Habitat Connectivity and Restoration Potential Assessment of Deer Lake Brook in Burnaby, BC

Review of the Connection Between Two Western painted turtle Occupied Sites in an Urban Environment

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Prepared by

Aimee Mitchell and Deanna MacTavish

of the

The South Coast Western Painted Turtle Recovery Project

For

Kym Welstead, Ministry of Environment, Surrey, BC

and

Joanne Neilson, BC Conservation Foundation, Surrey, BC

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1.0 INTRODUCTION

Burnaby Lake and Deer Lake are two municipal lakes within the Brunette Watershed in the Vancouver Metropolitan Area. They are connected by Deer Lake Brook, an approximate 1km stretch of stream that flows from Deer Lake into Burnaby Lake. Deer Lake Brook is an important habitat corridor for many species, which utilize the area and its surroundings. The lakes support known populations of Western painted turtles, a species classified as Red-listed under the BC Wildlife Act and Endangered under the federal Species at Risk Act, and observations have been made of turtles in the brook at either end.

Due to the current Highway 1 expansion project, the restoration and enhancement of Deer Lake Brook should be evaluated as a potential enhancement project. This will not only improve the area for western painted turtles, but other species of concern that can be found in the area. The restoration of Deer Lake Brook fits within the overall goal of the Habitat Stewardship Program for Species at Risk, since it will contribute to the recovery of an endangered turtle species as well as further enhance the area, making it beneficial to the survival of other species that utilize this important habitat corridor.

2.0 AREA

2.1 Historical and Current Use

The Coast Salish First Nations have inhabited the Deer Lake and Burnaby Lake areas for thousands of years, and in their legends, Deer Lake was considered to be a mystical place (City of Burnaby, 2005a). The area was also important to First Nations as a site for harvesting cranberries, as well as hunting elk and other big game (Drew, 2006). First Nations traditional use of the area lasted up until the early 1900's and declined as European settlement of the area increased (Wolf, 2011).

Surveying by European settlers first occurred in 1859 by Robert Burnaby, who with a surveying team explored the area surrounding Burnaby Lake (Wolf, 1998). Use of the area increased in the 1860's and 1870's, as hunters were drawn to the abundant game in the area (City of Burnaby, 2011a). During the 1880's and 1890's, settlement of the Burnaby area increased, as it was located between New Westminster, the colonial capital, and Vancouver, the terminus and port city for the Canadian Pacific Railway (City of Burnaby, 2011a). The country's first electric tramline, constructed in 1891, was the result of increased traffic between New Westminster and Vancouver (Wolf, 1998). The tramline opened the Deer Lake area up to farming, particularly strawberry farming when a group of farmers established strawberry fields in the 1890's to serve the New Westminster and Vancouver markets (Wolf, 1998).

By the early 1900's families were leaving the colonial capital of New Westminster and building large estates and cottages on the shores of Deer Lake (Fig. 1); many of these houses are still standing today (City of Burnaby, 2011b). Hart House, located near the shores of Deer Lake, approximately 80m west of Deer Lake Brook was built in 1912, converted into a restaurant in 1988, and continues to function as a restaurant to this day (Hart House, 2012). In 1922, the Bateman family settled near the northeast bank of Deer Lake Book; their house was known as Elworth House (Wolf, 1998). The City of Burnaby acquired the house and surrounding 4 acres of lands in 1970 and construction of the Burnaby Lake Village Museum began the following year (Chow, 2011). In 1984, the museum site expanded to approximately 10 acres, and now spans both sides of the brook (Chow, 2011).

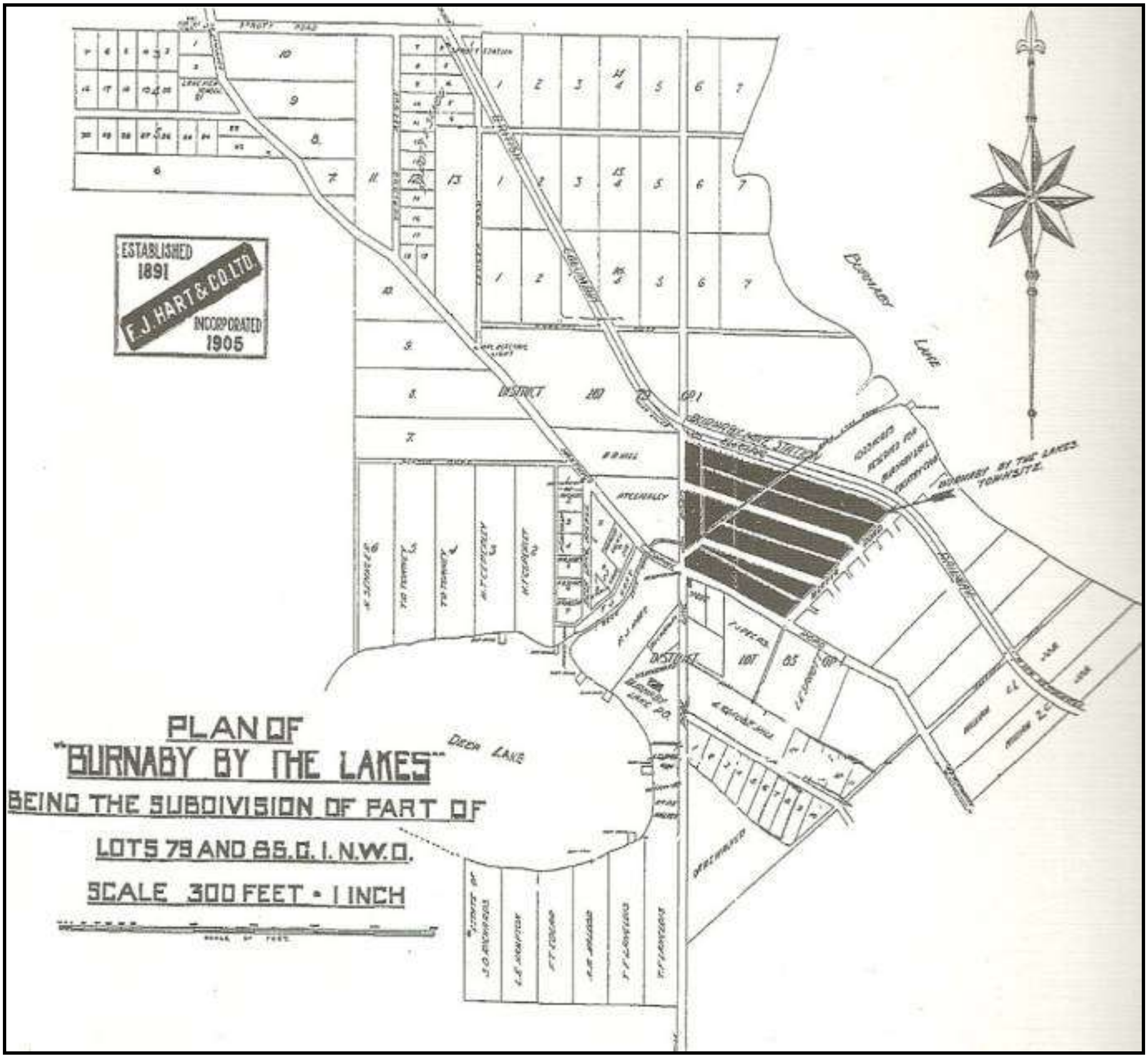

Figure 1: Map of the Deer Lake area, produced by F.J Hath & Co. in 1911, shows existing lots, owners of property, roads and Deer Lake Brook running between Deer Lake and Burnaby Lake (Wolf, 1998).

In the 1940's, planning for the Vancouver to Surrey section of the Trans-Canada Highway began (th.gov.bc.ca, 2000). Upon completion in the early 1960's, the highway consisted of two three-lane sections running past the south-west side of Burnaby Lake Regional Park (Fig. 2). Deer Lake Brook flows under the highway through a 110m long concrete culvert.

Figure 2: 1960's, the Trans-Canada Hwy. through Burnaby. Photo from BC Archives.

In early spring 2011, construction began on the Burnaby section of the Port Mann/Highway 1 Improvement Project (PMH1). As part of the project, the stretch of highway running through Burnaby will receive an extra lane in each direction (PMH1 Project, 2012). The section of land between the Trans-Canada highway and Glencarin Drive has been covered due to this expansion. As well, road upgrades and lane expansions will take place on the Kensington Ave. and Sprott St. overpasses in order to improve traffic flow. Included in the PMH1 are habitat enhancement projects, one of which is in the Kensington Interchange area (Fig. 3). Deer Lake Brook flows through the northeast quadrant of the Kensington area and work is being undertaken to enhance fish habitat in the brook by creating small ponds off the main water channel (PMH1 Project, 2012).

Figure 3: Habitat enhancement occurring near Deer Lake Brook at the Kensington Interchange as of Jan. 30, 2012. Photo by Deanna MacTavish.

2.2 Current Site Description

Deer Lake Brook represents the primary aquatic habitat that connects two western painted turtle occupied sites in the City of Burnaby in South Coast region of British Columbia (Fig. 4). Deer Lake is a moderate-sized urban lake and was once a popular swimming destination (VI, 2011). Other recreational activities, such as fishing, non-motorized boating and hiking/walking, are still very popular, resulting in the heavy use of this lake and surrounding parkland in the spring and summer. Parkland surrounds the entire lake as part of Deer Lake Park (including 5.6 km of walking paths); city buildings are situated on the north end within 100 m of the lake edge, and residential development is present on the east and southeast sides of the lake (City of Burnaby, 2011c).

Burnaby Lake Regional Park is located in the heart of the City of Burnaby and is one of the few remaining areas of significant ecological value within the Greater Vancouver area (ENKON, 2009). The lake is fed by several creeks including Still Creek, Deer Lake Brook, Ramsay Creek, and Eagle Creek. Deer Lake Brook serves as an aquatic connection to Deer Lake. Although the City of Burnaby has land tenure for the area, the park is jointly operated by the City of Burnaby and Metro Vancouver as a wildlife sanctuary. Burnaby Lake is a wetland ecosystem containing about 40 ha of open water and marsh habitat. This lake has a long history of human use. Early reports describe the lake as shallow and surrounded by expansive areas of wetland (ENKON, 2009).

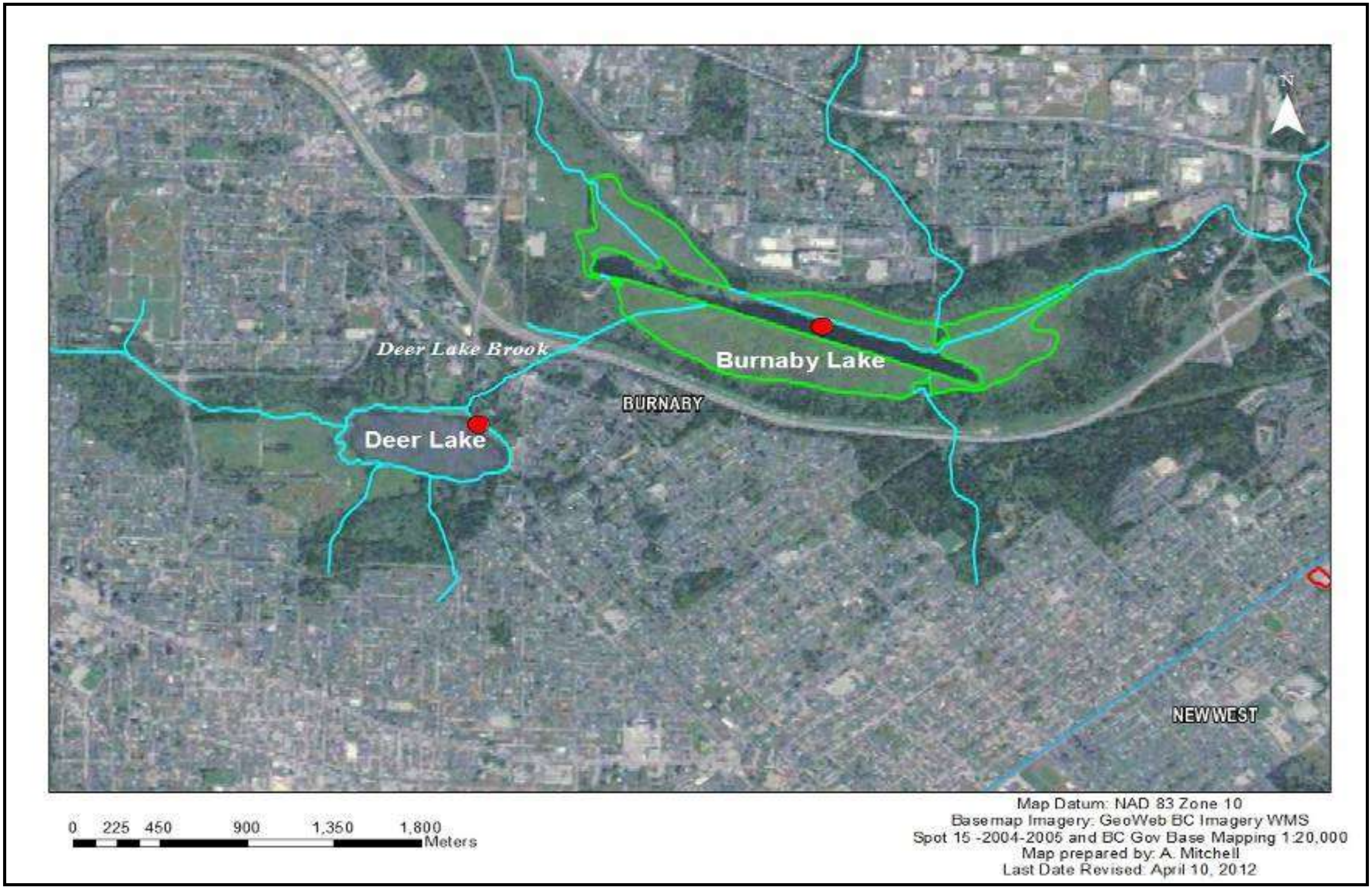

Figure 4: Current map of Deer Lake, Deer Lake Brook and Burnaby Lake in the City of Burnaby, BC. Red dots are western painted turtle Occurrences.

3.0 RESEARCH INFORMATION

3.1 Physical Data

3.1.1 Historical

The only available hydrometric data for Deer Lake Brook were collected from mid-June to September of 1965 (Fig. 5; Water Survey Canada, 2010). The average discharge of the brook at this time was approximately 0.065m^3/sec. Peak flows of 0.102m^3/sec occurred near the end of July and the minimum discharge occurred during late June at 0.042m^3/sec.

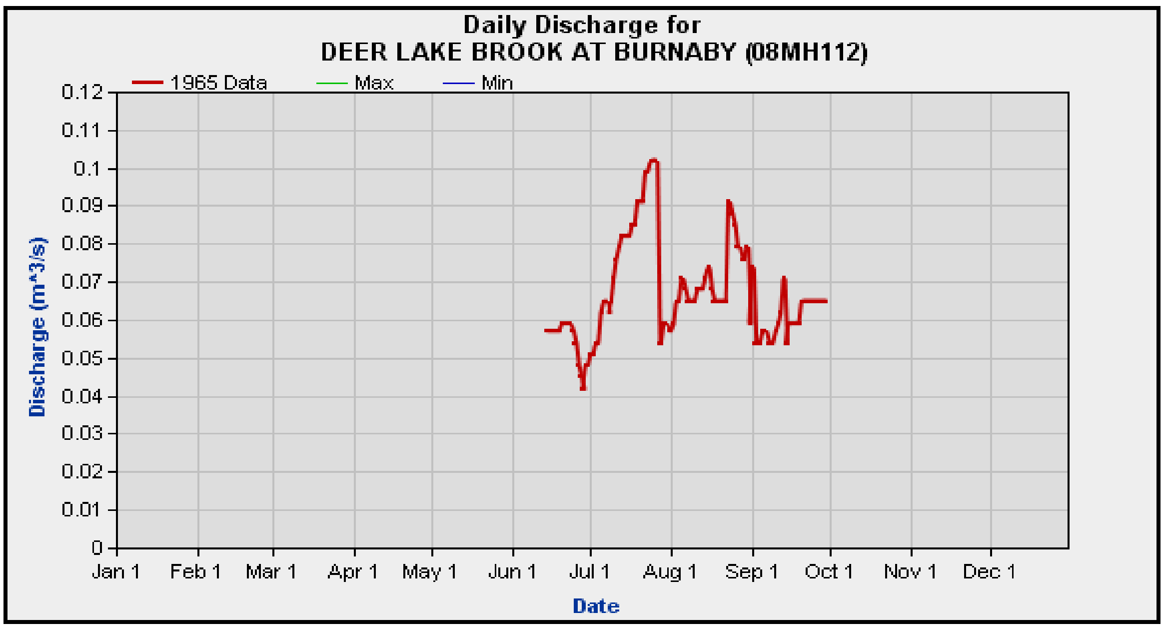

Figure 5: 1965 hydrometric data for Deer Lake Brook obtained from Water Survey Canada.

A stream assessment of Deer Lake Brook was conducted during late winter of 1995. The assessment was carried out by BC Institute of Technology (BCIT) students. The purpose of the assessment was to determine the suitability of Deer Lake Brook as fish habitat and to provide recommendations to increase fish usage of the brook (Bujold, 1995). For the study, the brook was divided into six reaches based on homogenous stream flow and form, and baseline data were gathered for each reach (Table 1).

Table 1: Summary of Reach Data for Deer Lake Brook as of February 2, 1995 (Bujold, 1995).

Stream Features	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6
Reach type	run	pool/run	riffle	Riffle	run	Run
Length (m)	260.7	156.0	224.1	292	46.2	93.9
Avg. channel width (m)	9.9	8.9	5.1	7.2	11.7	14.8
Avg. wetted width (m)	9.9	7.5	4.8	4.8	5.2	14.8
Avg. depth (m)	0.71	0.60	0.29	0.32	0.36	0.58
Gradient/100m (%)	2	3	6	8	9	1
Avg. velocity (m^3/s)	0.18	0.43	0.95	1.08	0.94	0.40
Avg. discharge (m^3/s)	0.88	0.96	0.94	1.08	1.24	0.51
Turbidity (m)	1.00	0.58	1.29	0.32	0.36	0.58
Cover (%)	75	75	30	70	55	40
Debris (%)	5	0	1	75	5	1
Side channels	21	12	0	0	0	25
Bed material (majority)	fines	Fines	gravels	gravels	gravels	fines
Water temp (°C)	6.5	6.5	6.5	6.5	6.0	6.0
pH	7.2	7.2	7.2	7.2	7.2	7.1
Conductivity (25°C)	123	131	123	123	130	130

The assessment determined that all six reaches provided varying suitable habitat for fish. While all the reaches provided habitat cover, reaches three to five had more suitable water velocity and substrate material for spawning, and reaches one, two, and six contained deeper pools and side channels with slower water velocities, making them better rearing habitat (Bujold, 1995). The high conductivity levels recorded in the study, which indicate high levels of dissolved minerals or ion levels, may be the product of leachates and runoff from the surrounding urban area (Bujold, 1995).

3.1.2 Recent

3.1.2.1 Baseline physical data

Baseline data were collected for all road crossings along Deer Lake Brook in the winter of 2012 (Table 2) in order to determine potential use of the brook as a wildlife corridor between Deer Lake and Burnaby Lake. GPS (Global

Positioning System) coordinates of the crossings (Fig. 6) were obtained in order to create an appropriate map of crossings along the brook. Vegetation cover, substrate and coarse woody debris data were also collected along the length of the brook and averages between crossings were recorded. Vegetation buffer data were also collected along the length of the brook on both sides of the stream bank and averages between crossings were recorded.

Table 2: Summary of road crossing data for Deer Lake Brook obtained on January 30, 2012.

	Crossing 1	Crossing 2	Crossing 3	Crossing 4	Crossing 5
Type (Material)	Brick	Concrete & metal	Concrete	Metal	Concrete
Number of openings	1	1	2	1	2
Shape	Bridge	Bridge	Circle	Rectangle	Rectangle
Length (m)	9	25	21	25	110
Width of opening (m)	7.5	2.5	1 & 1	3.5	2.5 & 2.5
Height of opening (m)	1.5	1.1	1 & 1	1.5	1.2 & 1
Light Visible	Yes	Yes	Yes	Yes	No
Barriers	Fence	Grate	No	No	No
Depth of Brook (cm)	25	30	32	45	52
Wetted Width (m)	5.5	6	3	4.5	6.5
Coarse Woody Debris	No	No	No	No	No
In-stream Vegetation	No	No	No	No	Bulrush sp.
In-stream Substrate (%)					
Boulders	10	5	5	-	-
Cobbles	25	45	35	20	-
Gravels	15	20	25	30	30
Fines	50	30	35	50	70
Riparian Cover (%)					
Red Alder	40	40	15	-	10

Western red cedar	15	10	5	-	-
Douglas fir	5	5	-	-	-
English Holly	trace	trace	-	-	-
Red-Osier Dogwood	-	-	30	10	5
Vine Maple	-	-	5	-	-
Willow ssp.			5	30	
Himalayan Blackberry	2	15	10	15	10
Sword Fern	5	-	-	-	-
English Ivy	2	20	10	5	-
Bulrush sp.	-	-	-	-	25

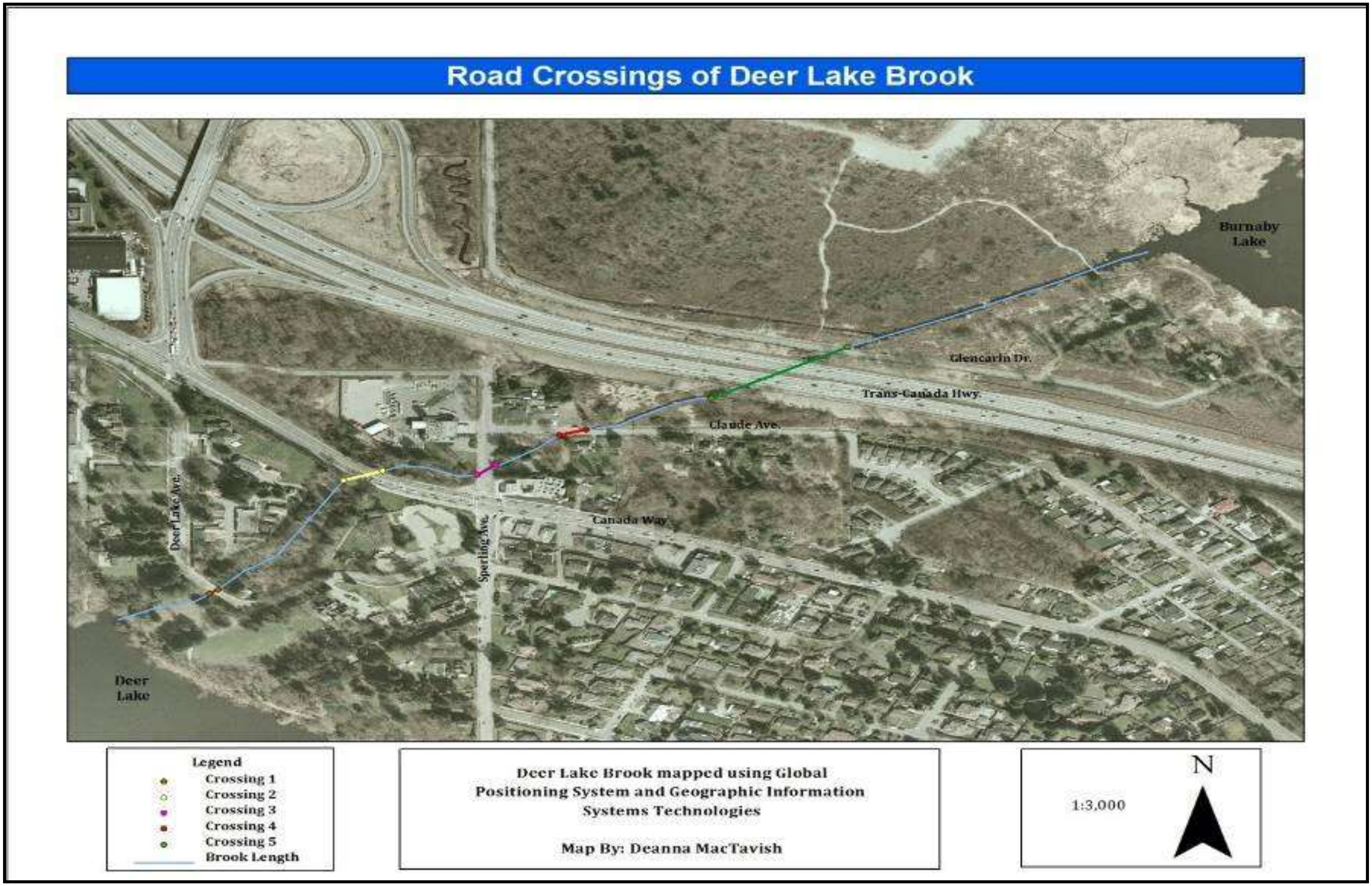

Figure 6: Road crossings over Deer Lake Brook from Deer Lake to Burnaby Lake. Mapped in 2012 using ArcMap.

3.1.2.2 Road crossings

The first roadway to cross Deer Lake Brook (Crossing 1) is a two-lane road known as Deer Lake Avenue. Deer Lake Ave. crosses over the brook via an 8m wide brick bridge (Fig. 7). A chain-link fence, which delineates the property line of the Burnaby Village Museum, straddles the brook on the downstream side of the bridge. This fence may hinder terrestrial species movements along the corridor and should potentially be removed. Crossing 2 (Fig. 8) is a large concrete culvert with a metal grate covering the upstream opening. The 25m long culvert runs under Canada Way, which is comprised of four traffic lanes. Light is visible from this end of the culvert. The metal grate on the culvert does not allow mid to large sized species to pass through and would prevent these species from using the culvert as a corridor.

Figure 7: Crossing 1 over Deer Lake Brook. Photo by Deanna MacTavish.

Figure 8: Crossing 2 over Deer Lake Brook. Photo by Deanna MacTavish.

Crossing 3 (Fig. 9) includes two side-by-side 1m concrete culverts. The 21m long culverts run underneath Sperling Avenue, which is comprised of two traffic lanes. While still having light visibility, the narrow diameter and length of these culverts may discourage their use by organisms using the brook as a corridor. Crossing 4 (Fig. 10) is a 25m long, large metal culvert running underneath Claude Avenue, which is two traffic lanes wide. The large size of the culvert allows light to be visible from both ends and allows passage for organisms of all sizes.

Figure 9: Crossing 3 over Deer Lake Brook. Photo by Deanna MacTavish.

Figure 10: Crossing 4 along Deer Lake Brook. Photo by Deanna MacTavish.

Crossing 5 (Fig. 11) is comprised of two side-by-side rectangular concrete culverts which are approximately 110m in width. The culverts pass underneath the eight-lane wide Trans-Canada Highway as well as the two-lane wide Glencarin Drive. Light is not visible at the ends of these culverts and their extreme length may discourage their use by species using the brook as a corridor.

Figure 11: Crossing 5 along Deer Lake Brook. Photo by Deanna MacTavish.

3.1.2.3 Vegetation cover, substrate and coarse woody debris

Vegetation overhanging the brook from its head to Crossing 1 was primarily red alder (*Alnus rubra*) and in-stream substrate was comprised mainly of fine sediment. Vegetation buffer data were collected from the head of the river to Crossing 1. The average buffer width on river right was 2m and the average buffer width of river left was 6m. No coarse woody debris was observed from the head of the brook to Crossing 1.

Vegetation overhanging the section of stream between Crossing 1 and 2 was primarily comprised of red alder (*Alnus rubra*) and substrate was mainly cobbles and fines. The average vegetation buffer width on river right was 3.5m and the average on river left was approximately 5m. No coarse woody debris was observed between Crossing 1 and Crossing 2.

Vegetation overhanging the section of stream between Crossing 2 and 3 mainly consisted of red-osier dogwood *(Cornus stolonifera) and* in-stream substrate was a mix of cobbles, gravels and fines. The average vegetation buffer width on river right was approximately 10m and on river left was approximately 7.5m wide. In-stream coarse woody debris between Crossings 2 and 3 was not observed.

Figure 12: Wooden beams and embankments along Deer Lake Brook between Crossings 3 and 4. Photo by Deanna MacTavish.

Overhanging vegetation between Crossings 3 and 4 was primarily composed of willow spp. (*Salix* spp.) and in-stream substrate consisted mainly of fines and gravels. The vegetation buffer on river right was approximately 3m wide and on river left was approximately 2.5m wide. No coarse woody debris was observed within the brook from Crossing 3 to 4. The stretch of stream between Crossings 3 and 4 is heavily channelized and both banks of the Brook are completely covered in metal and wood (Fig. 12). Large wooden beams, in three meter intervals, also span the width of the brook beginning approximately 2m downstream of Crossing 3 and continue downstream for 75m. After 75m, the banks of the brook are covered in metal up to Crossing 4. The installation of the beams was most likely to prevent stream-bank erosion as the stream-banks on both sides of the brook are very steep. The wooden beams, as well as the metal and wooden embankments, appear to be in good condition. The relatively smooth wood and metal stream-banks, as well as the lack of in-stream debris may pose a threat to terrestrial and semi-aquatic species as they may have a difficult time climbing out of the brook.

Overhanging vegetation between Crossing 4 and 5 mainly consisted of bulrush sp. (*Scirpus* spp.). In-stream substrate between the two crossings was primarily fine sediment. Emergent vegetation was present within this section and consisted of bulrush sp. The vegetation buffer on river right of the brook was approximately 1.5m wide and on river left was approximately 2.5m wide. No coarse woody debris was present in this section

The section of the Deer Lake Brook from Glencarin Dr. to its mouth at Burnaby Lake was visually assessed from Glencarin Dr. Overhanging vegetation was primarily Himalayan Blackberry (*Rubus armeniacus*) and in-stream substrate consisted mainly of fine sediment. The vegetation buffer on river right and river left appeared to be approximately 3m on both sides. Minimal coarse woody debris was observed in this section. In total, the length of the brook from its head at Deer Lake to its mouth at Burnaby Lake is approximately 1080m.

3.2 Species Information

3.2.1 Western Painted Turtles

3.2.1.1 Range and Status

Populations of painted turtles (*Chrysemys picta*) can be found throughout the United States, with the northern extent of their range found across southern Canada. There are three subspecies of painted turtle found in Canada (as well as the US):

- the eastern painted turtle (*C. picta picta*) - found in the Maritimes to eastern Quebec,
- the midland painted turtle (*C. picta marginata*) - found from western Quebec to eastern Ontario,
- and the western painted turtle (*C. picta bellii*) – found in western Ontario, throughout the prairies and BC (Senneke, 2003).

The western painted turtle is the only native freshwater turtle still found in British Columbia (Poff, 2011). Observations of the other freshwater species of turtle believed to be native to BC, the western pond turtle (*Actinemys marmorata*), have not been made since the 1960s (Gregory and Campbell, 1984). Two subpopulations of the painted turtle exist in BC; the Intermountain-Rocky Mountain and the Pacific Coast population (COSEWIC, 2006). The coastal population currently occupies 71 known sites across the south coast of B.C., from the Lower Mainland/Fraser River Valley through parts of Vancouver Island, some Gulf Islands, and up through the Sunshine Coast as far north as Powell River (Western Painted Turtle Recovery Team, 2009; Mitchell et al., 2012). However, many of these sites, particularly in the Lower Mainland, have very small population sizes (less than 5 known individuals) and are at serious risk of extirpation (Mitchell et al., 2012). Currently, this population is federally Endangered and provincially Red-listed (COSEWIC, 2006). While efforts to study and enhance the coastal populations are underway, limited research currently exists on the turtles in this area.

3.2.1.2 Ecology

3.2.1.2.1 Habitat

Painted turtles inhabit shallow wetlands, ponds, lakes and slow-moving streams within forests and grasslands at low elevations (COSEWIC, 2006). Two terrestrial habitats, riparian areas and terrestrial corridors which connect wetlands, are particularly important to the western painted turtle (COSEWIC, 2006). Riparian areas are used by the turtles as basking sites and nesting habitat and they are known to use terrestrial corridors to move between lakes and ponds in search of mating opportunities, nesting sites and basking habitat (Blood and MacCartney, 1998). Suitable aquatic habitats have muddy substrates, emergent vegetation and plentiful basking sites (COSEWIC, 2006). The availability of basking sites (Fig. 13) is an important habitat feature as painted turtles are ectothermic and need to bask for several hours during the day in order to raise their body temperature and metabolic activity (Cadi and Joly, 2004).

Figure 13: Western painted turtle basking in Deer Lake Park. Photo by Deanna MacTavish.

3.2.1.2.2 Over-Wintering Behavior

There is little available information on the specific over-wintering behaviors of western painted turtles in coastal BC with most studies occurring in the US and central Canada. In these areas, western painted turtles have been found to hibernate during the winter months by lying on, or being partially submerged under, the mud of shallow lakes and ponds (Crocker et al., 2000). However, there has been a study ongoing for several years on the over wintering behavior of turtles on the Sechelt Peninsula, on the Sunshine Coast of BC. Preliminary results of this work have shown similar results as in other areas in terms the characteristics of overwintering sites, but it also showed that turtles will often choose the same spot every year and sometimes overwinter in groups (M. Evleyn, pers. comm., 2012). A study conducted in 2010 and 2011 in the Alaksen National Wildlife Area in Delta, BC also showed turtles prefer shallow areas of ponds and are capable of travelling over two kilometers through a network of aquatic habitat types from their summer foraging locations to a suitable overwinter site (Kilburn and Mitchell, 2011a) .The length of hibernation and time of emergence in the spring is generally determined to be dependent on water temperature (Crocker et al. 2000; MacCulloch and Secoy 1983b). As water temperatures fall below 4°C, the activity level of Western painted turtles decreases and cold-induced metabolic depression occurs as an ice layer forms on the surface of the lakes and ponds they inhabit (Crocker et al. 2000). MacCulloch and Secoy (1983) found that the threshold temperature for emergence was 9°C.

It has been documented that during mild winters, hibernation may not occur and the turtles remain active all winter. A Rhode Island study found that during a mild winter, (mean temp. 5.8°C) painted turtles did not bury in the substrate (Crocker et al, 2000). Although painted turtles are capable of surviving while buried in anoxic mud over winter, the study concluded that they will surface and breathe air when possible (Crocker et al, 2000). A recent study of western painted turtles in 2010 and 2011 in Burnaby Lake prior to dredging activities found that of the 32 turtles tagged in the study, all of them remained active during the winter months, moving into adjacent tributaries. However, this lack of over wintering behavior was also likely indicative of a mild winter (Moreau, 2010, V. Kilburn, pers. comm., 2010).

3.2.1.2.3 Reproduction

Turtles emerge from hibernation shortly after the ice cover melts and soon after that mating begins and continues throughout the summer (COSEWIC, 2006). Western painted turtle nesting can occur from late May to early July (V. Kilburn, pers. comm.., 2011). Females have been known to nest over 100m from water and prefer nesting areas on south-facing sandy areas with little to no vegetation (Marchand and Litvaitis 2004b, V. Kilburn pers. comm., 2009). In BC, it was found that the average clutch size for western painted turtles was 12 to 13 eggs and females likely nest once per year (MacCulloch and Secoy, 1983b). Hatchlings also overwinter, resisting freezing by super-cooling or tolerating the freezing, and emerge from their nests the following spring (COSEWIC, 2006, Mitchell, 1988). However, there are some anecdotal reports of hatchlings emerging in September, such as at Burnaby Lake in the Lower Mainland (Kilburn per. comm., 2010). Spring hatchling emergence is known to occur as early as mid-March on Vancouver Island (C. Engelstoft pers. comm.. 2010) and as late as the second week of June in the Lower Mainland (Killburn and Mitchell, 2010). A Saskatchewan study found that the survival rate of western painted turtle hatchlings ranged from 0-52% (MacCulloch and Secoy, 1983b).

3.2.1.2.4 Food

When painted turtles are young they tend toward carnivory and mainly feed on tadpoles, aquatic insects and other aquatic invertebrates. However, as they mature they may switch to larger prey such as frogs, or scavenge but also sometimes take on some of a herbivorous diet of aquatic vegetation (Bouchard and Bjorndal 2005, COSEWIC, 2006). Prey items are not always chosen on the basis of abundance, ease of capture and prey size appear to be the dominant factors for prey selection of western painted turtles (MacCulloch and Secoy, 1983a) and the composition of diets is often site-specific (i.e., what is available). Although they are known to be omnivorous, studies have shown that *C. p. bellii* exhibit a preference for live, aquatic prey items or carrion (MacCulloch and Secoy, 1983a) in the northern extent of their range.

3.2.1.2.5 Predators

Painted turtles are most vulnerable during the egg stage of their life cycle primarily because:

- eggs are easily dug up by predators,
- nests are predictably and conveniently located close linear landscape features such as roads and shorelines and
- predators of painted turtle eggs, such as raccoons, often travel along these linear features (COSEWIC, 2006).

Hatchlings and small juvenile painted turtles found along shorelines are often predated upon by bullfrogs (*Rana catesbeiana*) and semi-aquatic mustelids. Larger juvenile and adult painted turtles may fall prey to coyotes (*Canis latrans*) and North American river otters (*Lontra Canadensis*) (COSEWIC, 2006).

3.2.1.2.6 Movement

Waterway currents can cause painted turtle movement from one area to another. Turtles may be swept downstream a by spring current and even slow currents can cause turtle movements (MacCulloch and Secoy, 1983b). Painted turtles are also known to travel over-land. Female Western painted turtles have been known to seek out nesting sites 150m from water, and males are known to travel at distance in search of females (COSEWIC, 2006). Turtle movement between bodies of water may vary according to the distance between them (Bowne et al, 2006). A study conducted in 2006 found that in areas where ponds were isolated, turtle movement did not occur, but movement did occur when ponds were located within 1000m of each other (Bowne et al, 2006). Movement can also be caused by the disruption of aquatic habitats; such as draining of ponds or dredging of waterways. Several observations have been made in the Lower Mainland since 2009 with the increase in road development where turtles have been salvaged from creeks and ditches (K. Welstead, pers. comm., 2011, A. Mitchell pers. obs., 2011). Turtles may also travel extensively through connected aquatic habitats; ponds, sloughs, ditches and make some small overland movements in search of foraging opportunities and for overwinter locations (Killburn and Mitchell, 2010a)

3.2.1.3 Human Impacts

3.2.1.3.1 Habitat Loss

Land developments can affect the structure of turtle populations (Marchand and Litvaitis. 2004). These developments lead to a decrease in the amount of suitable turtle habitat and cause habitat fragmentation. Channelization of waterways and other alterations to turtle habitat may cause a reduction of available food, loss of habitat diversity (Bodie, 2001) and can also cause decreased recruitment leading to reduction or loss of the population (Marchand and Litvaitis. 2004).

3.2.1.3.2 Road Mortality

Road mortality is believed to contribute to large declines in western painted turtle populations (COSEWIC, 2006). Females especially are at risk from road mortality as they are known to travel over-land seeking suitable nesting habitat (Bowne, et al, 2006).   Males have also been known to travel at distance, mostly likely to seek out new mating opportunities (V. Kilburn, pers. comm., 2010) and thus are also at risk when crossing roads. Road construction along waterways can destroy nests and directly kill juveniles (Maltby, 2000). As well, predators of western painted turtles and their eggs, such as raccoons and coyotes are known to make use of linear features such as roads, leading to increased predation rates resulting in reduction of turtle populations (COSEWIC, 2006).

3.2.1.3.3 Introduced Species

3.2.1.3.3.1 Red-eared Slider

Figure 14: Red-eared slider basking at Deer Lake. Photo by Deanna MacTavish.

The red-eared slider (*Trachemys scripta elegans*) (Fig. 14) is an introduced pond turtle species that is widely distributed throughout the Fraser Valley. It is native to the eastern US, and are commonly sold in pet shops around the world. Red-eared sliders have been for sale in BC pet stores as early as the 1960's and their presence in BC lakes and ponds has been directly attributed to humans releasing their pets into the wild (Bunnell, 2005). Red-eared sliders are found in the same habitat as western painted turtles and there may be competition between these species for food and basking sites. It is also possible that these turtles could spread disease from captive populations to the western painted turtle (Royal BC Museum, 2011).

3.2.1.3.3.2 American Bullfrog

Figure 15: American bullfrog found during Burnaby Lake Bioblitz. Photo by Rob Evans-Bioblitz Researcher.

The American bullfrog (*Rana catesbeiana*) (Fig. 15) is an introduced aquatic frog that is found the throughout wetlands, ponds and lakes of Fraser Valley and Vancouver Island. Their native range is eastern North America and their presence in BC is likely due to people importing and releasing them in attempts to start commercial frog farms (Orchard, pers.comm., 2010). American bullfrogs are voracious predators and have been known to predate upon Western painted turtle hatchlings and young juveniles (Orchard, pers.comm .,2010, COSEWIC, 2006).

3.2.1.4 Turtle presence in Deer Lake Brook, Deer Lake and Burnaby Lake.

Several surveys and studies on western painted turtles have been conducted both in Deer Lake and Burnaby Lake. Observations during these works also included information regarding Deer Lake Brook, although very limited formal turtle surveying was conducted in the brook itself. Surveys conducted by BC Conservation Corps in 2007 confirmed the presence of at least one western painted turtle at Burnaby Lake but did not detect any painted turtles in Deer Lake in that year (Semproni and Ogilvie, 2007). However, a northern diamondback terrapin (*Malaclemys terrapin*) was conclusively identified in Deer Lake Brook as well as an unidentified turtle. Semproni and Ogilvie tentatively identified this turtle as a Chinese pond turtle (*Damonia reevesi*), although poor quality photos precluded surveyors from obtaining independent verification.

Through the South Coast Western Painted Recovery Project (SCWPRP), five occurrence surveys were conducted in Deer Lake and four surveys were completed at Burnaby Lake from 2009 to 2011 (Mitchell et al., 2012). During these surveys two and nine western painted turtles were observed at these sites, respectively. A diamondback terrapin was also observed in Burnaby Lake but across from the mouth of the brook, likely the same individual observed in the brook in 2007.

Figure 16: Injured Western painted turtle caught at Deer Lake in 2010. Photo by: Aimee Mitchell

The SCWPTRP have also completed nesting habitat restoration at Burnaby Lake and have recorded seven western painted turtles nesting at the east end of the lake near the Cariboo Dam. Nesting surveys of Deer Lake in 2011 did not yield any reports of nesting by the turtles in that lake. However, one female turtle was mauled and killed (likely by a dog) in the summer of 2010 (Mitchell et al. 2012). This turtles presence on land at this time of year indicates she was most likely looking for a nesting site. In addition, one western painted turtle female was opportunistically captured in 2010 at Deer Lake near the entrance to the brook that showed signs of being attacked (Fig. 16)(Kilburn and Mitchell, 2011b).

In 2009 and 2010, a radio-tracking study of over-wintering behavior of western painted turtles at Burnaby Lake was conducted at part of the Burnaby Lake Rejuvenation Project which involved dredging of potential critical turtle habitat (Kilburn pers. comm., 2010; Moreau, 2010). Through this project 32 turtles were radio-tagged and several turtles were observed basking and swimming in Deer Lake Brook (Moreau, 2010). However, exact movement data is not accessible due to the unavailability to date of a report on the project.

3.2.2. Other Species

Deer Lake Brook has been known to support small populations of fish species and at one time this brook was considered to be an important spawning stream for salmon (R. Gunn, pers. comm., 2012). Salmonid habitat restoration projects have been initiated in the brook, including the creation of pools and the addition of gravel substrate suitable for spawning (BLRNPMPD, 1996). The presence of the following fish species have been recorded in Deer Lake Brook:

- coho salmon (*Oncorhynchus kisutch*),
- cutthroat trout (*Oncorhynchus clarki*),
- prickly sculpin (*Cottus asper*),
- rainbow trout (*Oncorhynchus mykiss*),
- threespine stickleback (*Gasterosteus aculeatus*),

- brown bullhead (*Ameiurus nebulosus*) * introduced,
- common carp (*Cyprinus carpio*) *introduced, and
- yellow perch (*Perca flavescens*) *introduced (BLRNPMPD, 1996).

To encourage fishing in Deer Lake Park by area residents, Deer Lake is stocked on an annual basis with catchable-sized Coastal Cutthroat Trout and rainbow trout (Fisheries Stocking Report, 2012).

The Pacific water shrew (*Sorex bendirii*), a Red-listed species under the BC Wildlife Act and classified as endangered under the Species at Risk Act, has been known to inhabit waterways in the Brunette Watershed (Brunette Basin Watershed Plan, 2001). Riparian habitat, slow streams or edges of faster creeks and marshes with abundant shrubs, coarse woody debris and extensive canopy cover are important habitat features for the shrew (Lindgren, 2004). The shrew is semi-aquatic and consumes terrestrial and aquatic invertebrates in slow-moving creeks, wetlands and throughout the forest floor (Lindgren, 2004). The high density of roads, highways, and power lines in the Lower Mainland has created fragmented habitat patches, which may be too small to support a viable population of Pacific water shrew (Galindo-Leal and Runciman, 1994). Due to the amount of roadways along Deer Lake Brook, the lack of canopy cover and coarse woody debris, it is unlikely that the brook currently provides suitable habitat for the Pacific water shrew. Restoration of the Brook would provide important habitat features and provide the shrew with a suitable transportation corridor between Burnaby and Deer Lake. Due to recent salvages of shrews during road works (K. Welstead, pers. comm., 2011) it is quite possible shrews being displaced in other locations would also utilize Deer Lake Brook.

The red-listed Nooksack dace (*Rhinichthys cataractae* ssp.) has been known to inhabit waterways in Burnaby (www.burnaby.ca, 2011). Specifically, its presence has been documented in the Brunette River within the Brunette Basin Watershed (www.geog.ubc.ca, 2010). They are primarily found in small, cool, clean streams with gravel substrate and overhead cover (Roberge and Stanley, 2001). Nooksack dace lay their eggs in the upstream ends of riffles while juveniles often form schools in water 10-25cm in depth over muddy substrate (Roberge and Stanley, 2001). Deer Lake Brook would be an ideal habitat for the Nooksack dace, however the lack of overhead cover in some sections of the brook may limit their use of these parts of the brook.

The coastal cutthroat trout (*O. clarkii*) is a Blue-listed species under the BC Wildlife Act but is not listed under the federal Species at Risk Act. Coastal cutthroat trout typically inhabit streams, ponds and lakes along most of the coast of British Columbia (Costello and Rubidge 2004). During spawning season, females select gravel areas where substrate sizes range from 5 mm to 50 mm (Slaney and Roberts, 2005) In-stream coarse woody debris are important for juvenile and adult cutthroat as they provide protection during high water flow and cover from predation (Slaney and Roberts, 2005). Deer Lake Brook is potentially an ideal site for spawning of coastal cutthroat trout. However, it is unlikely that they currently use the brook due to the lack of coarse woody debris to provide cover from predation.

The presence of the northern red-legged frog (*Rana aurora*), a Blue-listed species under the BC Wildlife Act, and listed as special concern under the federal Species at Risk Act, was confirmed during the 2011 biodiversity survey of Burnaby Lake Regional Park (Ramey, 2011). The red-legged frog requires a variety of habitat types during its life history. Breeding occurs in wetland areas including ponds, lakes, and slow-moving streams with in-stream vegetation (Maxey, 2004). Egg masses are attached to the stalks of in-stream vegetation in quiet water with little to no flow (Richter and Azous, 1995). Adult frogs feed on land 90% of the time, mainly in riparian areas and prey items include slugs, spiders and insects (Maxey, 2004). There is evidence that red-legged frog presence is correlated with large amounts of coarse woody debris, indicating that coarse woody debris is an important habitat feature (Aubry and Hall 1991). This habitat feature is currently lacking along much of Deer Lake Brook. The swift current and lack of in-stream vegetation within the brook, make it unsuitable habitat for egg-laying by the red-legged frog. Restoration of the Brook may enhance the habitat suitability for red-legged frogs, thus further aiding in the conservation of these Blue-listed species.

The presence of the Yellow-listed western brook lamprey (*Lampetra richardsonii*) was confirmed during the 2010 biodiversity study of Burnaby Lake Regional Park (Ramey, 2011). At present there is little biological information on the western brook lamprey. What is known is that they typically inhabit clear, cool streams with gravel riffles (COSEWIC, 2010). Lamprey nests are typically found in sand or gravel substrate less that 2cm in diameter. (COSEWIC, 2010). They are typically found in streams where current velocity ranges from 0 to 0.7m/s and where depth of water is between 10 to 25cm (COSEWIC, 2010) In-stream substrate within most of Deer Lake Brook is ideal for lamprey nesting, however high water velocity occasionally experienced in the brook may make it unsuitable habitat for lampreys.

The Yellow-listed northwestern salamander (*Ambystoma gracile*) was found during the 2011 biodiversity study of Burnaby Lake Regional Park (Ramey, 2011). This species has a diverse life history which includes an aquatic and terrestrial component. The aquatic larvae are found in cold, slow-moving streams with structures for hiding (logs, boulders, undercut banks) and terrestrial adults are found in both mature and young forests adjacent to streams (Zevit, 2010). Deer Lake Brook would be an ideal site to find northwestern salamanders, however the lack of coarse woody debris may discourage this species from using the brook as a corridor.

4.0 DISCUSSION

More research is needed in order to better understand the biology of the coastal western painted turtle. This provincially Red-listed and federally Endangered species is susceptible to loss of habitat and human interference. As the only native freshwater turtle in the province, it is vital that we protect and enhance its populations. Actual population numbers of the coastal population are unknown and the numbers that are available have only been recently acquired. This current lack of biological information specific to coastal populations makes it difficult to make management decisions for the species. A better understanding of this species would ensure that populations of the coastal western painted turtle are appropriately managed for and protected during developments and during in-stream and lake activities. This would also provide opportunities to make further recommendations for enhancement during such works as part of compensation for any activities that are disruptive to turtle survival.

While Burnaby Lake has a known population of western painted turtles, they have also been observed within Deer Lake Brook and Deer Lake. The turtles appear to have a favorite basking log in Deer Lake Brook, and can be seen swimming and basking in the brook and along its shores (Moreau, 2010; Lau, 2010, Semproni and Oglivie,2007). As Deer Lake Brook is just over 1000m in length and connects Deer Lake to Burnaby Lake, it is likely that the turtles could use this brook to travel between the two lakes in search of new habitat (including overwintering sites), mates and nesting sites. The linkage between these two lakes is important as it provides turtles and other species that use them with increased mating opportunities, places to forage, and habitat options. Parts of the brook are heavily channelized and sections of it are covered by road crossings. As well, much of the area surrounding the brook is highly urbanized. Restoration of the brook, as well as the surrounding area to a more natural setting would increase its use as a habitat corridor between the two lakes and enhance the suitable habitat for western painted turtles and other species at risk.

Strong contrasting edges associated with fragmented habitat, as well as roads decreasing connectivity, may influence individual turtle behavior (Bowne, et al, 2006). If the movement ability of a species is restricted between fragmented habitats, inbreeding can occur and this may be disastrous for the species as genetic diversity will be lost (Bowne et al, 2006). This factor is of particular interest for the Deer Lake and Burnaby Lake populations of the western painted turtle. As travel between the two lakes may occur via Deer Lake Brook, any alteration to the brook that could cut off these two populations from each other may cause a decrease in genetic diversity for both populations. By restoring the brook, the potential for its use as a corridor may increase, further facilitating species movement between two urban lakes, thus enhancing the genetic diversity of the area.

5.0 RECOMMENDATIONS

- Further research on Western painted turtles in the Lower Mainland and Vancouver Island is needed in order to make knowledgeable management decisions for the species.
- Further monitoring of Deer Lake Brook is needed in order to fully assess its use as a turtle movement corridor between Deer Lake and Burnaby Lake.
- Education of the public regarding the Western painted turtle and other species at risk in the area.
- Educate the public on the dangers of releasing pet turtles into lakes and ponds in BC.
- Monitoring of crossings along Deer Lake Brook to provide information about species movements or lack of through the culverts. This could include the use of motion-sensing cameras located at the outlets of the culverts.
- Widening of the bars on the metal grate covering the upstream end of Crossing 2 in order to allow mid-large sized animals to cross underneath Canada Way.
- Removal of the chain-link fence surrounding the Burnaby Village Museum and replacing it with a fence that allows species to pass through in order to increase use of this part of the brook.
- Addition of coarse woody debris to the brook in order to create habitat for western painted turtles, coastal cutthroat trout, Pacific water shrew, red-legged frog, Nooksack dace and northwestern salamander.

- Addition of in-stream emergent vegetation within the brook to create habitat for western painted turtles, coastal cutthroat trout, Pacific water shrew, red-legged frog, Nooksack dace and northwestern salamander.
- Addition of open, sandy areas along parts of the brook to create new nesting habitats for female Western painted turtles.
- Gather current hydrologic data for the brook.
- Increase overhead cover along parts of the brook to improve habitat conditions for Pacific water shrew, red-legged frog, Nooksack dace and northwestern salamander.
- Increase vegetation buffer along parts of the brook in order to increase species use of the brook as a habitat corridor.
- Potential day-lighting of sections of the Trans-Canada Hwy. crossing to increase use of the brook. This may not be possible as it would be a huge undertaking requiring large amounts of money, time and labour.
- Reduce effects of channelization between Crossings 3 and 4 in order to increase species use of that section of the brook.
- To reduce western painted turtle road mortality, measures such as fencing off roads and creating culvert systems that include barriers/ walls should implemented.

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Personal Communications

C. Engelstoft. Research Biologist, Alula Biological Consulting. Victoria, BC. Email: cengelstoft@gmail.com

M. Evelyn. Research Biologist, the Sunshine Coast Wildlife Project and the Ruby Lake Lagoon Nature Reserve Society. Pender Harbour, BC. Email: mjevelyn@gmail.com

R. Gunn. Program Head – Fish, Wildlife and Recreation Program, BCIT, Burnaby, BC. Email: Robert_Gunn@bcit.ca.

V.Kilburn. Herpelogist, South Coast Western painted turtle Recovery Project. North Vancouver, BC. Email: vanessakilburn@gmail.com

S. Orchard. Conservation Biologist/Herptologist – President of Bullfrog Control Inc. Victoria, BC. Email: bullfrogcontrol@gmail.com

K. Welstead. Species at Risk Biologist, Ministry of Forests, Lands and Natural Resource Operations. North Vancouver, BC. Email: Kym.Welstead@gov.bc.ca