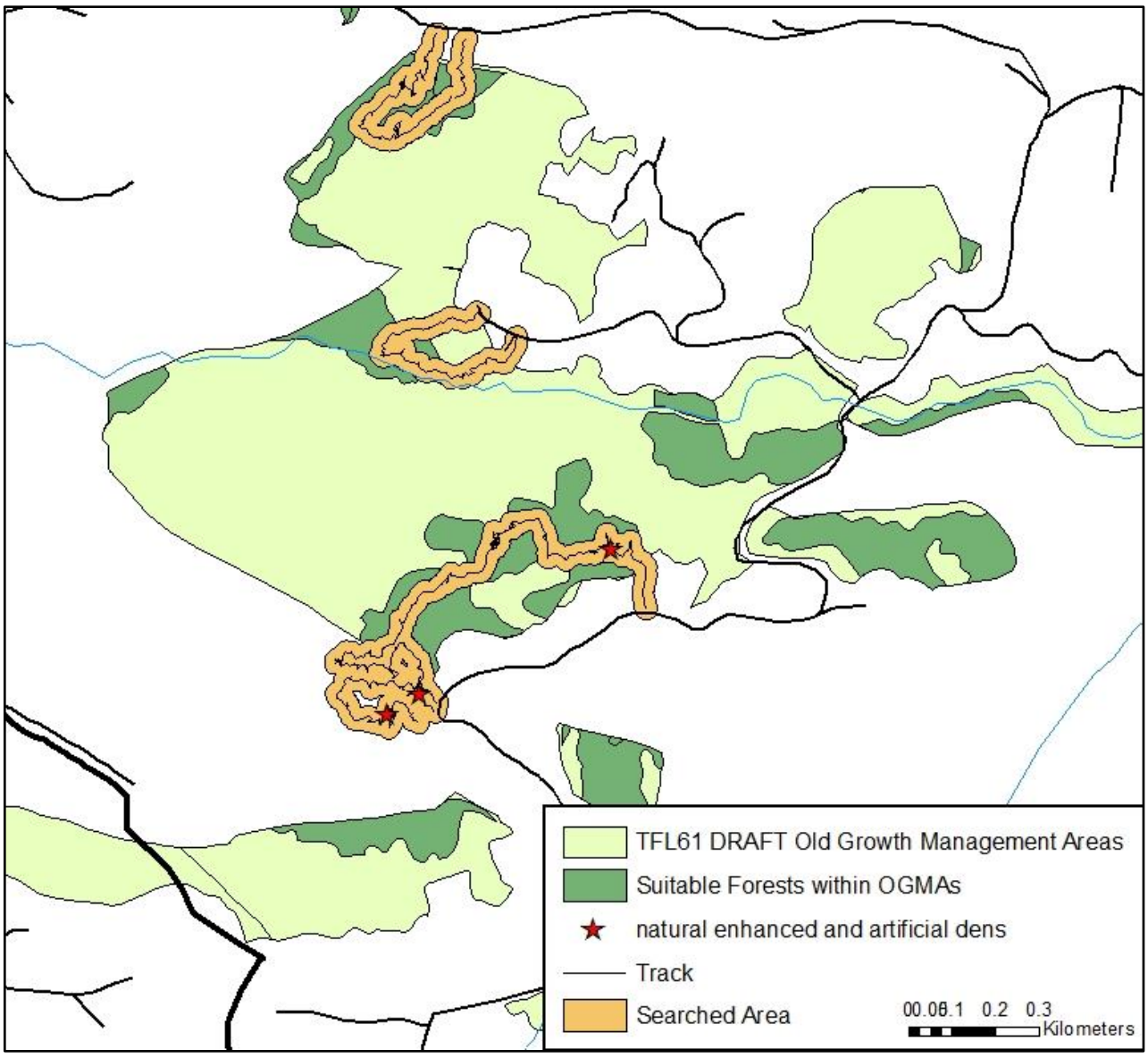

Figure 3. Example of areas searched for natural structures suitable for enhancement. In this case, searches were concentrated in suitable polygons identified by GIS that overlapped proposed Old Growth Management Areas (OGMAs). Tracks reflect one person's walking path, the searched area reflects two people searching a swath 25 m wide. Jordan River Watershed, 2014.

Artificial Den Structures

Design of Artificial Den Structures

In 2014, we installed 3 artificial bear denning structures made out of culverts in the Jordan River watershed and hired an industrial designer (Codetta Product Design Inc.) to develop options for materials, construction methods, den designs and costs for a novel design of artificial dens to be constructed in 2015 (year 2; Davis 2015). Dimensions for the new den design were based on dens excavated by bears in other areas of North America (Tietje and Ruff 1980, Beecham et al. 1983) because we assume that these dimensions better reflect the cavity size that bears would choose (since they dig the excavations) than those of den cavities in trees (where bears have little influence on the internal chamber size). We designed the shape of the den so that the entrance did not lead straight into the bedding chamber which is how natural dens tend to be configured. This likely increases the safety of dens and reduces the possibility of wind and rain entering the den. In May 2015 the

resulting “den pod” design was sent to 5 biologists specializing in black bears for comment; Dave Lindsay (TimberWest Forest Corp.), Lana Ciarniello (independent wildlife researcher, bear specialist), Grant MacHutchon (independent wildlife researcher, bear specialist), John Beecham (retired bear researcher, Idaho), and Richard Beausoleil (bear specialist, Washington Dept. of Fish and Wildlife).

Installation of Artificial Den Structures

We chose sites at which to deploy new artificial dens while searching for trees and stumps to enhance, but we limited our sites to those that were suitable distances from other den structures (most created structures are 1 km from other structures). We liaised with TimberWest and PATH in the selection of sites for artificial dens.

Once manufactured, artificial dens were installed at the chosen sites. The ground was prepared by removing vegetation and rocks and levelling the ground where the den was to be placed. A depression for the bed was made where the den chamber was to be located. The depression was lined with vegetation (usually swordfern, *Polystichum munitum*) to mimic a typical bed used by coastal black bears. Dens were anchored to the ground using 5 cable anchors (ShelterLogic’s Easy Hook® Anchors; www.shelterlogic.ca; Figure 4). The anchor was pounded vertically into the ground using a rod placed into the anchor, the rod was then removed and the anchor cable pulled upward to rotate the anchor into a perpendicular locked position underground that is very difficult to dislodge (often necessitating digging right down to the anchor to remove it if needed). Holes through which the anchor cables passed were drilled in the lip of the den so that they would match the anchor locations. Anchor cables were passed upwards through the hole, wrapped back around and through the hole again and secured using a cable clamp (Figure 5). We also attempted to use ShelterLogic’s ShelterAugers Earth Anchors, but soil depths were too shallow to be anchored effectively. They edge of the dens were then covered with soil and debris. A wildlife tree sign and flagging tape were used to mark the site.

Figure 4. Anchor on pounding rod before installation.

Figure 5. Anchor cable attached to the lip of a den pod.

Attracting Bears to Den Structures

We tried to encourage bears to investigate the den sites in 2 ways. A small amount of trapping lure (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. The cameras were configured to either capture still photographs or record 15-second video clips. In 2014, we deployed 4 cameras: 1 at an enhanced natural structure and 3 at culvert dens. In 2015 we added 10 more cameras, including 4 Reconyx cameras loaned by the Ministry of Environment that have allowed us to monitor a greater number of natural structures. Cameras are currently deployed at 14 structures over the 2015-16 winter (3 at culvert dens installed in 2014, 6 at den pods installed in 2015, 3 at hollow trees, and 2 at modified stumps) and will be downloaded in May 2016.

Temperature-Monitoring of Natural and Artificial Den Structures

Because the thermal properties of the artificial dens is unknown relative to those of natural structures, during the winter of 2014-15 we deployed temperature data loggers (Hobo Pendant Temperature/Light Data Logger MAN-UA-002) at one natural, two enhanced, and three artificial dens in the watershed. At each potential den, we paired one data logger inside the den chamber with one affixed in a nearby tree, which allowed us to compare the temperature within the cavity to the ambient temperature outside the cavity. Temperature data loggers have also been installed to monitor various structures over the 2015-16 winter. Data loggers are configured to collect temperature readings 4 times per day.

Results and Discussion

In May 2015, we visited last year's artificial and enhanced natural den structures, retrieved temperature data loggers and downloaded cameras. As expected, no structures were used for denning over the winter. 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.

In 2015, year 2 of the project, we achieved our stated objectives of creating additional potential den structures and evaluating the success of the structures created in year 1. We did this by creating dens in 2 natural structures (1 in a hollow tree, 1 in a stump) and 6 in artificial structures constructed from molded polyurethane and by continued monitoring of structures created in year 1. 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) that can be monitored over time to assess adoption of the structures by coastal black bears. We are also monitoring 2 hollow trees that have been investigated by bears but are as yet unused as den sites.

Enhancement of Natural Structures

Natural structures suitable for enhancement were rare in the Jordan watershed and finding trees to enhance proved to be very challenging. Forest harvesting has been extensive and the remaining old growth stands are often of low quality to forest companies because the trees are short or small diameter. We documented very few trees large enough to house dens on private forest lands. Additionally, burning after clear-cutting was extensive and thorough; stumps that remained from harvesting were often too burned out to have enough structural integrity to house a den.

We conducted searches in 2014 and 2015 for structures to enhance and, over 15 days with 2 people searching, we searched approximated 162 ha of suitable forests and clearcuts. In 2014 we found 3 hollow trees, 3 stumps and 1 log suitable for enhancement, though some of these were found incidentally as we drove around the study area. In 2015 we found 1 stump (#17) and 1 hollow tree (#15) suitable for enhancement and 2 trees that have the potential to become dens (one was left in a clearcut during logging next to a road that may be too busy for the tree to be used and the other needs to grow because it is currently too small). In each of 2014 and 2015 we found 1 hollow tree (# 1, 14) that have been investigated for use as a den (i.e., have teeth and claw marks in the cavity and on the entrance). It appeared we had searched the most suitable stands in 2014 and we do not feel that there are many forest stands left to search in the watershed that are likely to contain trees large enough for enhancement.

The enhanced stumps have been investigated by bears, including one large stump enhanced in 2014 (#3) that had a bear caught on camera going inside. Two other enhanced stumps (#7, #9) were located in relatively recent clearcuts that made them unsuitable for small bears in the short term due to a lack of escape trees and vegetative cover. However, one was found to have bear hair on the entrance in October 2015; we expect that these structures will become more suitable over time as the forest grows up around them. A 4th stump (#17) was found in second growth in 2015 and enhanced, a bear was photographed investigating the structure a few weeks later, however the stand around the stump was logged in the fall and it is now within a clearcut so it will likely be a number of years before it will be suitable for use.

Only 2 of the 4 enhanced hollow trees appeared to researchers to be immediately suitable for use as dens by bears and are being monitored by cameras; the other 2 may become suitable in the future (i.e., one needs to grow larger and the other needs to decay more). See Appendix I for details of enhancement techniques applied at each site.

Artificial Den Structures

Design and Manufacturing of Artificial Den Structures

The artificial den design was modified to be a top-only design (Figure 6) in June 2015 after feedback from all 5 reviewers thought that would be preferable to allow bears to excavate the den chamber into the ground. I had concerns with the change of the den design to one placed on the soil due to the decreased safety of the den from predatory attacks and because of the risk of inundation from rain. To address my concerns we did our best to anchor the dens securely to the ground and as of October 2015 we had not had any video of bears attempting to dislodge or get under the lips of the dens. The den hoods kept the rain out of the dens from the entrance and we attempted to choose installation sites that would not be subject to seepage that could inundate the dens; none of the dens were wet inside as of October 2015.

The new den design was sent to various potential manufacturers to get cost estimates. Multiple production methods and materials were considered.

- Fibreglass: The use of fibreglass would have allowed more design flexibility as production started but master plug and mold costs were estimated at $12,000 plus each den would have cost $2200 ($3100 each with insulation; CIF composites Inc., Saanichton, BC).
- Modified culvert: Creation of dens from culverts with a modified design from 2014 was estimated to cost $1800 each (Armtec, Nanaimo, BC). The modified design would still have been a round culvert (i.e., with a bottom) which did not achieve the design changes suggested by the 5 reviewers.
- Polyurethane: The final decision was to make artificial dens of polyurethane, we were able to reduce the tooling costs to $6300 with a den cost of $672.50 each (Method Innovation Partners Ltd., www.methodinnovates.com).

The design changed somewhat so that we could use rectangular sheets of polyurethane that were available without special order from the manufacturer. Unfortunately the supplier of camouflage-coloured polyurethane (Figure 6) stopped producing it once we ordered the dens so the polyurethane used was black (5 den pods) or olive green (1 den pod) in colour instead of camouflage. The polyurethane material is very strong (7 mm thick) and a reinforcement ring was added around the den entrance that provided greater protection to the bears and allowed a den hood (not shown in Figure 6, see Appendix I for photos of installed dens) to be bolted over the entrance. The mold for manufacturing the dens will be retained by Method Innovation Partners Ltd. for 1-2 years so that anyone interested can order den pods (minimum order of 10). The addition of insulation proved to be cost-prohibitive but should be explored if we determine that bears will adopt artificial den structures as winter dens because the addition of insulation can only be beneficial.

Figure 6. Artificial den structure design.

Installation of Artificial Den Structures

We installed the artificial dens in areas of extensive second growth forests because we assume that that is where the need is greatest and because we did not want the structures to be near natural food sources of bears. The new den pod design was lightweight (30 lbs.) and easy to carry by 2 people which allowed for installation farther from roads versus the 200 lb. culverts installed in 2014 that required 4 people to move (Davis 2015). Den pods could be installed in 1.5-2 hours if soil conditions were suitable.

Monitoring of Enhanced Natural and Artificial Dens

Motion-sensitive cameras at den structures were operational for 2249 days between 11 July 2014 and 27 October 2015 (Table 1) at the 3 artificial dens in culverts (#10-12), 5 den pods (#19-23), two enhanced stumps (#3, 17), one natural den (#14) and one enhanced hollow tree (#15).

We encountered more technical problem with the cameras in 2015 than in 2014; one camera had a technical fault that caused the loss of monitoring data at a newly installed den pod, this camera was replaced by Bushnell, and one brand new unused camera had the batteries leak and destroy the camera before installation; Duracell refunded the cost of this camera.

We documented bears investigating and entering a number of artificial dens during 2015 through the use of remote cameras. A bear entered one of the culverts installed in 2014, and another bear climbed ¾ of the way

Table 1. Remote camera effort and number of photo sequences at artificial and enhanced natural dens in the Jordan River Watershed, 2014-15.

Den type	Den #	Start data (dd/mm/yyyy)	End date (dd/mm/yyyy)	# of camera days	# of sequences							Total	Comments
					Bears	Deer	Marten	Squirrel	Bird	Other	Unknown		
Natural													
Hollow tree	14	23/06/2015	14/07/2015	21	1	0	0	0	0	0	0	1	
Natural enhanced													
Stump	3	24/10/2014	27/10/2015	368	8	1	4	1	1	1	7	23	Other: racoon (1)
Stump	17	22/06/2015	24/07/2015	32	1	0	0	0	0	0	0	1	Camera removed for logging
Hollow tree	15	23/06/2015	06/10/2015	105	0	1	0	0	0	0	3	4	
Artificial													
Culvert	10	11/07/2014	11/10/2015	457	5	13	0	0	0	2	15	35	Other: cougar and cub (1), people (1)
Culvert	11	11/07/2014	11/10/2015	457	18	19	6	19	3	0	46	111	
Culvert	12	11/07/2014	04/10/2015	371	15	17	5	1	0	1	5	44	Other: cougar (1). Camera not working for 79 days
Den pod	19	24/07/2015	11/10/2015	79	1	0	0	0	0	0	0	1	
Den pod	20	15/07/2015	11/10/2015	88	1	1	2	7	5	15	30	61	Other: mouse (15)
Den pod	21	15/07/2015	11/10/2015	88	0	0	0	0	0	0	8	8	
Den pod	22	17/07/2015	27/10/2015	102	9	1	1	21	8	3	37	80	Other: insect (1), mouse (2)
Den pod	23	17/07/2015	06/10/2015	81	11	2	1	14	32	2	57	119	Other: insect (2)
			Total	2249	70	55	19	63	49	24	208	488	

inside a newly installed den pod weeks after installation. One male bear investigated a culvert den a number of times and visited with a mate in May 2015. He appears to be marking the den (i.e., rubbing his back) in one video. Indeed, bears' rubbing their bodies on the den pods was documented repeatedly, as well as biting at the structures while rubbing on them. We were interested to find that bears were the most photographed wildlife species at created structures despite their being little incentive for them to be attracted to the dens. We are cautiously optimistic this may be because bears are interested in the structures as potential den sites especially because it appears there have been repeat visits by the same bear to some of the structures.

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 no 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.

Temperature-Monitoring of Natural and Artificial Den Structures

Temperature data loggers measured the temperature inside and outside 4 different structures (3 culvert dens and one natural hollow tree); we had malfunctions and loss of data loggers at 2 other structures. None of the monitored structures were occupied by animals during the monitoring period. Analysis of this data shows that, without bears present, the hollow tree moderated the high and low temperatures more than culverts (Figure 7). That is, when outside temperatures were colder, the hollow tree was warmer inside than the culverts, and when outside temperatures were warmer, the hollow tree was cooler inside than the culverts. The differences were minimal (<2°C), but we expect that the differences between structure types would be greater when they are occupied by bears.

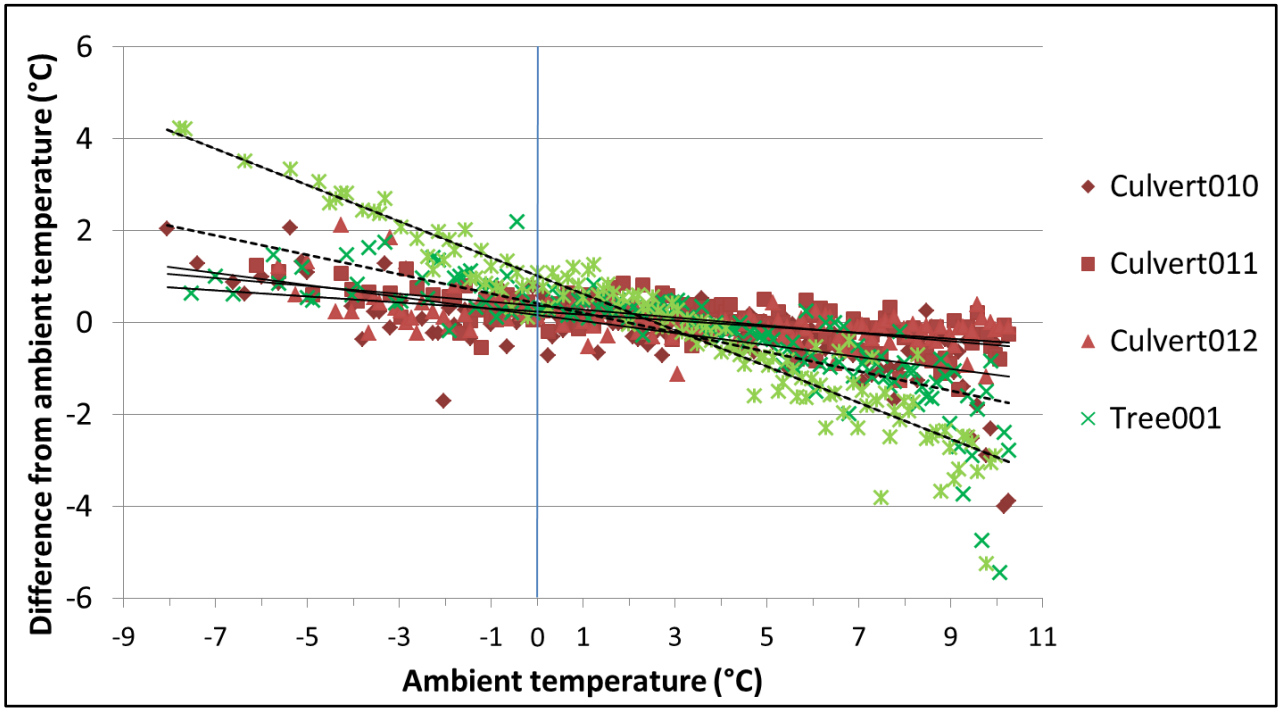

Figure 7. Comparison of temperatures inside and outside of artificial den structures and a hollow tree in the Jordan River Watershed between Oct. 2014 and May 2015.

Extension and Communications

Interest about the project continues to be extensive. However, because no dens were used over the 2014-15 winter there was less impetus to disseminate results. Extension and communication activities in 2015 included:

- reviewing TimberWest's den inventory form.
- A scientific poster about the project was presented at the Western Black Bear Workshop (12-14 May, Canmore, Alberta). The artificial den design with discussed with multiple researchers.
- A presentation was given to the Pacheedaht First Nation at a community luncheon (23 June). There was >40 attendees and a lot of interest and questions and the community has requested another presentation in May 2016.
- A team of researchers from the Ministry of Forests, Lands and Natural Resource Operations, Ministry of Environment and University of Berkeley studying the "ecology of decay" visited 3 of the hollow cedar trees in the Jordan River watershed found during searches for trees to enhance, some samples were collected to do DNA analyses to determine what fungi were present that may have caused the formation of the internal cavities.
- A presentation was given to the Victoria Natural History Society (Oct. 13). The presentation was advertised in the newsletter, through email reminders and tweets. 43 people attended to hear about the project and watch videos of bears investigating den structures. We were able to take a den pod for people to inspect, many people climbed in and out to test the dimensions!

Tuesday, October 13
NATURAL HISTORY NIGHT
Black Bear denning habitat: can we create new dens?
Coastal Black Bear require dens to survive through the winter and reproduce. Dens are generally in or under old growth structures: large hollow trees and stumps, logs and root wads. What happens when forest harvesting removes these structures? Can we create dens in natural structures and will bears use artificial structures? Come see what researcher **Helen Davis** has been doing in the Jordan River to test these ideas! Meet at 7:30 p.m. in room 159 of the Fraser Building, University of Victoria. Free! Everyone is welcome. Bring a friend.

- Both PATH and TimberWest were provided with locational data of all artificial and enhanced natural dens on their lands.
- Potential release sites for bears involved in conflicts were given to the COS to ensure bears released into the wild would be in areas with adequate den structures.

Despite our attempts at extension we documented one example where we failed to achieve the desired outcome of our extension program (conserve and enhance denning opportunities) when TimberWest cut down the trees surrounding an enhanced stump den (#17) during harvesting of second growth. This shows a clear lack of understanding of the problem and need for more extension activities.

Both CBC Radio and Shaw TV would still like to do a piece on the project; this has been delayed until May 2016 when we will have more results to discuss. Members of the Conservation Officer Service have expressed interest in joining us in the field to check dens in spring 2016.

Future Work

We have applied for funding from FWCP Coastal in 2016 and have confirmation of continued funding from TimberWest Forest Corp. In 2016 we would like to:

1. Download cameras at den structures in spring (May) and fall (October) to check for use and activity by bears.
2. Retrieve and download temperature data loggers in May.
3. Purchase 5 new motion-sensitive cameras to replace borrowed Reconyx cameras. The new cameras would be installed at enhanced natural dens.
4. Try putting non-toxic spray foam insulation inside one den pod and outside another to see whether bears and other wildlife are attracted to it and will damage it.

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.

TimberWest Forest Corps provided us with $5000 in funding, gate keys to access their private lands, conducted GIS analysis and reviewed the potential den installation sites. A summer student (Rachelle Shearing) joined us for a day in the field to install a den pod and company biologist Dave Lindsay joined us to see a den pod and review the harvesting done around stump den #17.

Pacheedaht Andersen Timber Holdings Ltd. provided gate keys to access their TFL lands and GIS spatial data to identify habitats of interest. Angus Hope and Loren Perraton provided guidance and support and Angus Hope joined us to tour some of the dens that were created.

I was assisted by Michael “Bear” Charlie who made the project a lot of fun whether we were hiking through horrendous brush, up steep slopes or cutting entrances into potential den trees. The project was supported by Helen Jones and Tom Jones (Pacheedaht First Nation) and another member of the Pacheedaht Forestry crew assisted us with artificial den installation.

BC Ministry of Environment employees assisted me on 1 day: Purnima Govindarajulu assisted with the installation of a den pod and Richard Weir provided moral support, advice, loaned us cameras and reviewed the final report.

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Appendix I. Catalogue of artificial and enhanced natural dens

Structure #1: natural den (tree)

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. Temperature data loggers installed. No camera. Located in a proposed OGMA.

Structure #3: Enhanced natural structure (stump)

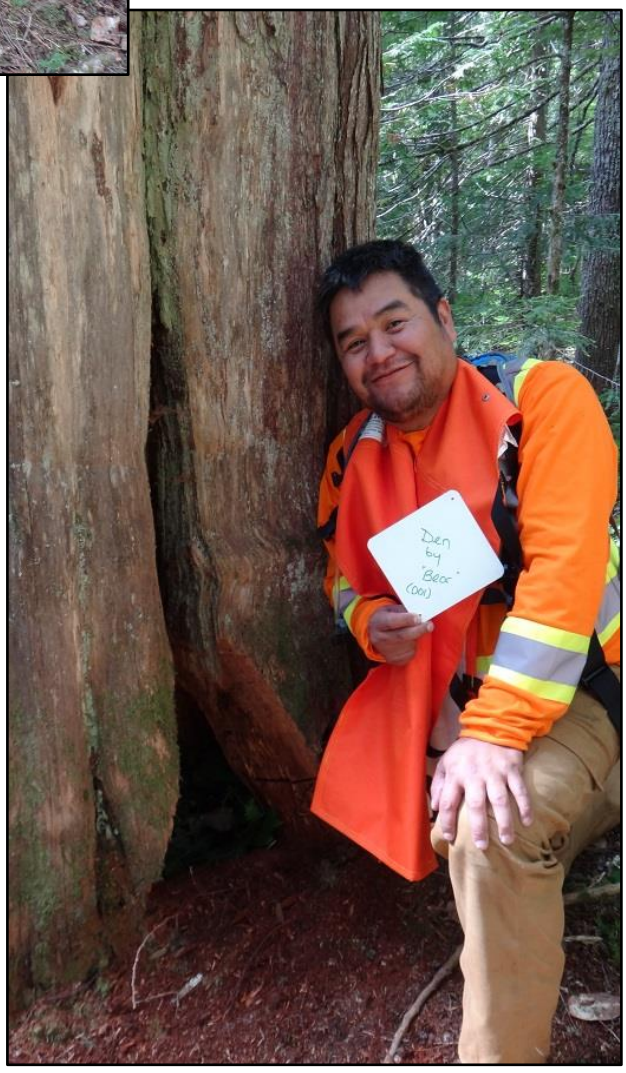
Diameter: 255 cm dbh
Species: western redcedar
Entrance: 82 cm (h) x 39 cm (w)
Habitat: second growth forest, CWHmm1
Modifications (2014): entrance already existed, top capped with plywood
Notes: Stump had large hole in top (photo below) and was very wet inside. Inside of stump had dried out considerably by October 2014 after capping in June (much quicker than anticipated). Entrance is a bit large but overall a very nice den. Temperature data loggers and remote sensing camera installed. A bear was videotaped entering the stump in 2015.

Structure #4: Enhanced natural structure (tree)

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. Temperature data loggers installed and camera added Oct. 2015. Located in a proposed OGMA.

Structure #5: Enhanced natural structure (tree)

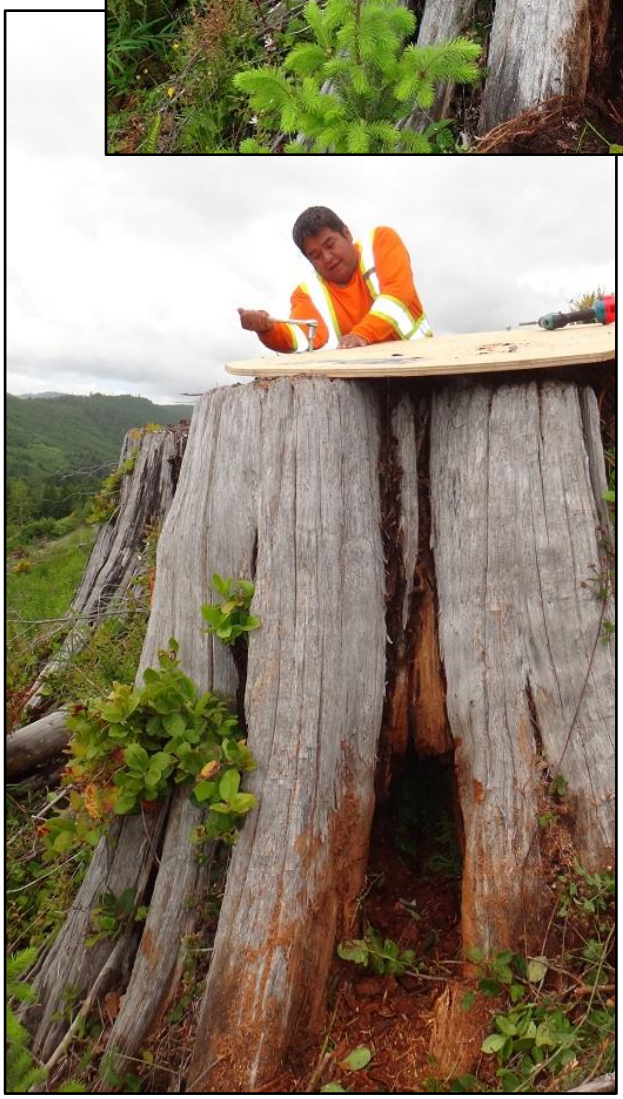
Diameter: 90 cm dbh
Species: western redcedar
Entrance: Before (photo left:) 45 cm (h) x 10 cm (w), after (photo below): 45 cm (h) x 35 cm (w)
Habitat: old growth forest, CWHvm2
Modifications (2014): entrance widened with chainsaw. Internal decayed wood removed to increase chamber size. Bedding added.
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)

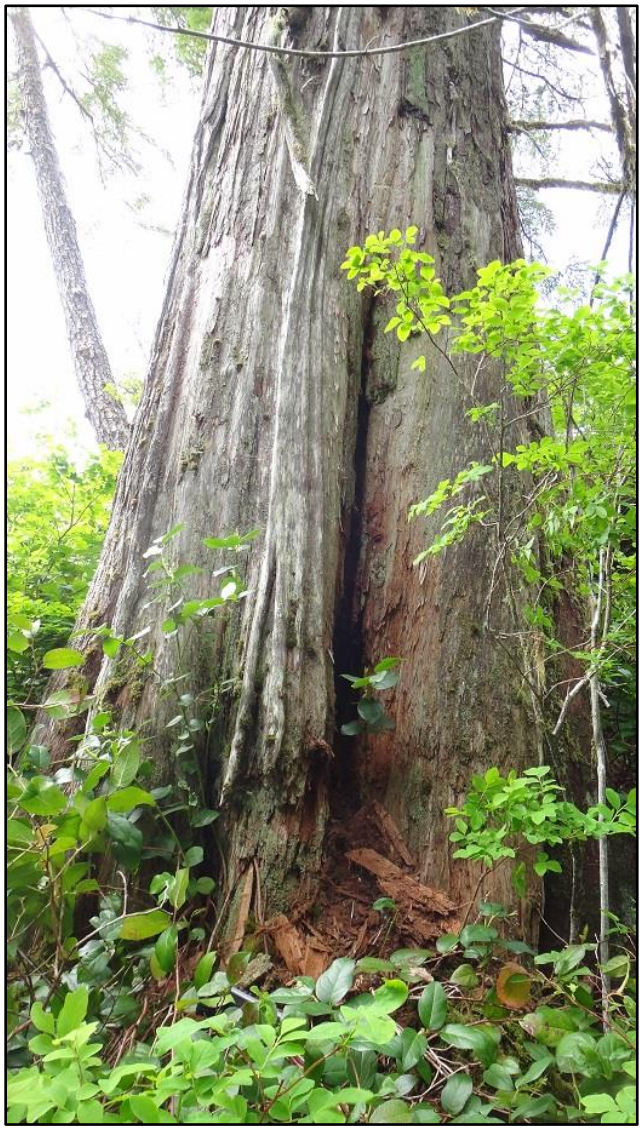
Diameter: 103 cm diameter
Species: mountain hemlock
Entrance: 57 cm diameter tube, about 5 m long
Habitat: Clearcut, CWHmm2
Modifications (2014): End of log capped with plywood, no other modifications. Debris piled against plywood to hide it (much more than in lower picture).
Notes: Closing off the end of the log created a good quality den that is more likely to be used once trees grow up around it. However, the log was very wet inside in October 2015 so it is unlikely it will be used as a den. No monitoring camera deployed.

Structure #7: Enhanced natural structure (stump)



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 bear. Suitability will increase once regenerating trees grow up around it. No visible signs of investigation in 2015. No monitoring camera deployed.

Structure #8: Enhanced natural structure (tree)



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: 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.

Structure #10: artificial den (culvert)

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, remote 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.
Notes: Monitoring camera deployed. Visited by bears 5 times between 2014-2015 (top photo), at least 2 different individuals. Cougar and cub also photographed at den.

Structure #11: artificial den (culvert)

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, remote 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. In 2014, the culvert den was investigated by bears 5 times of which there were at least 3 different individual black bears and a female and cubs (above left). In 2015, there were 12 detections of bears including one male and female breeding pair (above right). A number of bears have placed their heads inside the entrance.

Structure #12: artificial den (culvert)

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, remote camera installed, temperature data loggers installed.
Notes: Monitoring camera deployed. In 2014 the culvert den was investigated 6 times by bears (up to 4 different bears). In 2015 there were 9 detections of bears including **4 instances of a bear fully entering the structure**, 2 of partial entrances and 2 different bears investigating the structure 55 minutes apart.

Structure #13: potential natural den (tree)

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)

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, might enlarge it in 2016 depending on results of photo-monitoring. Monitoring camera deployed; photos taken in July 2015 of an old female bear (below) investigating the tree (batteries subsequently lost charge and camera was replaced in Oct. 2015).

Structure #15: Enhanced natural structure (tree)

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 photographed at tree during 2015, continues to be monitored by camera.

Structure #16: candidate natural den (tree)

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 will be placed at the site in spring 2016.

Structure #18: 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. Camera malfunctioned and had to be replaced so very little monitoring data. One bear was filmed July 25th, 8 days after installation.

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.

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 29 July 2015.

Structure #21: 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. 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.

Structure #22: artificial den (den pod)

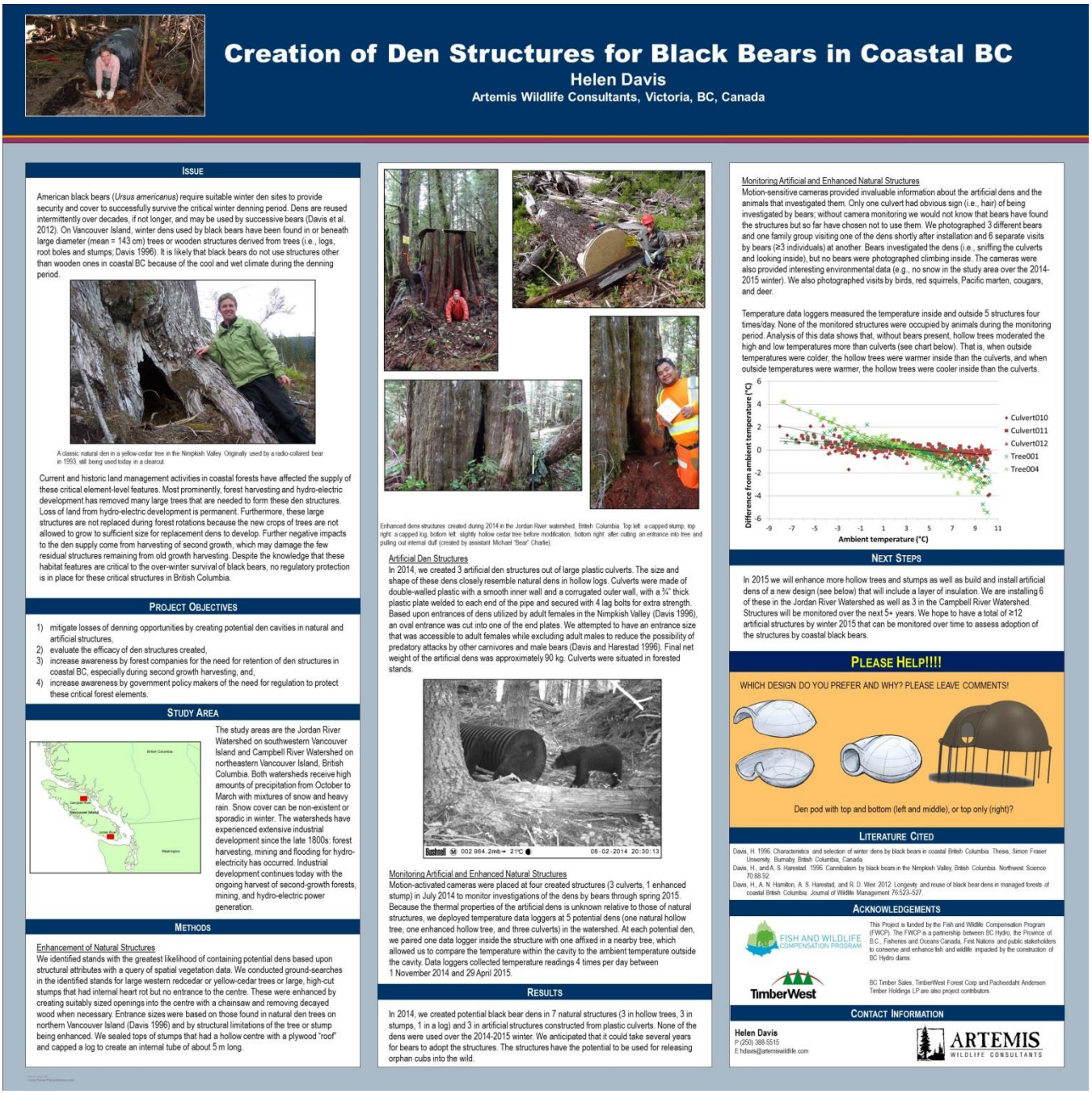
Type: polyurethane molded den pod
Entrance: 35 cm (h) x 30 cm (w)
Chamber: 75 cm (h) x 110 cm (w) x 110 cm (l)
Tunnel: 50 cm (h) x 65 cm (w) x 70 (l)
Habitat: second growth, CWHvm2
Notes: Installed 2015. There were 9 visits to this den pod by bears in 2015, the first visit was 8 days after installation; **13 days after installation a bear climbed ¾ of the way in 3 times over a 7 minute period**.

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).

Appendix II. Extension and Communications

Scientific poster presented at Western Black Bear Workshop (Canmore, Alberta) 12-14 May 2015.



Creation of Den Structures for Black Bears in Coastal BC

Helen Davis

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Issue

American black bears (*Ursus americanus*) require suitable winter den sites to provide security and cover to successfully survive the critical winter denning period. Dens are reused intermittently over decades, if not longer, and may be used by successive bears (Davis et al. 2012). On Vancouver Island, winter dens used by black bears have been found in or beneath large diameter (mean = 143 cm) trees 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.

A classic natural den in a yellow-cedar tree in the Nimpkish Valley. Originally used by a radio-collared bear in 1993, still being used today in a clearcut.

Current and historic land management activities in coastal forests have affected the supply of these critical element-level features. Most prominently, forest harvesting and hydro-electric development has removed many large trees that are needed to form these den structures. Loss of land from hydro-electric development is permanent. Furthermore, these large structures are not replaced during forest rotations because the new crops of trees are not allowed to grow to sufficient size for replacement dens to develop. Further negative impacts to the den supply come from harvesting of second growth, which may damage the few residual structures remaining from old growth harvesting. Despite the knowledge that these habitat features are critical to the over-winter survival of black bears, no regulatory protection is in place for these critical structures in British Columbia.

Project Objectives

1) mitigate losses of denning opportunities by creating potential den cavities in natural and artificial structures,
2) evaluate the efficacy of den structures created,
3) increase awareness by forest companies for the need for retention of den structures in coastal BC, especially during second growth harvesting, and,
4) increase awareness by government policy makers of the need for regulation to protect these critical forest elements.

Study Area

The study areas are the Jordan River Watershed on southwestern Vancouver Island and Campbell River Watershed on northeastern Vancouver Island, British Columbia. Both watersheds receive high amounts of precipitation from October to March with mixtures of snow and heavy rain. Snow cover can be non-existent or sporadic in winter. The watersheds have experienced extensive industrial development since the late 1800s: forest harvesting, mining and flooding for hydro-electricity has occurred. Industrial development continues today with the ongoing harvest of second-growth forests, mining, and hydro-electric power generation.

Methods

Enhancement of Natural Structures

We identified stands with the greatest likelihood of containing potential dens based upon structural attributes with a query of spatial vegetation data. We conducted ground-searches in the identified stands for large western redcedar or yellow-cedar trees or large, high-cut stumps that had internal heart rot but no entrance to the centre. These were enhanced by creating suitably sized openings into the centre with a chainsaw and removing decayed wood when necessary. Entrance sizes were based on those found in natural den trees on northern Vancouver Island (Davis 1996) and by structural limitations of the tree or stump being enhanced. We sealed tops of stumps that had a hollow centre with a plywood "roof" and capped a log to create an internal tube of about 5 m long.

Enhanced dens structures created during 2014 in the Jordan River watershed, British Columbia. Top left: a capped stump; top right: a capped log, bottom left: slightly hollow cedar tree before modification; bottom right: after cutting an entrance into tree and pulling out internal duff (created by assistant Michael "Bear" Charlie).

Artificial Den Structures

In 2014, we created 3 artificial den structures out of large plastic culverts. The size and shape of these dens closely resemble natural dens in hollow logs. Culverts were made of double-walled plastic with a smooth inner wall and a corrugated outer wall, with a ¾" thick plastic plate welded to each end of the pipe and secured with 4 lag bolts for extra strength. Based upon entrances of dens utilized by adult females in the Nimpkish Valley (Davis 1996), an oval entrance was cut into one of the end plates. We attempted to have an entrance size that was accessible to adult females while excluding adult males to reduce the possibility of predatory attacks by other carnivores and male bears (Davis and Harestad 1996). Final net weight of the artificial dens was approximately 90 kg. Culverts were situated in forested stands.

Monitoring Artificial and Enhanced Natural Structures

Motion-activated cameras were placed at four created structures (3 culverts, 1 enhanced stump) in July 2014 to monitor investigations of the dens by bears through spring 2015. Because the thermal properties of the artificial dens is unknown relative to those of natural structures, we deployed temperature data loggers at 5 potential dens (one natural hollow tree, one enhanced hollow tree, and three culverts) in the watershed. At each potential den, we paired one data logger inside the structure with one affixed in a nearby tree, which allowed us to compare the temperature within the cavity to the ambient temperature outside the cavity. Data loggers collected temperature readings 4 times per day between 1 November 2014 and 29 April 2015.

Results

In 2014, we created potential black bear dens in 7 natural structures (3 in hollow trees, 3 in stumps, 1 in a log) and 3 in artificial structures constructed from plastic culverts. None of the dens were used over the 2014-2015 winter. We anticipated that it could take several years for bears to adopt the structures. The structures have the potential to be used for releasing orphan cubs into the wild.

Monitoring Artificial and Enhanced Natural Structures

Motion-sensitive cameras provided invaluable information about the artificial dens and the animals that investigated them. Only one culvert had obvious sign (i.e., hair) of being investigated by bears; without camera monitoring we would not know that bears have found the structures but so far have chosen not to use them. We photographed 3 different bears and one family group visiting one of the dens shortly after installation and 6 separate visits by bears (≥3 individuals) at another. Bears investigated the dens (i.e., sniffing the culverts and looking inside), but no bears were photographed climbing inside. The cameras were also provided interesting environmental data (e.g., no snow in the study area over the 2014-2015 winter). We also photographed visits by birds, red squirrels, Pacific marten, cougars, and deer.

Temperature data loggers measured the temperature inside and outside 5 structures four times/day. None of the monitored structures were occupied by animals during the monitoring period. Analysis of this data shows that, without bears present, hollow trees moderated the high and low temperatures more than culverts (see chart below). That is, when outside temperatures were colder, the hollow trees were warmer inside than the culverts, and when outside temperatures were warmer, the hollow trees were cooler inside than the culverts.

Next Steps

In 2015 we will enhance more hollow trees and stumps as well as build and install artificial dens of a new design (see below) that will include a layer of insulation. We are installing 6 of these in the Jordan River Watershed as well as 3 in the Campbell River Watershed. Structures will be monitored over the next 5+ years. We hope to have a total of ≥12 artificial structures by winter 2015 that can be monitored over time to assess adoption of the structures by coastal black bears.

Please Help!!!!

WHICH DESIGN DO YOU PREFER AND WHY? PLEASE LEAVE COMMENTS!

Den pod with top and bottom (left and middle), or top only (right)?

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Davis, H., A. N. Hamilton, A. S. Harestad, and R. D. Weir. 2012. Longevity and reuse of black bear dens in managed forests of coastal British Columbia. Journal of Wildlife Management 76:523-527.

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BC Timber Sales, TimberWest Forest Corp and Pacheedaht Andersen Timber Holdings LP are also project contributors.

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