Field Assessment Report and Background Review CN 2017 Herbicide Application in the Skeena Sub, Terrace to Prince Rupert, BC

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1. Introduction

Owing to concerns with what appeared to be extensive herbicide spraying—including apparent over-stream application—along the lower Skeena River and tributaries during the late summer of 2017, Luanne Roth of the T.Buck Suzuki Environmental Foundation contacted me in September of 2017 to obtain a professional opinion and to provide documentation and evidence on whether such application had, indeed, occurred.

2. Author's Professional History and Disclosure

The author, Amanita Coosemans, is a professional biologist, registered since 1998 with the Association of Professional Biologists of British Columbia, and with the College of Applied Biology in BC since that organization's inception in 2002. My educational and professional background include vegetation ecology, plant physiology, specific pesticide training (Pesticide Applicator's Certificate with Forestry Supplement, June 2000), wildlife ecology, and aquatic/fish and fish habitat assessment and restoration. I have worked with herbicides as an environmental monitor during their application, and have undertaken both pre-/post- herbicide environmental assessments for forestry. My professional CV is available upon request.

In 2002, 2003, 2004 and 2005, the author worked as a consultant to CN, acting as environmental monitor to meet with the permitting requirements of the BC Ministry of Water, Lands and Air Protection, which included presence of an approved monitor during pesticide application. In this capacity, I was responsible for ensuring environmental compliance and reporting to regulatory agencies, in addition to providing CN with technical information and advice regarding vegetation management to assist them with their Integrated Pest Management (IPM) planning.

Because of my history directly with CN's pesticide program, I was cognizant of conflict of interest potential (both real and perceived) during this project. Field methods and reporting on results for this project do not rely on any information derived from previous contracts: All access was through public crossings and/or via stream channels, and no information was collected nor shared that could not be collected by any professional with similar qualifications.

3. Project and Legislative Background

3.1 Project Location and Fish

CN's Skeena Sub encompasses a segment of railway track >90 miles (~145 kilometres) in length, between Terrace and Prince Rupert, BC. Much of this track lies directly adjacent—or within view of—Highway 16 West. A substantial portion of the right-of-way (ROW) lies directly adjacent to the Skeena River, and the tracks cross many major fish-bearing streams/rivers in this section (e.g. Kitsumkalum R., Zymagotitz R., Shames R., Exstew R., Exchamsiks R., Kasiks R., Kwinitsa Cr., Khyex R., Antigonish Cr., McNeil R.) before following Inverness Passage up to the community of Port Edward, crossing to follow the western perimeter of Kaien Island ,and terminating the track at Prince Rupert.

The "lower Skeena" denotes the ~115 kilometres of river from the Kitsumkalum River (just downstream of Terrace), to the mouth, just south of Prince Rupert, BC. Tidal influence typically extends upstream to the Kasiks River. The lower Skeena River and its tributary streams are well-known for their high fish values: The Skeena River is the second most important salmon producer in BC, with annual escapements of over two million fish. Skeena region fisheries specialist, Mitchell Drewes, emphasizes the importance of the lower Skeena, its side-/back- channel and tributary habitat for steelhead parr, and also notes the importance of the tidal and estuarine areas for rearing sockeye (pers. comm., February 2018). The Skeena River mainstem and adjacent channels from Kasiks River upstream to Shames is an area "extremely important to pink and chum salmon, which spawn in large numbers" (Gottesfeld and Rabnett 2007). Gottesfeld and Rabnett go on to say that "122 fish species have been identified in the Skeena River system and estuary. Each has its own niche and function, and as such contributes to the fish community. In turn, the fish community contributes to the ecology, nutrient regime, and structural diversity of the lower Skeena drainage basin."

3.2 Railways and herbicide regulation

Herbicide use for native vegetation control and/or invasive species management is common practice in CN's Skeena Sub, from Terrace to Prince Rupert, BC, and is known to occur most years in the late summer to early fall period[1].

In British Columbia, the *Integrated Pest Management* ("*IPM*") *Act* and *Regulations* regulate pesticide sale and use, and specify reporting, monitoring and enforcement requirements. The *IPM Act* requires users of pesticides for the management of vegetation on railway rights-of-way (ROW), yards & associated facilities on more than 20 ha/year to file a pesticide use notice (PUN) with the responsible Ministry *and* requires that such users receive a confirmation of the notification prior to

[1]as evidenced both by the state of the trackside vegetation and by the signage placed at public crossings at the time of application and for two-weeks post-treatment (personal observations).

pesticide use. A key PUN requirement is the preparation of a detailed pest management plan (PMP) that is prepared and undertaken according to regulations —including a public consultation requirement. Immediately prior to pesticide application, public notification is required through signage (which indicates, among other details, the date & time of application and type(s) of pesticide utilized) which must remain in place for a minimum of 14 days following treatment.

Unless otherwise prescribed, all PUN confirmation holders are expected under the *IPM Act* to ensure that a minimum 10m pesticide-free zone ("PFZ")—measured horizontally from the high-water mark (HWM)—is maintained along all water bodies, classified wetlands and wet or dry streams. To achieve this, PUN confirmation holders are expected to provide adequate no-treatment zones to ensure that the PFZs are maintained, and to establish an appropriate distance between the treatment area and natural water bodies to prevent release of pesticide spray or runoff into the water body. PUN confirmation holders for pest management on railways and railway facilities are further specifically required, for the treatment of ballast and railway yards and individual tree treatments along the ROW, to maintain a minimum 1 m no treatment zone along any temporary freestanding water body that is not fish bearing at any time of the year and does not drain into fish bearing waters.

Notwithstanding the above, reduced PFZs are allowed for glyphosate-based pesticides under the *IPM Act*, as follows:

> For railway ballast, signal, switch and yard areas, a minimum 2 m PFZ must be maintained along all water bodies that are fish bearing at any time of year, or that drain directly to fish-bearing waters. For non-fish bearing waters, glyphosate may be applied up to 2 m from the high-water mark; up to but not within the high-water mark of temporary free standing water bodies that are not fish bearing at any time of year and do not flow directly into fish bearing water bodies; or over dry streams that are not fish bearing at any time of the year and do not drain directly into fish bearing water at any time of the year. For the control of noxious weeds and invasive plants (provided that selective application methods are used), the distance to any water body is reduced to a 1 m PFZ. (*IPM Act*, Sections 74(1)(a) to 77(2)).
>
> For areas that are not required to be vegetation free (i.e. railway ballust, signal, switch or yard), the general rule for railway use of glyphosate is a 5 m PFZ (*IPM Act*, Section 74(1)(b)).

Regardless of their size, pesticide-free zones must have adequate buffer areas associated with them during application to ensure that they remain completely free of pesticide contamination from "drift" or other causes.

3.3 Glyphosate

Given a history of glyphosate use on the Skeena sub, limited public access to vegetation beyond the edges of watercourses, and the fact of its having the smallest legislated PFZ per the *IPM Act*, the works described within this report have focussed on potential use of glyphosate over- and adjacent to- fish-bearing waters. The content of this report in no way reflects on potential use of other herbicide compounds that may or may not have been utilized within the area that is the subject of this report.

Foliar herbicides may be *contact* (killing plant tissues that are directly contacted) and/or *translocated* (absorbed and drawn throughout the plant). A contact herbicide rapidly weakens plant cell membranes, causing the cells to be quickly destroyed. Translocated herbicides such as glyphosate do not necessarily show toxic effects immediately: dependent on application rate (concentration), species may show toxic effects only after several weeks—although glyphosate can also behave as a contact herbicide at higher concentrations.

Glyphosate is an amino acid compound which is a broad-spectrum, post emergence, translocated herbicide: Glyphosate inhibits an enzyme involved in the synthesis of several amino acids. At recommended concentrations, the herbicide is drawn into growing locations of plant tissues and roots, causing decreased vigour or death over a period of days or weeks. At these concentrations, foliage dies slowly, although rate is dependent on many factors, including species (nature of the foliage, including its shape, surface area, type and density of hairs, thickness of waxy cuticle, etc.), weather conditions, pre-treatment health, season, etc.

The way glyphosate is absorbed by foliage depends on species, individual leaf attributes and timing, and the chemical may be washed away by rain and abrasion. The glyphosate chemical adsorbs rapidly to soil and sediment, where microbes rapidly degrade it into its metabolite, aminomethylphosphonic acid (AMPA)—a chemical that also adsorbs to soil. Glyphosate is not readily broken down by water or sunlight. (US Environmental Protection Agency 1993).

4. Methods and Field Activities

On September 26, and again on October 14 and 15, 2017, I visited sites along the Skeena Sub. Although much of the track is not physically accessible to the public, numerous areas do allow public crossings of the railway track and ROW (e.g. the boat launch area at Port Edward, and several minor road crossings between Terrace and Prince Rupert that allow legal public and/or industrial crossing of the ROW). Furthermore, all water bodies are publicly accessible below the high-water mark. Finally, some areas of track that cannot be legally accessed can be reasonably well viewed from Highway 16 West and areas of Crown Land. My assessment and results, therefore, are derived from such legally available means as described above.

4.1 Visual Evidence of Herbicide Application and Timing

Appearance of vegetation suspected of having been affected by pesticide was compared with adjacent vegetation of the same species in order to effectively take into account the factor of microclimate variability between sites, and to help estimate the timing of application. Herbicide-affected vegetation varies across species in its manifestation; however, it is typical to note a lack of normal leaf detachment in deciduous species, strongly differing from the normal seasonal senescence pattern where leaves are cleanly shed at an abscission layer (i.e. when a herbicide has been used during the growing season, the leaf is not shed in this predictable location on the stem as it normally would be during autumn, and often continues to hang on the stem through the season). In conifers, only the pattern of chlorosis (yellowing of leaves), indicating disruption of normal processes, provided visual evidence of potential herbicide exposure: Although some chlorosis occurs as part of normal tree renewal and may be quite prominent in certain species (e.g. western redcedar), the normal pattern emanates from the stem and affects older tissues, while herbicide also affects the tips and new growth and can thus be distinguished from normal senescence. Finally, natural chlorosis in most conifers shows rust-coloured and relatively robust, while herbicide damage can sometimes result in blackish-coloured, drooping branchlets.

At several sites where it is possible to legally access the CN tracks and right-of-way, measurements were taken from edge of track to edge of affected vegetation, in order to contribute to an overall estimate of total area suspected to have been subjected to herbicide application in 2017. Where visual evidence was not compelling or conclusive, no determination about herbicide spray were made, and such vegetation in no way contributed to estimations made in this report.

4.2 Collection of Foliar Samples and Submission to Laboratory for Testing

Samples of foliage were collected on October 14th and 15th according to standard vegetation sampling techniques that prevent cross-contamination. Materials used were as follows: clean/new nitrile gloves (replaced after each individual sample); clean/new Ziplock sample bags; and clippers (cleaned with rubbing alcohol before and after each individual sample was taken). Woody tissues (cones or twigs) were removed from foliar samples of deciduous vegetation. For conifers, only the current year's growth was collected. Bags were then tared and weighed using a Pesola hanging scale to determine rough wet weight (grams) to ensure sufficient minimum weights for potential submission of samples to laboratory. Selected samples were kept cool (~4°C) for 2-3 days prior to being packed with ice and shipped to CARO Analytical Testing in Richmond, BC, who were retained to test the samples for glyphosate and AMPA (see Attachment 1, Chain of Custody record).

5. Results and Discussion

5.1. Estimating Timing of Herbicide Application

During my September 26th and subsequent October visits, I did not observe any signage, indicating either that no signage had been posted, or that it had been removed prior to my inspections. The state of the vegetation during the September visit indicated that spraying had likely occurred several weeks prior—likely late August or early September. As signage is required to be maintained for only 14 days' post-treatment and I potentially attended the site beyond this period, I have no evidence whether or not signage was placed according to regulation.

5.2. Assessment of Selected Areas Suspected of Herbicide Application

Given limited access and a limited amount of available time and budget, not all areas of CN's Skeena Sub could be assessed for evidence of herbicide application. As such, efforts were focused on a small number of select areas that had a reasonable degree of accessibility and that showed evidence of herbicide damage in close proximity to waterbodies. Table 1 identifies areas for which the author was able to examine vegetation—either from a nearby vantage point or directly—and provides brief notes for each. Photos referenced in this table are available in the attached Photo Document (Attachment 2). Where "high spray" is described, this refers to areas where use of a high spray boom appears to have been used[2]. Note that all sites listed in the table below are fish-bearing or (in the case of the ~54 mile stream) flow directly into fish-bearing waters.

Table 1: Site field notes

Site Name/ Location	CN Mile-post	Date	Comments	Photo Ref#	Sampling Comment
Skeena River, 17.5 to 18 Mile	~17.5 to 18	26 Sept. 2017	Rip-rap ballust directly over Skeena River (estimated distance of 7m from track edge to river, directly over permeable materials). Appears sprayed on both sides of track. Visible from Hwy 16 but not accessible without trespass.	-	-

[2] While typical application of railway ballust and right-of-way uses a spray boom that directs pesticide to the ground (horizontal), use of a high spray boom directs the application of pesticide to reach higher vegetation (e.g. on a cliff wall or slope, or simply to reach higher on tall vegetation such as tall shrubs and trees). In the case of this suspected application where "high spray" was used, the total observed height of affected vegetation was equal to that of a double-stacked container car—i.e. a train car containing two standard shipping containers (each 2.9m in height) stacked one on top of the other.

Site Name/ Location	CN Mile-post	Date	Comments	Photo Ref#	Sampling Comment
Shames River	~15.5	14&15 Oct. 2017	Vegetation samples taken at/over waterbody edge on stream right. On Oct 14 this portion of the channel was a dry sediment wedge, and on Oct 15 this area had flowing water.	1-2	"CN01" Red-osier dogwood sample collected. Positive laboratory result for glyphosate
Esker Overpass	~20.5	26 Sept. 2017	View from overpass but no direct access. Spray appears to be within 5m of water's edge, but could not be confirmed.	3	-
Polywog Creek	~29	14 Oct. 2017	Possible spray near creek but access difficult.	-	-
42-mile Area	~42	14 Oct. 2017	High spray boom use evident in area immediately west from ~42M.	-	-
Polymar Creek	~43	14 Oct. 2017	Upstream wetland and creek have apparent herbicide damage within 5m. Poor access: did not access site.	4-6	-
Snow Creek	~45.7	15 Oct 2017	Herbicide effects evident over Sitka willow, red alder and red-osier dogwood over the channel on both banks. Could not safely access left-bank.	7-13	"CN04" Red-osier dogwood and red alder leaves collected from upstream right bank. Not submitted for analysis.
Kwinitsa River	~49.2	15 Oct 2017	On upstream side, water comes from the east, parallel to tracks, where safe access was not possible. Limited views from highway suggest the entire side is sprayed within 2m of the watercourse.	14-17	-

Site Name/ Location	CN Mile-post	Date	Comments	Photo Ref#	Sampling Comment
54 Mile Area	~54	15 Oct 2017	Steep area adjacent track (north side) with evidence of continuous use of high spray across numerous small streams. Photo depicts stream that is highly visible from highway, with alluvial substrate evident, apparently sprayed within 1m. These streams are likely too steep to be fish-bearing, but drain directly (i.e. within 50m) into the Skeena River.	18-21	-
Log Creek	~55	14 Oct. 2017	High spray evident near creek. Did not access.	22-24	-
Igneous Creek	~55.9	14&15 Oct. 2017	High spray evident near creek, and western redcedar, red alder, and salmonberry appear to have been sprayed over the creek.	25-31	"CN05" Cedar collected within 4m of HWM on upstream right bank: not submitted. Red alder collected 3+m over creek on upstream left: Positive laboratory result for glyphosate.
56 to 59 Mile	~56 to 59	14 Oct. 2017	High spray apparent through unnamed watercourses	-	-
Basalt Creek	~60	14 Oct. 2017	Left bank has apparent herbicide close to creek "edge" and below high water mark in tidal wetland edge of watercourse. Could not access.	32-33	-
Marigonish Creek	~62	15 Oct 2017	Herbicide effects evident up to and over tidal marsh wetland, and within 2.5m of stream edge.	34-39	"CN06" Salmonberry collected from 2.5 to 4m above stream edge (over tidal marsh): glyphosate not within detectable limits.

Site Name/ Location	CN Mile-post	Date	Comments	Photo Ref#	Sampling Comment
Aberdeen Creek	~65.7	14 Oct. 2017	Affected vegetation collected from the downstream right bank, 3.5m from conservative normal HWM & within 1m of recent alluvial deposits. Tidal meadows (wetland) occur on the upstream side of the CN crossing.	40-43	"CN02" Collected samples from spruce and red alder. Samples not submitted to lab.
Port Ed Cannery	~81.9	14 Oct. 2017	Small stream channel located between cannery driveway and CN tracks: vegetation affected across channel. On the Skeena River/estuary side of the track, herbicide application evident immediately adjacent Inverness Passage (Skeena River estuary).	44-49	-
Port Ed Boat Launch	~86	14 Oct. 2017	Within <3m horizontal distance of tidal water.	50-51	"CN03" Collected deer fern sample. Glyphosate not within detectable limits.

5.3. Estimation of Total Herbicide Spray Area

Given that the *IPM Act* requires the submission and confirmation of a Pesticide Use Notice (PUN) for rail-related pesticide applications greater than 20 hectares per year, a rough calculation of whether this suspected application exceeds this threshold is as follows:

At several public use crossings, measurements taken from edge of track to the outer edge of suspected herbicide use ranged from 4.6 to 7.6 metres. The inter-track width is approximately 1.5m (5"). The maximum total spray width measured by the author at a public crossing was 16.7m. Assuming the inter-track area and just one side of the track was sprayed at the most conservative width of 4.6 meters, the total spray width for this scenario is 6.1m. At this width, just 32.8 km (~20.4 miles) of sprayed track distance would add to a 20ha application area. In a scenario with a (still conservative) 10m total spray width, just 20km (12 miles) of sprayed track would meet the 20ha threshold described in the *IPM Act*.

Of the ~145km (~90 miles) of track between Terrace and Prince Rupert, much of the track is visible—either because it is adjacent or because viewpoints are available

—from Highway 16. Virtually all segments of track visible to the author during her field visits in September and October (>55km/34 miles) showed evidence of recent herbicide application, thus supporting the conclusion that the 20ha threshold—for which a PUN must be received and confirmed—was achieved.

5.4 Timing Implications: Fish species of the lower Skeena and its tributaries

Many aquatic species utilize the lower Skeena watershed, including the river, its tributaries, and its estuary. This section briefly discusses the distribution and life history of fish species that are documented within the Skeena system and that use the river or its tributaries for all or a portion of their lives, and examines the life-stage potential for each to be present during the suspected pesticide application.

Please note that, although it is not within the scope of this report to discuss or describe species that are strictly marine or estuarine, such species will have been present in the area thought to have been affected by herbicide application in the estuarine environment at the westernmost end of the suspected application. Their exclusion from this report is in no way meant to diminish either their importance or the potential for possible serious impacts on these species (e.g. crab, mussels, clams, rockfish, halibut, sable fish) or important marine vegetation (e.g. eelgrass, micro- and macro- algae, etc.) that provides habitat for these species.

The following subsections and supporting tables provide summary information on fish species documented[3] in the watersheds thought to be affected by CN's suspected 2017 pesticide application. Table 2 summarizes species groups and individual species for which historical records are documented.

Table 2. Fish species documented in the lower Skeena River watershed

Species Group	Species (English)	Species (Latin)	Species Code
Cod	Burbot	*Lota lota*	BB
Herring	American Shad	*Alosa sapidissima*	SH
Lamprey	Pacific Lamprey	*Lampetra tridentata*	PL
Lamprey	River Lamprey	*Lampetra ayresi*	RL
Lamprey	Western Brook Lamprey	*Lampetra richardsoni*	BL

[3] Species presence and timing data derived from the BC Ministry of Environment's Fisheries Inventory Data Queries Tool (FIDQ) (http://www.env.gov.bc.ca/fish/fidq/queries.html) and Habitat Wizard web-based application (http://maps.gov.bc.ca/ess/sv/habwiz/), as well as the Pacific Salmon Foundation's web-based application (www.salmonwatersheds.ca)

Species Group	Species (English)	Species (Latin)	Species Code
Minnow	Lake Chub	*Couesius plumbeus*	LKC
Minnow	Longnose Dace	*Rhinichthys cataractae*	LNC
Minnow	Northern Pikeminnow	*Ptycheilus oregonensis*	NSC
Minnow	Northern Redbelly Dace	*Phoxinus eos*	RDC
Minnow	Peamouth Chub	*Mylocheilus caurinus*	PCC
Minnow	Redside Shiner	*Richardsonius balteatus*	RSC
Salmonid	Bull Trout	*Salvelinus confluentus*	BT
Salmonid	Chinook Salmon	*Oncorhynchus tshawytscha*	CH
Salmonid	Chum Salmon	*Oncorhynchus keta*	CM
Salmonid	Coho Salmon	*Oncorhynchus kisutch*	CO
Salmonid	Cutthroat Trout	*Oncorhynchus clarki*	CT
Salmonid	Cutthroat/Rainbow trout cross		CRS
Salmonid	Dolly Varden	*Salvelinus malma*	DV
Salmonid	Pink Salmon	*Oncorhynchus gorbuscha*	PK
Salmonid	Rainbow Trout	*Oncorhynchus mykiss*	RB
Salmonid	Sockeye Salmon	*Oncorhynchus nerka*	SO
Salmonid	Steelhead	*Oncorhynchus mykiss*	ST
Sculpin	Coastrange Sculpin	*Cottus aleuticus*	CAL
Sculpin	Prickly Sculpin	*Cottus asper*	CAS
Sculpin	Slimy Sculpin	*Cottus cognatus*	CCG
Smelt	Eulachon	*Thaleichthys pacificus*	EU
Smelt	Longfin Smelt	*Spirincus thaleichthys*	LSM
Stickleback	Threespine Stickleback	*Gasterosteus aculeatus*	TSB
Sturgeon	Green Sturgeon	*Acipenser medirostris*	GSG
Sturgeon	White sturgeon	*Acipenser transmontanus*	WSG

Species Group	Species (English)	Species (Latin)	Species Code
Sucker	Largescale Sucker	*Catostomus macrocheilus*	CSU
Sucker	Longnose Sucker	*Catostomus catostomus*	LSU
Sucker	White Sucker	*Catostomus commersoni*	WSU
Whitefish	Mountain Whitefish	*Prosopium williamsoni*	MW
Whitefish	Pygmy Whitefish	*Propsopium coulteri*	PW

The following subsections/paragraphs provide a brief summary of each species identified as having a record of presence in the Skeena River (BCMoE's FIDQ 2018), indicating its potential presence in the area of concern at the time of suspected pesticide application (late August/early September).

Salmonids (Salmon, Trout and Char)

During the late August/early September period, the lower Skeena River (i.e. the reaches from Terrace to the marine waters south of Prince Rupert) may be inhabited by adults all five species of Pacific salmon (coho, chinook, chum, pink and sockeye), returning from the Pacific Ocean to their freshwater spawning grounds[4]. Some of these fish may spawn in the Lower Skeena itself or its tributaries, while others are passing through to spawn at upriver sites.

Upon becoming free-swimming, some salmon species proceed immediately downriver (chum, pink), while others (chinook, coho, sockeye) may spend up to several years in freshwater as fry. Sockeye salmon typically remain in freshwater lakes—and not streams or rivers—until they move to the marine environment as smolts during spring; however, juvenile sockeye often rear in estuaries and appear to spend a considerable amount of time in side channels and tributaries of tidal rivers (Drewes 2018, pers. comm.; Simmons *et al.* 2013), and are therefore expected to have been present in some of the affected areas during the suspected pesticide application. On the other hand, owing to the timing of their emergence from the gravel in early spring (April - May) and rapid migration to sea, juvenile pink and

[4] estimated timing of all known populations entering the mouth of the Skeena River to access spawning grounds throughout the Skeena watershed (derived from data provided by Pacific Salmon Foundation's www.salmonwatersheds.ca):
Chinook: May 14 through September 9 (early and late runs).
Chum: July 11 through September 30.
Coho: July 1 through November.
Pink (odd years): July 3 through September 23 (greater numbers & spread in even years).
Sockeye: May 16 through October 3.

chum salmon are not expected to have been present—even in the estuarine areas—during late August/early September.

Coastal cutthroat trout (provincially a blue-listed species) are typically a spring spawner (February to May), but some are known to spawn in the fall. Within two months of spawning (i.e. April to July), eggs have hatched and the young are free-swimming. Some cutthroat remain in freshwater throughout their lives, while others use an anadromous life history strategy, regularly using near-shore marine environments. Whether resident or sea-run, cutthroat trout adults and juveniles may be present year-round in the area.

Rainbow trout/steelhead are members of the same species using different life-history strategies (lake or stream resident vs. anadromous). Anadromous juveniles may remain in the stream for up to several years. The lower Skeena, its back channels and its tributaries are known to support high numbers of steelhead parr during the late summer period (Gottesfeld and Rabnett 2007; Drewes 2018 pers. comm.). Though typically spring spawners, fall spawners are also known. Summer run steelhead have been documented at the Tyee test fishery through the late-August - early September period (MoE FIDQ 2018). Whether resident or sea-run, both adults and juveniles of this species may be present year-round in this area.

Both Dolly Varden char and bull trout are typically fall spawners, with fry emerging in spring (April - May). Bull trout are federally listed under Schedule 1 of the *Species at Risk Act* (SARA), are listed provincially as Identified Wildlife, and are provincially Blue-listed. Both species may be resident or anadromous. Whether resident or sea-run, both adults and juveniles of both species may be present year-round in this area.

Smelts

Eulachon are an anadromous species that enter the Skeena River in the early spring (February-June through range, but normally March - April in this area) to spawn in the lower Skeena reaches. Emergence is up to three weeks after eggs are laid, and larvae are carried to sea by the current shortly after hatching. Other than spawning (which a few individuals may do twice in a lifetime), eulachon are mainly ocean residents, though juveniles may spend several months in the nearshore/estuarine environment (COSEWIC 2013). Eulachon is a Blue-listed species provincially, and the Skeena and Nass River populations are identified federally by COSEWIC as Special Concern (2013), but are not yet listed in SARA Schedule 1. The reduced risk work window for this area is June 15 - February 15. Although no life stage of eulachon is expected to have been using upriver habitat during the suspected pesticide application in late August/early September 2017, juvenile eulachon—and possibly adults—are likely to have been present in the estuarine environment within the suspected application area.

Longfin smelt are also a largely anadromous coastal species that occupies a similar range to the eulachon, "occurring in fresh water in rivers close to the sea" (Scott and Crossman 1973). This species spawns in freshwater streams from October to December, with "young observed moving down the spawning streams in April" (ibid). It is possible that adults of this species were present in the lower Skeena and tidal waters during the late August/early September period.

Sturgeon

Sturgeon of the Pacific are large, long-lived anadromous bottom-feeding fish that spend most of their time in marine environments. Relatively little is known about these species.

Green sturgeon is a provincially and federally -listed species ("red-listed" and "Special Concern"), known to occur in small numbers in the lower Skeena (marine environment), although spawning (locations, timing, etc.) are as yet unknown in Canada (BC Conservation Data Centre 2018). They appear to primarily inhabit coastal waters and estuaries. Green sturgeon are most typically (but rarely) observed in river mouths/estuaries in August and September, and spawning is thought to occur in spring (May-June), with the presumption that adults move into riverine environments throughout the fall and winter months. Juveniles spend 1-4 years in freshwater before their first migration to the ocean, moving progressively into more saline environments over time, and juveniles are most frequently found in overflow channels, low flow habitats and in estuaries[5]. It is possible that this species was present in the area during the suspected pesticide application in 2017.

White sturgeon is a federally "Endangered" species that has been reported in the Skeena River; although the most recent COSEWIC report (2003) for this species indicates that records of white sturgeon in the Skeena are, in fact, green sturgeon. Nevertheless, the species remains included in the BC Ministry of Environment's online fisheries database (BC MoE FIDQ 2018) for the Skeena River, with a 1994 record (near the river mouth southeast of Port Edward, just upstream of Inverness Passage), adding a level of uncertainty around this species. Notwithstanding this record and other unsubstantiated reports of this species in the Skeena, it appears unlikely that white sturgeon would have been present in the lower Skeena during the late August/early September period.

"Coarse Fish": Cod, Herring, Lamprey, Minnow, Sculpin, Stickleback, Sucker and Whitefish

"Coarse" fish refers to a loose grouping of fishes that have limited or no current commercial or recreational value. Most of those species, in the lower Skeena watershed, are year-round residents, and all contribute to the healthy functioning of the aquatic ecosystem: Each plays a role in nutrient cycling, competition, predator-

[5] Nakamoto et al. 1995, cited in COSEWIC 2004.

prey dynamics, etc., and each moves through the food chain (both aquatic and terrestrial).

Burbot is the only freshwater species of Canadian cod. It spawns under ice, generally from January to March. Burbot are typically lake residents, but some (more typically northern) populations inhabit large, cool rivers. Burbot are mainly known from lakes upriver (e.g. Smithers area), and it is, therefore, unlikely that burbot were present in the river or tributaries during the suspected time of spraying.

American shad is an anadromous species, introduced to the west coast from the Atlantic in the 19th century. In Canada, the species moves upriver to spawn during spring, and as late as July. Eggs hatch rapidly (within two weeks), and fry remain in their natal river for the summer, drifting to the sea by fall. There are no recent records of this species in the Skeena (Gottesfeld and Rabnett 2007). It is therefore unlikely that this introduced species was present in the area during the time of suspected herbicide application.

Lamprey are year-round residents of the lower Skeena River and many of its tributaries. The Pacific and river lamprey are anadromous, while the western brook lamprey is non-anadromous, remaining in the coastal reaches of freshwater streams throughout its life cycle. All are spring spawners, but spawning migrations may begin for the anadromous species as early as July (Scott and Crossman 1973). Any or all of the three lamprey species may have been present during the late summer period.

Chub, dace, pikeminnow and shiners are all "minnows," a group of resident freshwater species:

- Lake chub is an upriver species and are not thought to be present in the lower Skeena.
- Longnose dace is a benthic species characteristic of clear, swift streams, as well as gravelly or bouldery lakes, and occurs year-round throughout the Skeena watershed: it may have been present within the area during the suspected herbicide application.
- Northern pikeminnow occurs throughout the Skeena system, but is most typical of lake habitat (spawning on lakeshores or a short distance up a tributary stream) and is not expected to have been present in the area of the suspected herbicide application.
- Northern redbelly dace is a species of lakes, quiet creeks and ponds with fine substrates. Although an old (1985) record occurs in the Skeena watershed, it is likely erroneous as this species' distribution does not include the Skeena (Klinkenberg (ed.) 2018, Scott and Crossman 1973).

- Peamouth chub occur throughout the Skeena watershed, often schooling in vegetated shallows of lake and river habitat, and tolerant of brackish waters. This species may have been present in the area during the suspected herbicide application.
- Redside shiner is a variable species of large lakes, small ponds, and fast streams, and migrates to spawn in streams or lakes during late spring or summer; it is possible that this species was present in the area during the suspected herbicide application.

Coastrange, prickly and slimy sculpin are species of stream, river and lake habitats of the Skeena drainage. They are spring spawners and year-round residents. Although the species is widespread in BC, the Cultis Lake population of coastrange sculpin is confined and listed under the federal *Species at Risk Act* (SARA)'s Schedule 1 as Threatened and is Red-listed provincially: the Skeena population is not considered to be at risk. Any or all of these sculpin species may have been present during the suspected herbicide application.

Threespine stickleback is a small species of lakes, rivers and streams in coastal BC, and is present throughout the Skeena watershed; this species may be anadromous or resident, spawning in shallow freshwater during summer months. This species is also tolerant of brackish water. Its presence is possible throughout the area thought to be impacted during the suspected herbicide application.

Three species of sucker (largescale, longnose and white) are benthic resident species of streams and lakes of the lower Skeena. All three species are spring spawners of streams (or sometimes lakeshores); any or all of the species may have been present during the suspected pesticide application.

Mountain whitefish are bottom-feeding residents of lakes and rivers, occurring throughout the Skeena system, and mainly spawning in tributary streams during the late fall. As year-round residents, their presence is expected in the area during the late August/early September period. Pygmy whitefish is also a benthic species, preferring deep water lake habitat, and possibly spawning during late fall/early winter in shallow waters of streams or lakes. It appears unlikely that pygmy whitefish were present in the area thought to be affected by the suspected herbicide application.

Summary

Table 3 summarizes the fish species/life stages that were potentially present in the affected area of the Skeena River watershed during the time of suspected pesticide application (late August/early September 2017).

Table 3. Fish species & life stages potentially present during late August period.

Species Group	Species (English)	Species Code	Species of Concern?	Lifestage(s) Potentially Present During Application: Egg	Juvenile	Adult
Lamprey	Pacific Lamprey	PL	-	N	Y	Y
Lamprey	River Lamprey	RL	-	N	Y	Y
Lamprey	Western Brook Lamprey	BL	-	N	Y	Y
Minnow	Longnose Dace	LNC	-	N	Y	Y
Minnow	Peamouth Chub	PCC	-	N	Y	Y
Minnow	Redside Shiner	RSC	-	N	Y	Y
Salmonid	Bull Trout	BT	SARA Schedule 1: Special Concern; Blue-listed provincially	N	Y	Y
Salmonid	Chinook Salmon	CH	-	N	Y	Y
Salmonid	Chum Salmon	CM	-	Y	N	Y
Salmonid	Coho Salmon	CO	-	N	Y	Y
Salmonid	Cutthroat Trout (Coastal subspecies)	CT (CCT)	Coastal subspecies is Blue-listed provincially	N	Y	Y
Salmonid	Cutthroat/ Rainbow trout cross	CRS	-	N	Y	Y
Salmonid	Dolly Varden	DV	-	N	Y	Y
Salmonid	Pink Salmon	PK	-	Y	N	Y
Salmonid	Rainbow Trout	RB	-	N	Y	Y
Salmonid	Sockeye Salmon	SO	-	N	Y	Y
Salmonid	Steelhead	ST	-	N	Y	Y
Sculpin	Coastrange Sculpin	CAL	-	N	Y	Y
Sculpin	Prickly Sculpin	CAS	-	N	Y	Y

Species Group	Species (English)	Species Code	Species of Concern?	Lifestage(s) Potentially Present During Application: Egg	Juvenile	Adult
Sculpin	Slimy Sculpin	CCG	-	N	Y	Y
Smelt	Eulachon	EU	SARA Schedule 1: Special Concern; Blue-listed provincially; BC Identified Wildlife	N	Y	Y
Smelt	Longfin Smelt	LSM	-	N	Y	Y
Stickleback	Threespine Stickleback	TSB	-	Y	Y	Y
Sturgeon	Green Sturgeon	GSG	SARA Schedule 1: Special Concern; Red-listed provincially	N	Y	Y
Sucker	Largescale Sucker	CSU	-	N	Y	Y
Sucker	Longnose Sucker	LSU	-	N	Y	Y
Sucker	White Sucker	WSU	-	N	Y	Y
Whitefish	Mountain Whitefish	MW	-	N	Y	Y

- Adults of all five species of Pacific salmon may be present in lower Skeena at this time.
- Juvenile coho and chinook salmon and steelhead are present in the important rearing habitat of the lower Skeena and tributaries year-round.
- Adult and juvenile rainbow and cutthroat trout are resident species, using the high value rearing habitat of the lower Skeena and its tributaries year-round.
- The lower Skeena and its tributaries provide important habitat for large numbers of juvenile steelhead during the late summer period.
- Although eulachon adults were not in freshwater during the suspected application, it is possible that they were present in the estuary or near-shore environment of

the lower Skeena River. Juvenile eulachon were likely to have been present in the estuarine area.

- Longfin smelt adults may have been using the lower river and estuary at the time of suspected application.

- Green sturgeon adults may have been in the river mouth or estuary at the time of suspected herbicide application, and juveniles—which remain in freshwater for up to four years—may have been present in low flow backchannels, tributaries, and estuarine habitat during that time.

- "Coarse fish" of the Skeena (described specifically above) are year-round residents and were undoubtedly present during the suspected application. These fishes—many of which are bottom-feeders—are an important part of the region's food web.

Reduced Risk Timing Windows

BC's Ministry of Environment (MoE) provides "reduced risk" timing windows for a selection of fish and wildlife species (originally produced by the former BC Ministry of Water, Land and Air Protection's ("MWLAP") Skeena Region (2005)). These reduced risk windows represent the annual period within which "works" in the regions (broken down by Forest District, "FD") are least likely to affect what are generally considered the most sensitive life stages (i.e. spawning, incubation and fry emergence periods) for that species. Table 4 provides the reduced risk windows for the coastal ("North Coast FD") and interior ("Kalum FD") portions of the lower Skeena which are the subject of this report (with colour-coding to emphasize whether the timing of the suspected application occurred outside—red—or near the edge—orange—of the reduced risk period). Do note, however, that some species identified in Table 4 were not likely present in the area during the suspected herbicide application (e.g. kokanee salmon, white sturgeon). Although this information is presented as an important component of the risk analysis, the reader is strongly cautioned that, with respect to pesticide-related impacts, these life stages may not, in fact, be the only sensitive stages in a species' life history.

Table 4. MoE Reduced Risk Work Windows for the lower Skeena.

Species (English)	Species (Latin)	Species Code	Reduced Risk Window: Kalum FD		Reduced Risk Window: North Coast FD	
Chinook salmon	*Oncorhynchus tshawytscha*	CH	June 1	July 15	June 1	July 15
Coho salmon	*Oncorhynchus kisutch*	CO	June 15	September 1	June 15	August 31
Pink salmon	*Oncorhynchus gorbuscha*	PK	May 15	August 1	May 15	August 1

Species (English)	Species (Latin)	Species Code	Reduced Risk Window: Kalum FD		Reduced Risk Window: North Coast FD	
Chum salmon	*Oncorhynchus keta*	CM	May 15	July 10	May 15	July 15
Sockeye salmon	*Oncorhynchus nerka*	SO	June 1	July 20	June 15	July 31
Kokanee	*Oncorhynchus nerka*	KO	June 15	August 15	June 15	July 31
Steelhead	*Oncorhynchus mykiss*	ST	August 15	January 31	August 1	December 31
Rainbow trout	*Oncorhynchus mykiss*	RB	August 1	January 31	August 15	January 31
Cutthroat trout	*Oncorhynchus clarki*	CT	August 1	January 31	August 15	December 31
Dolly Varden char	*Salvelinus malma*	DV	June 1	August 31	June 15	August 31
Bull trout	*Salvelinus confluentus*	BT	June 1	August 31	-	-
White sturgeon	*Acipenser transmontanus*	WSG	June 1	September 15	-	-
Green sturgeon	*Acipenser medirostris*	GSG	none	none	none	none
Eulachon (candlefish)	*Thaleichthys pacificus*	EU	June 15	February 15	June 15	February 15
Coastal Tailed Frog	*Ascaphus trueii*	ASTR	none	none	none	none

5.5 Laboratory Testing Results

On October 14 and 15, samples of foliage were collected from six species and a total six sites (within five meters of a waterbody) where both appearance and odour indicated likely presence of herbicide (details provided in Appendix A). Given a limited budget and a lack of baseline information on species differences in longer-term retention of glyphosate and its degraded products, just four foliar samples collected from four species on four separate waterbodies were submitted to CARO laboratories in Richmond, BC, and were tested for glyphosate, AMPA and glufosinate. As stated, all collected samples suggested through appearance and odour that they had been sprayed with glyphosate: As little information is available on this subject, the choice of samples submitted for testing was made, in part, to help determine species differences in detectability of glyphosate over time. Of the submitted samples, two returned positive detections of glyphosate:

Shames River (watershed code 400-157500-): red-osier dogwood (*Cornus stolonifera*) leaves collected over-stream on the downstream right bank side of the railway bridge—Result: glyphosate present at 2.66µg/g fresh weight.

Igneous Creek (watershed code 400-049200-): red alder (*Alnus rubra*) leaves collected over the watercourse on the upstream left bank side of the railway bridge —Result: glyphosate present at 0.021µg/g fresh weight.

The two submitted samples for which glyphosate, AMPA and glufosinate were not within detectable limits (0.005, 0.1, and 0.005 µg/g wet weight for each of the three chemicals, respectively) were salmonberry (*Rubus spectabilis*) leaves collected at Marigonish Creek (watershed code 400-032600-), and deer fern (*Blechnum spicant*) fronds collected adjacent to the Port Edward boat launch. Note again that the samples were collected approximately 6+ weeks following the suspected date of pesticide application: We speculate that it is possible that the foliage of these species may not retain glyphosate as effectively over time as other sampled species, and that lack of detectable glyphosate in these two samples does not necessarily indicate a lack thereof.

Details of species and locations sampled—and results of laboratory testing, where applicable—are provided in Appendix A. Original Chain of Custody and official results from CARO Analytical Services (Richmond) are provided as attachments to this document (Attachment 1, Chain of Custody; Attachment 3, CARO Results Report).

6. Conclusions

A herbicide application appears to have occurred along much of the CN right-of-way between Terrace and Prince Rupert, BC, during the late August or early September 2017 period. The suspected application includes many areas within the minimum 2m/5m pesticide free zones required for glyphosate-based pesticides adjacent to waters that are fish-bearing or flow into such waters. Evidence to support this conclusion includes appearance and odour of the vegetation, as well as positive confirmation of the presence of glyphosate in two foliar samples that were collected in October 2017 from vegetation growing over fish-bearing streams (submitted to an independent laboratory for analysis).

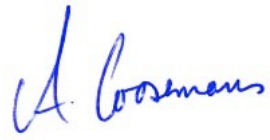
Lower tributary stream reaches and side channels in the lower Skeena are exceptionally rich and important habitats for salmonids, and support rearing, resident and migrating salmon, trout and char—as well as many other species—during the late summer period when this suspected herbicide application is thought to have occurred. Virtually all waters associated with CN's Skeena Sub are either fish-bearing or flow directly into fish-bearing reaches. Furthermore, important salmon spawning grounds are located in side channels of the Skeena River—in some

cases directly adjacent the tracks—and pesticide spray in these areas had the potential to affect sensitive life stages (e.g. eggs). Although our focus is often around the sensitive spawning/egg stages for many fish, it is possible that rearing fish may be equally or more vulnerable to the effects of pesticide, as they are in feeding and growth mode, and also contribute substantially to the ecosystem as food for other fish and wildlife species. In that vein, "coarse fish" should be considered as "important" subjects within this investigation, as they may be a significant part of the diet of many fish and wildlife species; additionally, many are "bottom-feeders," and may thus be more affected by herbicide-related chemicals that become bound-up in sediment.

Specific to habitat quality, the loss of riparian and in-stream vegetation—and the cover and nutrients that such vegetation provides—results in a degraded fish habitat. Vegetation stabilizes soils and runoff, provides shade to wetlands and waterbodies, provides areas of protection from predators, and provides nutrition through leaf litter fall and associated insects. As such, damage or destruction of riparian and in-stream vegetation through use of pesticides may be prohibited under Section 35 of Canada's federal *Fisheries Act*[6], as such vegetation is an integral part of fish habitat.

Thank you for the opportunity to work with you on this project. If you have any questions or concerns, please don't hesitate to contact me.

Kind regards,



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[6] 35(1) states: "No person shall carry on any work, undertaking or activity that results in serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery." "Serious harm to fish" is defined as: "the death of fish or the permanent alteration to, or destruction of, fish habitat," with fish habitat defined as "spawning grounds and any other areas, including nursery, rearing, food supply and migration areas, on which fish depend directly or indirectly in order to carry out their life processes."

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Appendix A: Foliar Sampling

Table A-1. Details of sampled foliage.

Sample	Collection Date	Sample Location (general)	UTM Coordinate of sample	Species	Estimated Foliar Sample Weight (wet)	Submitted to Lab?	Lab Result (Glyphosate)
CN01 Shames		Shames River: 0 to 2m over stream channel		Red osier dogwood	100g	Y	**+ (2.66µg/g)**
CN02-1 Aberdeen		3.5 to 5m from normal HWM		Red alder	75g	N	(Not submitted)
CN02-2 Aberdeen		3.5 to 5m from normal HWM		Spruce	75g	N	(Not submitted)
CN03 Boat launch		<3m from normal HWM		Deer fern	400g	Y	Not detected
CN04 Snow		Snow Creek: over stream channel		Red alder	100g	N	
CN05-1 Igneous		Igneous Creek: <4m from HWM on right bank		Western redcedar	150g	N	(Not submitted)
CN05-1 Igneous		Igneous Creek: 0 to 3m over stream channel		Red alder	150g	Y	**+ (0.21µg/g)**
CN06 Marigonish		Over Marigonish Creek tidal wetland, 2.5 to 4m from creek edge		Salmonberry	150g	Y	Not detected