Evaluation of an Electrical Gradient as a Seal Deterrent

Puntledge River Study, April 10 – 24, 2007

Preliminary Results

From April 10 – 25, 2007, staff from the Pacific Salmon Commission (PSC), Department of Fisheries and Oceans Canada (DFO), and Smith-Root Inc. installed and tested an electrical deterrent system to create an electrical voltage gradient across the Puntledge River, in Courtenay, B.C. During March – May harbour seals (*Phoca vitulina)* typically enter the Puntledge River around dusk and use the light-shadow boundary from the lights on the 5th Street Bridge to forage for out-migrating juvenile salmon. The Puntledge River at the 5th Street Bridge was considered to be an ideal location to field test the electrical deterrent system as it is freshwater, the gear can be fixed, and the response of harbour seals that predictably congregate to forage on out-migrating Chum salmon fry (*Oncorhynchus keta*) can be easily observed. Our primary objective was to assess how foraging seals respond to electrical fields so as to be able to evaluate whether the method might be a humane, effective and practical deterrent. The Puntledge River Study was Part II of an ongoing PSC Southern Boundary Restoration & Enhancement Fund (SEF) Project. The Animal Care Committee, Department of Fisheries and Oceans, Canada (DFO) approved the Animal Use Protocol for the Puntledge River study and Marine Mammal Scientific License 2007-10 was issued by DFO.

Part I of the SEF Project was conducted on March 26, 2007 at the Vancouver Aquarium (Vancouver, BC) by the PSC, DFO, Smith-Root Inc. and Vancouver Aquarium staff. The captive seals at the Vancouver Aquarium demonstrated an avoidance response at minimal voltage gradients and pulse width settings (0.5 volts/cm and 200 – 400 micro-seconds). These values served as a starting point for Puntledge River trials. Prior to commencement of all trials the seals were allowed to acclimate to the study area and equipment. Dr. Martin Haulena (Vancouver Aquarium Staff Veterinarian) observed all trials at both the Vancouver Aquarium and in the Puntledge River.

The electrical array was installed into the Puntledge River between April 10 and April 12, 2007. The 5th Street Bridge crosses the Puntledge River approximately 1 km upstream from Comox Harbour. The river has been channelized upstream and downstream of the 5th Street Bridge. At the 5th Street Bridge the river depth and flow are influenced by tide, but salt water intrusions have not been observed at this location (personal communication, Brian Munro, DFO). Water conductivity in the Puntledge River was 25.5 µSiemen/Cm, considerably lower than at the Vancouver Aquarium. The bottom gradually sloped towards mid channel, although the water was slightly deeper on the south or right bank side of the river. The bottom substrate consisted primarily of rocks of varying size. The mid channel depth ranged from approximately 1.5 meters at low tide to 2 – 3 meters at high tide, with the current velocity being the greatest at low tide and little or no flow at high tide. The respective night time high tides at Comox Harbour were at 03:07 (4.6 m.), 03:43 (4.7 m.) and 04:13 (4.7 m.) on April 12 – 14 and 00:15 (4.9 m) and 01:19 (4.8 m) on April 23 & 24.

The electrodes of the array consisted of 4, half-inch copper cables spaced 1.8 meter apart with plastic PVC cross-members every 4.6 Meters. (Figure 1). Eleven PVC cross-members were spaced at 4.6 meter intervals, perpendicular to the cables and parallel to the flow, across the 49 meter width of the Puntledge River. The electrical array was floated into place, sunk and anchored on the bottom of the river. The downstream edge of the array was located approximately 3 meters upstream from the 5th Street Bridge. The array measured approximately 5.5 meters in width by 49 meters in length and lay on the bottom of the river below the area where seals are known to congregate and forage. The entire 5.5 m x 49 m water column directly above the array could be electrified? energized when the power was turned on. The array was designed by Smith-Root to produce a graduated electric field at a very low level of pulsed direct current (DC). The copper cables were attached to 3 of Smith-Root 1.5 POW DC Pulse Generator units powered by a portable 5.5 KW, AC generator. The pulse frequency was fixed during the trials at 2 Hz. The intensity of the voltage field was manipulated by varying the pulse width. Final calibration of the system was completed on April 12, 2007 and the voltage gradient in the field area was mapped prior to testing. Electrical field density readings ranged between 0.12-0.28 volts/cm. By design, the highest field strength was at the most upstream edge of the array.

The first series of trials were conducted on April 12 - 14, 2007. During the evening of April 12, 2007, the parameters of the electric field were reviewed with Vancouver Aquarium veterinarian, Dr. Martin Haulena; DFO Marine Mammal Coordinator, Marilyn Joyce; Marine Mammal Biologist, Peter Olesiuk; Puntledge River Hatchery Manager, Chris Beggs, and staff from Smith-Root and the Pacific Salmon Commission, and it was agreed that the study could proceed. The initial pulse width setting was 200 micro seconds. With the power turned off to the electrical array at 00:00 (midnight) on April 13, 3 seals were observed from the 5th Street Bridge. Two of those seals appeared to be actively feeding within the array area. At 00:15 the power was turned on to the array. Both seals showed an abrupt change in behaviour and both seals left the vicinity of the electrical array. At 00:16 1 seal was observed, and 16 seconds later the seal swam within the electrical field. After 12 seconds the seal swam downstream and out of sight. At 00:20 1 seal was observed above the array and at 00:21 the seal quickly swam upstream and out of sight. At 00:30 power was turned off. At 00:34 1 seal was observed upstream and after a few seconds swam upstream and out of sight. At 00:38 1 seal was observed within the array area, but within a few seconds the seal swam away and out of sight. This same pattern of behaviour occurred twice over the next 10 minutes. With no seals observed after an additional 45 minutes of observations the trials were concluded at 01:25, April 13.

Dr. Martin Haulena did not identify any behaviour by the seals that would indicate the animals were distressed during, or immediately following the period that the electrical equipment was turned on. Seals resumed usual behaviour during the time that they occupied the area 10-20 meters upstream of the apparatus. In addition, Peter Olesiuk, Marilyn Joyce and Dr. Christine MacWilliams were present as DFO observers. No seals were observed on the following evening, April 13/14. This may have been due to heavy rain, high water levels, high river velocity, and high turbidity.

A second series of trials were conducted during the evening hours of April 23–24 and April 24-25, 2007. Prior to April 23rd Chris Beggs (Puntledge River Hatchery Manager, DFO) observed several seals foraging beneath the 5th Street Bridge as well as upstream of the Bridge. Present during the April 23 – 24 trials were Keith Forrest (PSC),

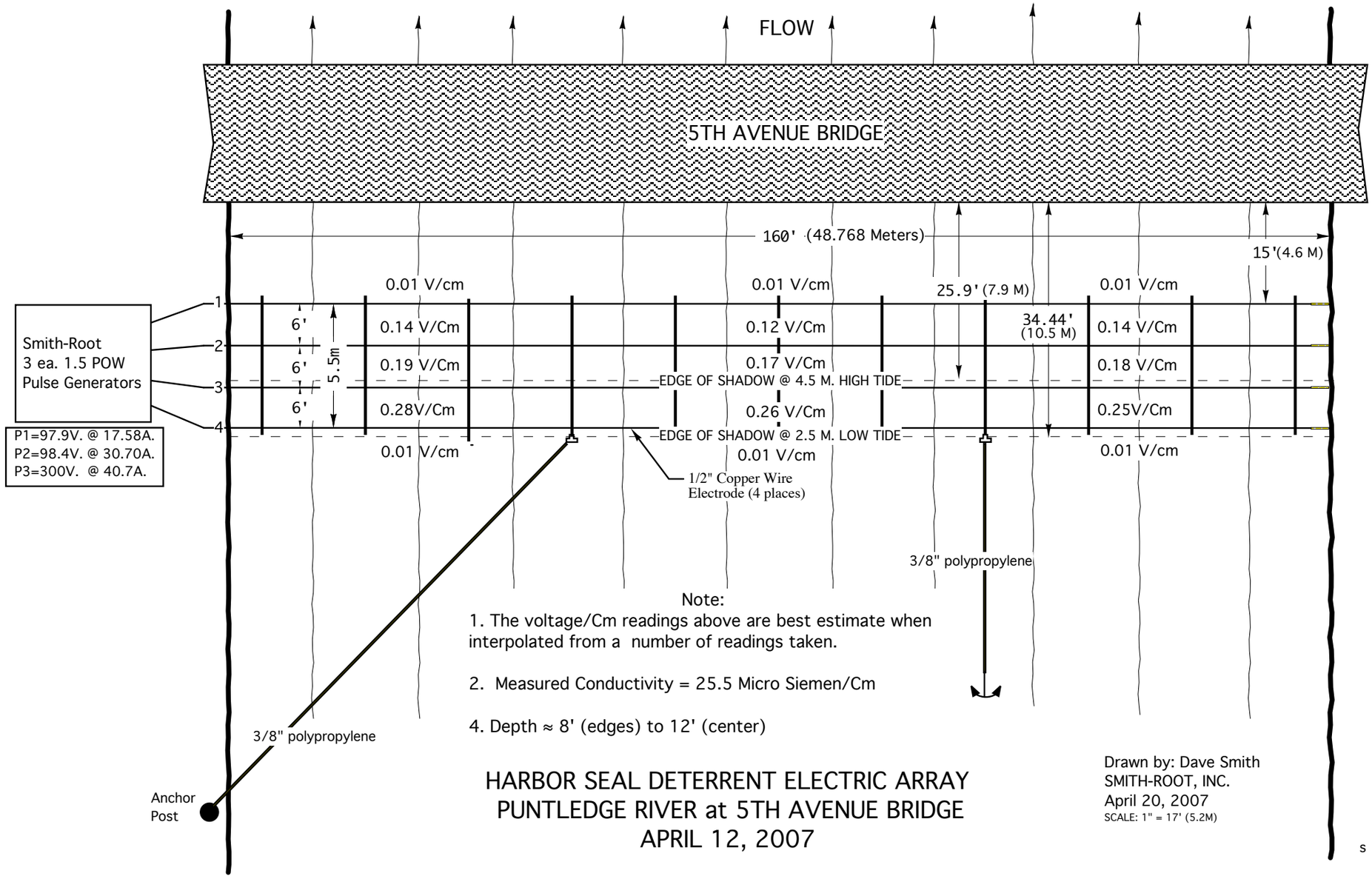
Chris Beggs (DFO), Brian Munro (DFO), Peter Olesiuk (DFO), Dr. Martin Haulena (Vancouver Aquarium), Lisa Harlan (Smith-Root), Lee Carstensen (Smith-Root). The electrical field density readings ranged between 0.16–0.26 volts/cm. On April 23, at 21:30 7 seals were observed feeding within the array area in addition to several other animals feeding upstream of the 5th Street Bridge. The seals were observed for 30 minutes prior to turning on the power to the array. The power was turned on to the array at 22:07. The pulse width was set at 500 micro-seconds. At 22:10 3 seals were present upstream of the array. At 22:11 1 – 2 seals remained in the vicinity of the array. The observed seals were no longer feeding. At 22:13 the power was turned off to the array and 2 seals appeared from upstream. At 22:19 3 seals were present in the array area and by 22:24, 4 seals were present. The seals did not appear to be foraging as vigorously compared to earlier observations. Over the next 30 minutes, the number of seals observed from the 5th Street Bridge ranged between 2 – 8 animals. In addition to the 5th Street Bridge observations 7 seals were observed approximately 200 meters upstream from the Bridge. At 23:00 there were 4 seals present within the array area and the power was turned on. The pulse width was set at 1 millisecond. The 4 seals responded abruptly, splashed and immediately left the area. At 23:06 1 seal briefly swam into the array, but turned way immediately. At 23:08 the power was turned off to the array. No seals were observed over the next 45 minutes and trials were concluded at 23:43 pm.

On April 24, 2007 the power was turned on at 19:00, 1.5 hours before dark. The pulse width was set at 1 millisecond. From the 5th Street Bridge the array was continually monitored and observations upstream of the Bridge were conducted every 15 minute intervals. At 20:35 1 seal turned around as it approached the array from downstream. At 21:10 a second seal turned around as it entered the array area from downstream. At 21:30 a third seal turned around as it swam upstream into the array area. One seal was observed upstream of the bridge and at 22:30 1 seal was observed swimming downstream towards the array. Between 22:30 and 23:00 several seals were observed downstream of the 5th Street Bridge. At 23:00 the power was turned off to the array and by 23:30 there were 10 – 12 seals actively feeding upstream of the Bridge (near the tennis courts). At 00:30 no seals were present beneath the 5th Street Bridge, however 10 – 12 seals remained feeding upstream of the Bridge. With the array removed from the Puntledge River, on April 26, 2007 at 00:01 9 seals were observed feeding slightly upstream of the 5th Street Bridge light shadow in addition to 6 seals feeding upstream of the Bridge.

In conclusion, during this study an avoidance response of the seals to the array area was demonstrated at pulse width settings of 200 and 500 micro-seconds. However continuous deterrence of seals from foraging was not demonstrated at these settings. A clear avoidance response was evident at a pulse width setting of 1 millisecond and seals avoided moving upstream through the electrical field. The voltage gradient and pulse width settings are much less than required for an effective barrier of freshwater fish migration (Dave Smith, Personal communication, Smith-Root Inc). The one seal that was observed upstream of the electrical array, on April 24th, may have swam through the electrical field unobserved, or the animal may have already been upstream prior to turning the power on to the array at 7:00 pm. There did not appear to be any lingering or adverse effects of the electric field on the seals as they were observed swimming and feeding normally within the array area shortly after the power was turned off and during the evenings that followed. Dr. Martin Haulena was present to observe all trials in the

Puntledge River and indicated that a 1 millisecond pulse width would be the maximum setting that he would authorize during the trials in the Puntledge River.

Factors such as water conductivity, pulse width, voltage gradient, size of animal, species, motivation and habituation to electric field could influence the avoidance response by individual animals. Additional pilot studies, will be required to ascertain how these factors may influence the avoidance response of seals and other pinnipeds to a DC-pulsed electric voltage gradient. However, this feasibility study indicates that this technology has potential for deterring marine mammal predation on fish.



Note:

1. The voltage/Cm readings above are best estimate when interpolated from a number of readings taken.

2. Measured Conductivity = 25.5 Micro Siemen/Cm

4. Depth ≈ 8' (edges) to 12' (center)

HARBOR SEAL DETERRENT ELECTRIC ARRAY
PUNTLEDGE RIVER at 5TH AVENUE BRIDGE
APRIL 12, 2007

Drawn by: Dave Smith
SMITH-ROOT, INC.
April 20, 2007
SCALE: 1" = 17' (5.2M)

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