Western Painted Turtle Management Plan

For the City of Langford

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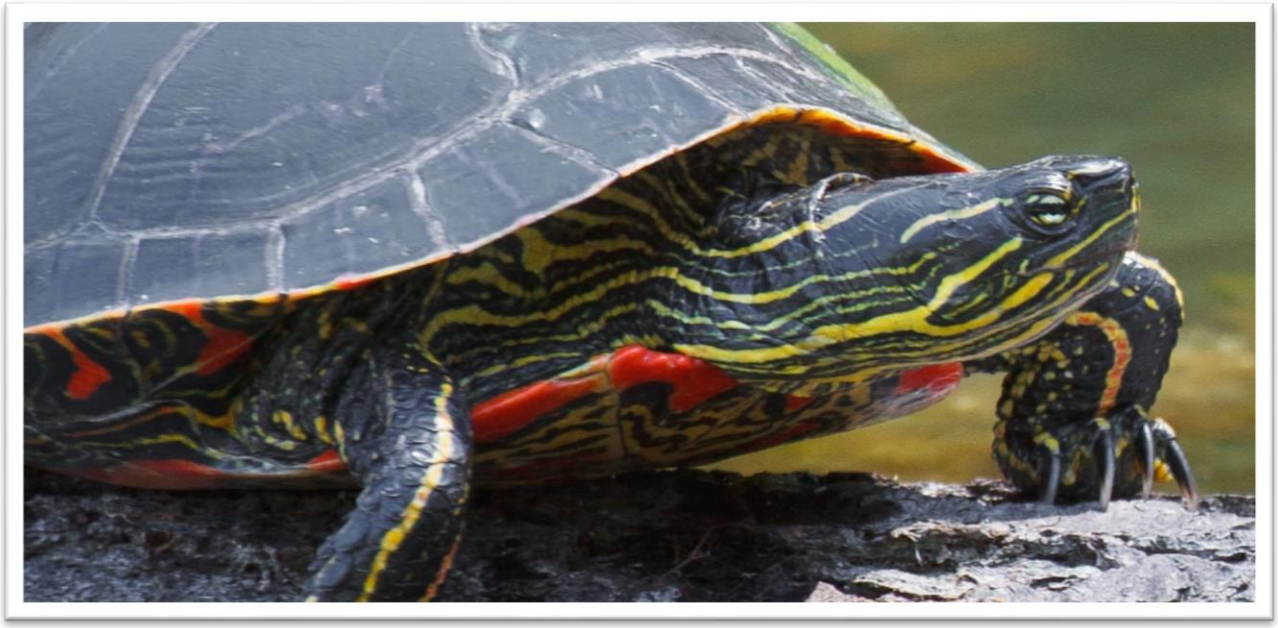

Photo courtesy Grace Brouwer

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Executive Summary

Western painted turtles (*Chrysemys picta bellii*) form an integral part of Southern Vancouver Island's ecology, and the Pacific Coast population is listed as endangered (red-listed) by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). They have been observed at Langford, Glen, and Florence Lakes in the City of Langford. Due to the residential growth surrounding these lakes, turtles have often been in contact with and sometimes interfered with by the public. On behalf of the City of Langford, WPT Ecological Consulting has worked to protect the turtles by developing a Western Painted Turtle Management Plan; providing recommendations specific to Glen, Langford, and Florence Lakes to improve turtle habitat; and creating a preliminary Communications Plan for the City of Langford to convey scientific information to the public and to promote behaviors that protect turtles.

Biodiversity encompasses the variation in genetics, species, or ecosystems within a specified geographical area. Protecting biodiversity is necessary to maintain healthy, resilient ecosystems in the face of changing environmental conditions. Ecosystem services are natural processes that benefit humans and include the regulation of climate and the provision of outdoor recreational activities, cultural heritage, and aspects of spirituality. Greater biodiversity tends to increase the net benefits provided by ecosystem processes. One service that the western painted turtles provide is the removal of phosphorus from lake nutrient cycles by incorporating it into their skeletons. Because turtles are long-lived, they effectively reduce the overall state of eutrophication of an impacted lake ecosystem such as Langford Lake. The protection and/or enhancement of suitable habitat for the western painted turtle will also enhance the biodiversity of Langford, Glen, and Florence Lakes.

To develop the Western Painted Turtle Management Plan, WPT Ecological Consulting has conducted literature reviews of the western painted turtle's life cycle and best management strategies for habitat creation and enhancement, and interviews with biologists who have experience with western painted turtles. Door-to-door interviews with Langford Lake residents provided valuable insight into the lake community's perspective of the turtles and anecdotal evidence of nesting locations.

Western painted turtles require suitable basking habitat to raise their body temperature for foraging and mating, as well as undisturbed nesting habitat on land within 150 metres from their aquatic habitat. It was found that there is limited nesting and basking habitat at all three lakes. The most significant western painted turtle population inhabits Langford Lake, where approximately 80% of the developed shoreline is lined with retaining walls that prevent shore access to potential nesting grounds.

Development and recreational use around Langford and Glen Lakes in particular create challenges for turtle proliferation. Therefore, WPT Ecological Consulting recommends the creation of nesting habitat along the western shore of Langford Lake north of the boat launch, and along the northwestern shore of Glen Lake north of the public beach. Additionally, basking habitat could be installed at strategic locations throughout Langford, Glen, and Florence Lakes. The creation of nesting sites and installation of basking logs could be monitored to establish their effectiveness. Additionally, the overall turtle populations in each lake could be continually monitored. Finally, we suggest the City of Langford could mandate an annual review of turtle conservation activities to ensure habitat enhancement and communication objectives are maintained.

Future projects could include an invasive species inventory and management plan investigating the effects of invasive animals such as the American bullfrog which preys on painted turtle hatchlings, and invasive plants which can alter soil chemistry and outcompete native plants. This will help enhance native ecological stability and establish healthy riparian zones surrounding the lakes. A habitat connectivity study looking at how turtles may migrate between aquatic habitats within the Langford environs would also enhance understanding of turtle populations and their movement.

A commitment from the City of Langford to protect western painted turtles through community engagement and habitat management communicates to residents and visitors the value the city places on environmental stewardship. As a quickly growing and developing city, it is important to be perceived as environmentally astute, and to be taking into account the potential effects that development has on local ecosystems. Western painted turtles have great local significance and are beloved by many southern Vancouver Islanders, and a Western Painted Turtle Management Plan is an excellent first step to ensuring their protection and long-term survival.

List of Acronyms and Abbreviations

cfu/mL – Colony forming units per millilitre

DO – Dissolved oxygen

GHG – Greenhouse gas

HAT – Habitat Acquisition Trust

OCP – Official Community Plan

TDSD – Temperature-dependent sex determination

TN – Total nitrogen

TP – Total phosphorus

TOC – Total organic carbon

UV – Ultraviolet

VIHA – Vancouver Island Health Authority

WPT – Western painted turtle

Glossary

Abiotic – the non-living chemical and physical attributes of the environment that affect living organisms and the functioning of ecosystems, for example, light, temperature, rocks, soil and pH (abiotic, 2008).

Aerator – a device that bubbles oxygen gas through a lake or body of water to increase the concentration of dissolved oxygen.

Anoxic – conditions which are lacking oxygen.

Bacteriological – of or relating to bacteriology or bacteria.

Bacteriology – the identification, study, and cultivation of bacteria.

Biodiversity – the number, variety, and genetic variation of different organisms found within a specified geographic region.

Biogeoclimatic zone – a geographic area with similar patterns of energy flow, vegetation and soils due to a similar climate (Ministry of Forests and Range, 2008).

Brumation – a period of winter dormancy during which metabolic activity slows down (Engelstoft & Ovaska, 2012).

Carapace – a bony or chitinous case or shield covering the back of an animal (carapace, 2015); the upper shell.

Cloaca – the posterior opening that serves as the only opening for the intestinal, reproductive, and urinary tracts of species such as turtles.

Ectotherm – an organism that is unable to maintain its own body temperature, instead relying on the external environment to either warm or cool it (Friedl, n.d.).

Eutrophic – excessive richness of nutrients in a lake or other body of water, frequently due to runoff from the land, which causes a dense growth of plant life, the decomposition of which causes death of animal life from lack of oxygen.

Eutrophication – the process by which a waterbody acquires high concentrations of nutrients (primarily phosphates and nitrates) which promote excessive algae growth. As the algae die and decompose, the water is depleted of available oxygen, causing the death of other organisms such as fish. Eutrophication is a natural, slow, aging process, but human activity can greatly increase its rate (Art, 1993).

Fecal coliform unit – bacteria that generally originate in the guts of warm-blooded animals, may include organisms that originate in feces or do not originate in feces, and may be used as an indicator of water quality.

Hypolimnion – the lower, colder layer of a stratified lake, existing below the thermocline and typically nutrient-rich and oxygen-limited.

Littoral – the zone near a lakeshore with rooted vegetation (littoral, 2015).

Mesotrophic – with regard to lakes, a lake in which the relative productivity is intermediate and has a medium level of nutrients.

Metapopulation – several population groups of one species that are spatially separated by natural or artificial boundaries.

Oligotrophic – with regard to lakes, a lake in which the primary productivity is low due to a low level of nutrients.

Plastron – the underbelly part of the shell of a turtle, typically consisting of nine symmetrically placed bones overlaid by horny plates (plastron, 2015).

Recruitment – additions to a population, either through birth or immigration (Townsend, Begon and Harper, 2008).

Secchi disk – a device used for measuring the depth to which light can reach. The disk is lowered into the water until it can no longer be seen, and that depth is measured as the depth to which light reaches.

Stratification – the separation of lakes by a thermocline, dividing the top into the epilimnion and the bottom into the hypolimnion.

Super-cooling – remaining unfrozen at temperatures below the equilibrium freezing point for their body fluids (Packard, Packard, Morjan, & Janzen, 2002).

Thermocline – a distinct layer in a lake or body of water in which there is a large change in temperature over depth.

Tragedy of the commons – a situation where individuals acting independently and rationally according to each's self-interest behave contrary to the best interests of the whole group by depleting some common resource (Hardin, 1968).

1. Introduction

The western painted turtle (*Chrysemys picta bellii*) has been identified at several lakes on Vancouver Island, including Langford, Glen, and Florence Lakes. In 2006, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) listed the coastal population of western painted turtles as endangered, or as a Red-Listed Species. Due to the residential growth surrounding the lakes in Langford, the turtles have often been in contact and sometimes interfered with by the public. To protect this species, WPT Ecological Consulting endeavored to research and observe the turtles and the persons living near or using the lakes, with the goal of creating management and communication plans.

1.1 Biodiversity and Ecosystem Processes

Biodiversity encompasses the number, variety, and genetic variation of different organisms found within a specified geographic region. Diversity at the genetic level is important as it represents the raw material for evolution and adaptation. In the face of changing environmental conditions, greater genetic diversity in a species or population means a greater likelihood that some individuals will be able to adapt to those changes (Hooper et al., 2005). Less diversity leads to uniformity, which is a problem in the long term, as it is unlikely that any individual in the population would be able to adapt to changing conditions.

Likewise, species diversity allows for greater resilience of the entire ecosystem in question. Maintaining a variety of species that respond differently to various environmental impacts can stabilize ecosystem processes in response to disturbances and changes in abiotic conditions (Hooper et al., 2005).

Ecosystem services are natural processes that provide benefit to humans, which can include producing renewable resources, delivering environmental benefits such as climate regulation, and providing cultural services, including outdoor recreation, cultural heritage, and spiritual aspects. Greater biodiversity tends to enhance the benefits provided by these services.

Western painted turtles provide a valuable environmental service in that they act as a nutrient ‘sink’ for long-term storage of the nutrient phosphorus. In an eutrophic lake, as a turtle consumes plant matter, a large proportion of phosphorus, a limiting nutrient, is incorporated into its skeleton rather than excreted as waste. As a long-lived species, turtles retain phosphorus from plant matter that would otherwise be consumed by aerobic microorganisms, which would consequently reduce the available dissolved oxygen required by gilled organisms (Sterrett, Maerz, & Katz, 2014).

Threats to biodiversity include introduction of invasive or non-native species, pollution, habitat destruction, overexploitation of resources, climate change, and human development and expansion. All of these threats interconnect, in that the harm caused to a single species or a small group of organisms will have cascading effects on the other organisms that make up that ecosystem (Rands et al., 2010). Diminished diversity will ultimately result in an overall decline in ecosystem health, and a reduction in benefits received from ecosystem services.

1.2 Conservation

The Pacific Coast population of Western painted turtles is designated as endangered by COSEWIC and has been listed in the federal Species at Risk Act (SARA). As a listed species, it is illegal for anyone to handle or cause harm to *C. picta bellii*. Species that have been assessed more than once by COSEWIC have generally not shown improvements in status, and research points to the lack of effective control measures put in place across Canada (Favaro et al., 2014). Given the role played by western painted turtles in lake ecosystems, the City of Langford is encouraged to take measures to ensure that the turtles are able to maintain a breeding population. To account for potential lake-specific disturbances, it is prudent to ensure that each lake covered in this study is evaluated for enhancements to support turtle nesting activity. This will support metapopulations of turtles and allow the species to remain resilient.

The lakes are subject to tragedy of the commons and as more and more development occurs in the watershed, the natural characteristics that maintain the quality of the lake are destroyed, and enjoyment is diminished. All parts of a watershed, including upland areas, are important components of the system that serves to regulate water quality and maintain a healthy aquatic environment. Wetlands are an essential part of watersheds for habitat variety and water level regulation, most notably as a buffer to flooding.

Effective management entails sustaining conservation measures over the long term, even if positive outcomes are not immediately observed (Favaro et al., 2014). It is of utmost importance that the City of Langford's ongoing management of the watersheds within city limits be regularly updated, and carried out continuously. Changes to environmental conditions and biotic factors in the watershed occur over all scales of time (annual, decadal, etc.), and an ideal approach to the management of human impacts must take this into consideration. The City of Langford can be effective regarding activities on watershed properties but less effective concerning activities in and on the lakes given that the lakes fall within provincial jurisdiction. New developments adjacent to watercourses must adhere to the *Riparian*

Areas Regulation and are obliged to retain a biologist who will conduct an investigation of sensitive ecosystems, as required by the British Columbia Ministry of Environment.

1.3 Metapopulations

A metapopulation is a group of populations that are separated spatially, consisting of the same species. For turtles, lakes are effectively islands, separating groups from one another that only interact when individuals travel from one lake to another. Metapopulations also include areas of suitable habitat that are unoccupied. Local extinctions may occur due to variable environmental conditions, though individuals travelling from a source population may rescue populations from extinction. Unoccupied areas also may be re-populated by individuals, as long as conditions are suitable.

The concept of metapopulations is critical in the consideration of species protection and habitat enhancement. While it is important to enhance conditions in areas where a species is present, nearby areas that may provide suitable alternative habitat must also be protected and enhanced. Multiple areas of suitable habitat will allow a species like the western painted turtle to survive any environmental or man-made stresses that may temporarily impact one of these lakes.

Langford Lake has a considerable population of western painted turtles, yet few individuals have been seen at Glen and Florence Lakes. We have found that there are very few suitable basking structures for turtles on Glen and Florence Lakes, and poor access to suitable nesting habitat.

2. Objectives

In order to help protect the population of western painted turtles in Langford, Glen, and Florence Lakes, WPT Ecological Consulting in conjunction with the City of Langford has several main objectives, including:

- Developing a Western Painted Turtle Management Plan for the City of Langford.
- Providing recommendations specific to Glen, Langford, and Florence Lake, respectively, to improve nesting locations and turtle habitat.
- Creating a Communications Plan for the City of Langford to communicate scientific information to the public and promote behaviours that protect turtles.

Our research questions include:

- Why are turtles important?
- How can residents change their behaviour and effectively reduce their impact on the turtles?
- What is the life cycle of the western painted turtle, and how should the City of Langford implement management strategies to successfully protect and enhance the turtle habitat and their year round activities in Langford, Glen, and Florence Lakes?
- How much knowledge does the local population have regarding the western painted turtle?
- What is their experience, if any, of interactions with the turtles?
- How can we best communicate with the Langford community about the importance of protecting the turtles?

3. Life Cycle

Understanding the lifecycle of western painted turtles is critical for managing the population and providing evidence to justify protection measures.

3.1 Background Information

The Pacific Coast Population of the western painted turtle (*Chrysemys picta bellii*) is considered to be at risk. It was listed as endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2006. COSEWIC granted this status, citing that "[t]here are few records from Vancouver Island and the mainland south coast/Fraser River valley, and both regions are undergoing major loss of wetlands and a rapid increase in roads, development, and people. Recent searches of the lower Fraser River valley and of eastern Vancouver Island indicate the subspecies has declined in some of the handful of areas where it was previously observed" (COSEWIC, 2006).

Provincially, the western painted turtle is Red-Listed, which "includes any indigenous species or subspecies that have, or are candidates for, Extirpated, Endangered, or Threatened status in British Columbia. Extirpated taxa no longer exist in the wild in British Columbia, but do occur elsewhere. Endangered taxa are facing imminent extirpation or extinction. Threatened taxa are likely to become endangered if limiting factors are not reversed. Not all Red-Listed taxa will necessarily become formally designated. Placing taxa on these lists flags them as being at risk and requiring investigation" (British Columbia Conservation Data Centre, 2015). Additionally, NatureServe ranks the western painted turtle as S2 Imperiled "because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation..." (NatureServe, 2014). Due to the overwhelming concern for the well-being of this species, it is important to make efforts towards the protection and enhancement of the western painted turtle population.

3.2 Morphological Description

The western painted turtle is aptly named, with bright yellow stripes on its head, neck, tail and legs, and bold red markings on its plastron and the underside of the edge of its carapace. The western painted turtle is the only native pond turtle left in BC (Reptiles of British Columbia, n.d.). Western painted turtles can best be identified by the colour of their plastron, which is highly coloured with red or orange and black markings (BC Turtlewatch, 2008). The markings are unique to, and can be used to identify, individuals; many researchers have been known to photocopy plastrons (Schneider, Krasny, & Morreale,

2001). The carapace ranges from blackish green to olive in colour, although young turtles often appear lighter. The carapace shape is fairly smooth and flat, with no ridge down the middle (BC Turtlewatch, 2008). Western painted turtles have webbed hind feet, and slender claws on their front feet, with males having much longer claws than females. They can grow to a carapace length of up to 25 cm long (Reptiles of British Columbia, n.d.) and may live up to 50 years or more (COSEWIC, 2006).

Since Red-Eared Sliders occupy similar habitat, the key identifying differences are the red mark behind the eye and the pale yellow plastron of the Red-Eared Slider (BC Turtlewatch, 2008). Refer to Appendix I for the British Columbia Ministry of Environment's BC Turtlewatch *Western Painted Turtle Identification Guide* with pictorial differences between the two species.

3.3 Distribution

Chrysemys picta bellii is found in wetlands in low elevation forests and grasslands of western and central North America. Its range in Canada is limited to the southern regions ranging from southwestern Ontario to Vancouver Island, where it has always been rare (COSEWIC, 2006). Table 1 is a compilation of western painted turtle sightings made by Engelstoft and Ovaska at Langford, Glen and Florence Lakes from their annual reports to Habitat Acquisition Trust from 2008 to 2013.

Table 1 - Summary of western painted turtle sightings at Langford, Glen and Florence Lakes by Christian Engelstoft and Kristiina Ovaska, 2008 to 2013. Data compiled from (Engelstoft & Ovaska, 2009), (Ovaska & Engelstoft, 2010), (Engelstoft & Ovaska, 2011), (Engelstoft & Ovaska, 2012), (Engelstoft & Ovaska, 2013), (Engelstoft & Ovaska, 2014), (Engelstoft & Ovaska, 2015)

Date	Start Time	Observation Time (person minutes)	Air Temperature (°C)	Water Temperature (°C)	Cloud Cover	Western Painted Turtle Sightings	Red-Eared Slider Sightings	Unidentified Turtle Sightings	Access Method	Notes
Langford Lake										
27-Jun-08	1:40	52	32	24	<50	6	0	0	n/a	turtles reported caught in harvester during aquatic weed clearing; confirmed nesting grounds
30-Jun-08	2:00	200	22	n/a	<50	2	0	0	n/a	
11-Sep-08	3:00	34	22	n/a	0	0	0	0	n/a	bullfrogs heard
03-Jun-09		276	29	n/a	0	24	5	1	n/a	bullfrogs
07-May-10	10:15	200	13	n/a	50	27	5	1	canoe	turtles caught during aquatic weed clearing in harvester; nesting sites confirmed
08-Sep-11	12:15	170	n/a	n/a	0	12	1	0	boat	
02-Oct-12	10:52	64	19	16	0	0	0	0	boat	
14-May-14	11:10	180	18	n/a	0	37	9	0	boat	
18-Sep-14	15:00	60	n/a	n/a	0	0	0	0	boat	
Glen Lake										
27-Jun-08	12:30	96	n/a	n/a	n/a	0	0	0	boat	
12-May-10	12:20	90	16	n/a	50	3	7	0	n/a	
25-May-11	10:35	60	18	16	<50	1	5	0	on foot	
22-Apr-13	12:15	50	15	n/a	0	0	6	0	on foot	
14-May-14	14:50	20	18	n/a	0	0	0	0	on foot	
Florence Lake										

Date	Start Time	Observation Time (person minutes)	Air Temperature (°C)	Water Temperature (°C)	Cloud Cover	Western Painted Turtle Sightings	Red-Eared Slider Sightings	Unidentified Turtle Sightings	Access Method	Notes
11-Sep-08	1:56	98	21	23	0	0	1	0	n/a	bullfrogs
30-Apr-10	12:20	20	n/a	n/a	60	0	0	0	on foot	
06-May-10	11:19	86	13	n/a	80	1	1	0	canoe	
25-May-11	9:25	80	19	16	<50	2	3	0	on foot	
08-Sep-11	10:45	120	n/a	n/a	0	0	1	0	boat	bullfrogs
22-Apr-13	10:50	80	14	n/a	0	1	1	0	on foot	

Engelstoft and Ovaska, in their 2008 report, confirmed nesting sites on Langford Lake. Based on landowner reports and photos, the nesting sites were located on banks, usually close to the lake, on the developed side of Langford Lake in people's yards (Engelstoft & Ovaska, 2009).

3.4 Habitat

Western painted turtles are found in shallow ponds, lakes, sloughs, and slow-moving streams. Ideal wetlands have muddy substrates, an abundance of emergent vegetation for foraging, and logs and open banks that are useable as basking sites (St. John, as cited in COSEWIC, 2006). Western painted turtles also require suitable riparian zones bordering the wetlands (COSEWIC, 2006).

According to Orchard (as cited in COSEWIC, 2006), an optimum lake or pond has:

- 80% of its water depth ≤ 3 m
- A mud or sand substrate in 80% of the shallow zone (≤ 3 m)
- Emergent aquatic plants in at least 80% of the littoral zone
- At least one emergent basking site in water no more than 1 m deep for each 30 m of shoreline (COSEWIC, 2006).

3.5 Range and Migration

Painted turtles forage, mate and brumate in water, but movements of several hundred metres overland are not uncommon (Gregory and Campbell, as cited in COSEWIC, 2006). Typically, these overland movements are migratory as individuals move between breeding locations or brumation sites in different ponds (COSEWIC, 2006). Rowe noted that midland painted turtles (*Chrysemys picta marginata*) of both sexes occupied similar-sized home ranges, with individuals usually favouring one or two core areas. During two years of study, he documented average home range sizes of 1.8 ha in 1999 and 0.7 ha in 2000 (Rowe, 2003). It is assumed that western painted turtles have similarly sized home ranges.

3.6 Mating

Western painted turtles mate in shallow water, probably throughout the active season (COSEWIC, 2006), which can begin as early as February and extend until November. Mating is the only activity where western painted turtles exhibit aggressive behaviour (Matsuda, Green, & Gregory, 2006).

Females are able to store viable sperm for two to three consecutive years; therefore, a fraction of clutches may have multiple paternities (COSEWIC, 2006).

3.7 Nesting

Engelstoft and Ovaska have been observing western painted turtles at many locations on southern Vancouver Island since 2008. Figure 1 shows a summary of egg-laying activities by female turtles at East Pond in Elk/Beaver Lake Regional Park from 2009 to 2014. Based on data from a time-lapse camera at East Pond in Elk/Beaver Lake Regional Park in 2012, Engelstoft and Ovaska observed that most nesting activity took place in late afternoon (after 1530 h) or evening, although one female nested in the morning. Nesting times ranged from 1 hour and 21 minutes to nearly 5 hours and the average time was 2 hours and 49 minutes. Some turtles proceeded directly to their nesting site while others meandered, and some turtles appeared to make several exploratory forays before choosing a site. Engelstoft and Ovaska believe turtles may abandon nesting sites for reasons other than disturbance (Engelstoft & Ovaska, 2013); these reasons are unclear but could include inappropriate soil qualities, for example reaching sub-soil that is difficult to dig.

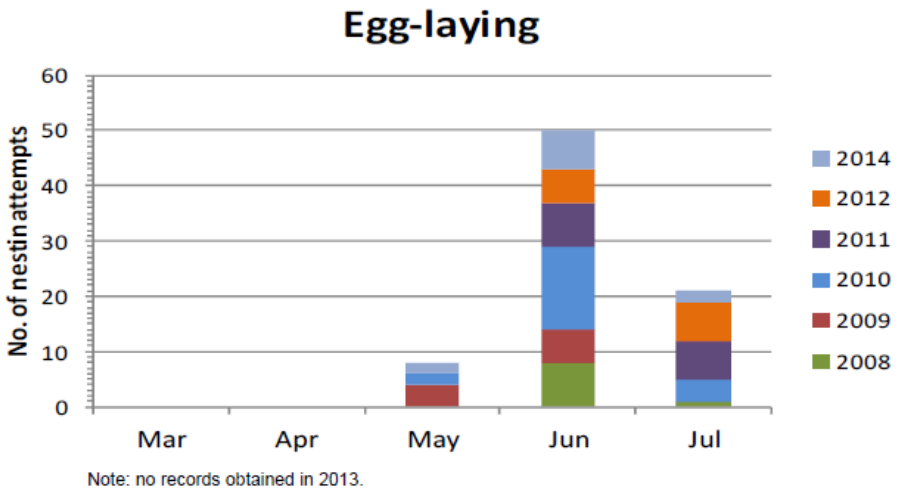

Figure 1 – Frequency distribution of number of females digging nests at East Pond, Elk/Beaver Lake Regional Park, from 2009 to 2012 (Engelstoft & Ovaska, 2015)

Females dig a flask-shaped nest 10 to 15 cm deep, within 150 m of water in a location that optimizes incubation conditions and provides a suitable habitat for hatchlings. This is typically an exposed patch of fairly compacted soil or sand where digging is possible, often on an open, gentle, south-facing slope. Up to 23 eggs are laid, which are then covered with soil and packed down (COSEWIC,

2006). Engelstoft and Ovaska have observed that clutch sizes of 8 to 12 eggs are typical in our region (Engelstoft & Ovaska, 2014). Western painted turtles often use the same nesting areas from year to year, even after site modification (Engelstoft & Ovaska, 2011). Signs of nesting activity include nest holes ("test" holes dug by nesting turtles or holes from where hatchlings had emerged). Aside from physically observing a female digging a nest, wet patches may indicate the presence of a freshly dug nest, since the female urinates on the nest following egg laying to compact the soil. These wet patches are typically only visible until the morning following egg-laying. Pieces of turtle eggshells in or near emerged holes also indicate nesting, but identification of the species is difficult from the eggshell features alone (Ovaska & Engelstoft, 2010).

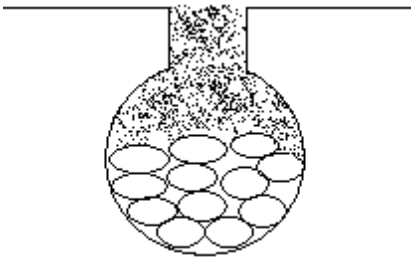

Figure 2 – Sketch of a western painted turtle nest (Engelstoft & Ovaska, 2011)

Eggs are elliptical and white, measuring up to 35 x 22 mm and weighing up to 9 g when laid (Ernst et al., as cited in COSEWIC, 2006). Egg size and hatchling size increase with the female's age (i.e. the size of the pelvic aperture). Incubation averages 72 to 104 days (COSEWIC, 2006). The literature reports that a significant proportion of females lay a second clutch one to two weeks later (Gregory and Campbell; St. Clair et al.; Samson, as cited in COSEWIC, 2006), but Ann Matteson, Project Biologist at Enkon Environmental Ltd., believed the Pacific Coast population only lays a single clutch per year (Ann Matteson, pers. comm., January 27, 2015). St. Clair, Gregory and Macartney studied the Rocky Mountain population of western painted turtle at Kikomun Creek Provincial Park and observed that females there reproduced once per year at most. They further note that delayed maturity and faster growth may provide northern females with the ability to produce larger clutches at a lower annual frequency, compared to true southern populations (St. Clair, Gregory, & Macartney, 1994).

Our project activities discovered nesting locations that were not recorded in the literature. On June 1, 2015, a lake visitor photographed two turtles attempting to nest on the side of the gravel boat ramp at Langford Lake and forwarded the photos to the Habitat Acquisition Trust. The gravel was too compacted for successful nesting; the resident returned the next day to find abandoned holes (C.

Engelstoft, pers. comm., June 7, 2015). At 2245 h on June 8, 2015, while performing bullfrog eradication activities, Stan Orchard and Kevin Jancowski encountered a turtle nesting at Scout Point (the swimming beach north of the boat ramp); the female was still there when they returned at about midnight (S. Orchard, pers. comm., June 9, 2015). On the evening of June 9, 2015, Kristiina Ovaska noted several recent turtle diggings adjacent to the boat ramp as well as a female on the beach near Scout Point; however, this female was disturbed by humans and their pets, and returned to the water (K. Ovaska, pers. comm., June 10, 2015).

During our door-to-door survey on the north shore of Langford Lake, a resident reported annual turtle nesting activities on his property, and the article published in the Goldstream Gazette prompted another resident to contact the journalist to say that turtles have been nesting in his compost area for 38 years (M. Davies, pers. comm., June 4, 2015). The Recommendations section will address the use of this information further.

3.8 Incubation

The temperature during a critical period of incubation determines the sex of the offspring (temperature-dependent sex determination, TSD or TDSD). Constant temperature ≥ 29°C produces female hatchlings, while temperatures ≤ 26°C produce male hatchlings. At 28°C, approximately equal numbers of males and females are produced (COSEWIC, 2006).

3.9 Hatchlings

Hatchlings usually over-winter in the nest and emerge the following spring (COSEWIC, 2006). The timing of hatchling emergence varies annually, and is likely dependent on weather and other environmental conditions (Ovaska & Engelstoft, 2010). After nesting, parents do not provide any care for hatchlings (COSEWIC, 2006). While freezing temperatures are not often a concern for painted turtle populations in Greater Victoria, hatchlings can tolerate freezing conditions for months by becoming super-cooled. The capacity to resist freezing is highly dependent on the physical attributes of the soil in which the nest is located (including moisture content) and increases as winter approaches. Physiological variations between individuals also influence their response to environmental conditions (Costanzo, Dinkelacker, Iverson, & Lee, 2004).

Engelstoft and Ovaska have been monitoring western painted turtles at East Pond in Elk/Beaver Lake Regional Park and have compiled hatchling emergence from 2009 to 2014, as shown in Figure 3.

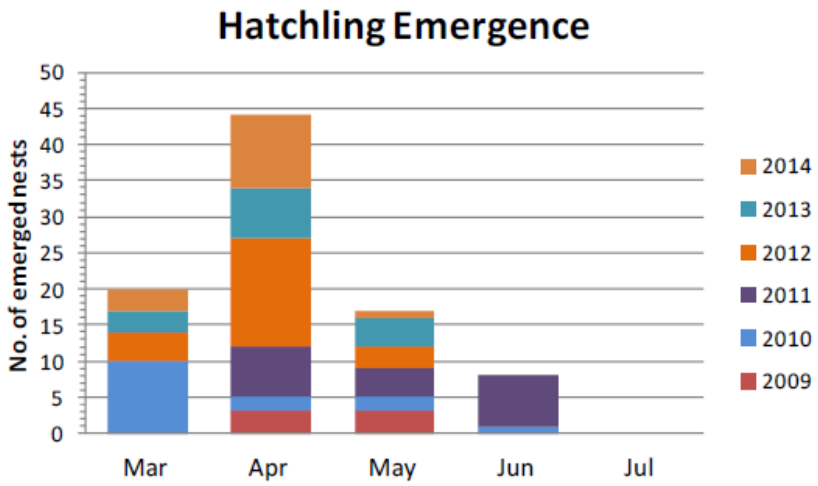

Figure 3 – Frequency distribution of monthly turtle hatchling emergence from nests at East Pond, Elk/Beaver Lake Regional Park, from 2009 to 2014 (Engelstoft & Ovaska, 2015)

All turtles previously reported in the three lakes appeared to be adult individuals and it was unclear whether or not painted turtles were successfully reproducing in any of the lakes. Christian Engelstoft and Kristiina Ovaska, in a meeting on April 15, 2015, stated that they have seen immature turtles approximately two years old clinging to low-hanging willow branches along the shore at Langford Lake. On May 12, 2015, Stan Orchard reported that two hatchlings were removed from the stomachs of bullfrogs captured at the north end of Langford Lake on May 6, 2015, confirming that western painted turtles are successfully reproducing on this lake.

3.10 Maturity

Survival to adulthood is estimated at 0.9%. Young turtles grow rapidly during the summer months, and a plastron length of 83 mm can be achieved in three to five years depending mainly on food supply (Nussbaum et al., 1983, as cited in COSEWIC, 2006). Growth rate decreases as sexual maturity is approached, and adults have slow, indeterminate growth rates (Samson, as cited in COSEWIC, 2006). Reproductive maturity is reached in as much as eight to ten years for male western painted turtles and up to 12 to 15 years for females. The lifespan of western painted turtles is likely over 50 years (COSEWIC, 2006).

3.11 Basking

Western painted turtles sleep on the pond/lake bottom or on partially submerged objects, and are only active during daylight hours. As ectotherms, turtles bask in sunlight to raise their body

temperature to a level suitable for foraging and mating. Ultraviolet light from the sun also reduce skin parasites, and is essential for the synthesis of vitamin D (COSEWIC, 2006). Western painted turtles bask several times a day, typically for several hours at sunrise before feeding and sometimes again in the afternoon and evening. The amount of basking required varies with temperature (warmer ambient temperature requires less basking), age (juveniles appear to need to bask less), and activity (females appear to bask longer prior to the nesting season) (COSEWIC, 2006). They use logs, rocks, mud banks, and other floating objects as basking platforms. They do not exhibit aggression during basking and will even pile on top of one another. It is unknown if there is social hierarchy (COSEWIC, 2006).

Western painted turtles are most visible from April to mid-May while basking on logs, on other floating objects, on rhizome mats of pond lilies, or along the shoreline. They are most visible during these months in part due to reduced vegetation, but also because at this time of year they most need the warmth from sunlight. Later in the summer, they are typically observed swimming in shallow and weedy bays, an activity more difficult to detect (Ovaska & Engelstoft, 2010).

3.12 Brumation

While the state of low activity in western painted turtles is commonly called hibernation, brumation is a more correct term (Engelstoft & Ovaska, 2012). Except for hatchlings, all life stages lie dormant on the muddy substrate of shallow water bodies during winter. The turtles stay in one location or small area throughout the winter (St. Clair and Gregory, as cited in COSEWIC, 2006). The length of brumation is determined by water temperature (COSEWIC, 2006), and occurs when water temperature exceeds substrate temperature, usually about 6°C (Zevit & Matsuda, 2012).

In August 2010, Engelstoft and Ovaska tagged six adult western painted turtles at Swan Lake with radio-telemetry devices. Turtles were observed using most of the lake during late summer and early fall, usually near the shoreline. From November on, the turtles brumated under shrubs in water less than 125 cm deep, with four of the six turtles brumating close together within a small area (Engelstoft & Ovaska, 2011).

Dormant turtles need very little oxygen, and may absorb dissolved oxygen from the water through their skin, throat linings and thin-walled sacs in the cloaca. During an extended brumation in anoxic conditions, western painted turtles rely on anaerobic glycolysis for energy, a much less efficient energy pathway (Dinkelacker, Costanzo, & Lee 2005). This results in the coordinated depression of both ATP production and consumption processes so that the rates of substrate depletion and lactic acid

production are reduced. In addition, the turtle's own shell and skeleton provide an extensive buffering capacity to neutralize the lactic acid produced by the anaerobic glycolysis; carbonate buffers are released from the shell while the shell also takes up lactic acid for buffering and sequestration (Jackson, 2002).

Ann Matteson, Project Biologist at Enkon Environmental Ltd., stated that she and her colleagues have discovered that western painted turtles at Burnaby Lake in the Lower Mainland do not brumate. This turtle population moves into a watercourse that is believed to be more oxygenated and higher in nutrients, in which the turtles move much more slowly, but remain active (Ann Matteson, pers. comm., January 27, 2015).

3.13 Diet

Young juvenile painted turtles eat mostly tadpoles and invertebrates such as insects, crayfish and snails. Older juveniles eat bigger prey such as frogs and fish, and scavenge (Gregory and Campbell, as cited in COSEWIC, 2006). As turtles mature, they become increasingly omnivorous, feeding on live animals and carrion as well as plants (Gregory and Campbell, as cited in COSEWIC, 2006), although it appears that more northerly populations are more carnivorous (Cooley, Floyd, Dolinger, & Tucker, 2003). Because of the small, fixed tongue, turtles swallow food more easily when submerged (Gregory and Campbell, as cited in COSEWIC, 2006), using suction to move food to the throat (Matsuda et al., 2006). Feeding begins when water temperatures reach 15 to 18°C and ends when the temperature drops below this threshold (Ernst et al., as cited in COSEWIC, 2006).

4. Optimum Timing of Activities

4.1 General Turtle Observation

Early spring and late fall sightings may provide a clue to brumation site locations. Using radio-telemetry at Swan Lake, Engelstoft and Ovaska observed that turtles tended to stay close to the brumation site in March, spreading along the lakeshore as the weather improved. Turtles stayed along the north shore of the lake during July and August, and started moving towards the brumation site as the weather cooled (Engelstoft & Ovaska, 2012).

4.2 Nesting Observation

Based on data from a time-lapse camera at Elk/Beaver Lake Regional Park in 2012, Engelstoft and Ovaska observed that most nesting activity took place in late afternoon (after 1530 h) or evening, although one female nested in the morning. Some turtles proceeded directly to their nesting site while others meandered. It appears that some turtles made several exploratory forays before choosing a site (Engelstoft & Ovaska, 2013). Nests can also be discovered the morning after digging by looking for circular, flattened patches of ground with a wet spot where the female has urinated on the nest after completion (Engelstoft & Ovaska, 2011)

4.3 Basking Site Enhancement

Since basking site enhancement will necessitate some disturbance near the shoreline, it is important to be aware of other species that may be using the area, particularly for reproductive purposes. It may be advisable to delay basking log installation to avoid disturbing shoreline vegetation and shallow waters used for egg-laying in spring by native amphibians (Pacific tree frog (*Pseudacris regilla*) and northwestern salamander (*Ambystoma gracile*)) (Engelstoft & Ovaska, 2014)

4.4 Nesting Site Enhancement

Based on observations on southern Vancouver Island, Engelstoft and Ovaska report that the most appropriate time for nesting enhancement activities is in May, after known turtle nests have emerged and before females begin digging new nests (Engelstoft & Ovaska, 2011).

5. The City of Langford Official Community Plan (OCP)

The cities of Langford and Colwood came together in 2007-2008 to devise coordinated Official Community Plans (OCP) for their respective municipalities with the objective of creating an integrated and sustainable future for their communities. The OCPs include, among many strategies, sustainability and growth management plans. Knowing the policies that are in place for the protection of species and habitat as well as the strategies for sustainability and growth are crucial when developing a management plan for an endangered species such as the western painted turtle.

The OCP Steering Committee, comprised of interested citizens from Langford and Colwood, provided valued oversight during the process of developing the Official Community Plans. The OCP review team included staff from Langford and Colwood, professional planners, architects, landscape architects, transportation engineers, and housing and economic development experts (The City of Langford Official Community Plan, 2008). The broad range of professionals contributing to the OCPs provided a thorough and multi-faceted report with policies tailored to each city's individual needs and visions.

Prior to 2001, the population growth in Langford was relatively stagnant. However, between the years of 2001 to 2006, the growth rate spiked to approximately 32%. The OCP reported Langford's population in 2006 as 24,892 with 8650 dwellings; their projected growth for 2028 is 47,244 residents with 19,685 dwellings. The annual percentage increase in Langford's population is 4.0%, compared to 0.9% overall in the Capital Regional District (CRD). Due to the significant growth expected in Langford, the CRD deemed Langford a major growth area within the region's urban containment boundary as defined in the Regional Growth Strategy (The City of Langford Official Community Plan, 2008).

Langford is settled around several of what the OCP has termed 'environmentally sensitive areas' (ESAs), which include but are not limited to: "(i) Endangered and threatened habitats such as Garry Oak ecosystems and/or wildlife corridors, (ii) Riparian corridors, wetlands, shoreline habitats, and (iii) Heritage landscapes" (The City of Langford Official Community Plan, 2008). Due to the classification of Langford as a major growth area, citizens recognized the need for sustainable development and preservation of these environmentally sensitive areas. With this in mind, the citizens generated a list of sustainability goals and a growth management plan that dictate how development will (or will not) proceed in environmentally sustainable areas.

The OCP outlines several sustainability goals, with the intent that the value of an ecosystem must be maintained and that the natural capital will shape any future development (The City of Langford Official Community Plan, 2008). Concurrently, the first goal listed in the sustainability plan for Langford is to maximize the ecological value of an area. This includes the protection of environmentally sensitive areas, such as riparian zones surrounding the lakes. The OCP also proposes to enhance personal and community health, ensuring opportunities for safe and healthy recreational, educational, emotional, spiritual, artistic and cultural activities. This also ties into another goal: fostering sense of place and diversity. Because Langford has such a rich biodiversity and is surrounded by several environmentally sensitive areas, maintaining and enhancing environmentally sensitive areas is crucial in creating a sustainable future for Langford.

Because of Langford's explosive growth, the OCP has outlined policies to protect its environmentally sensitive areas. Perhaps one of the most important policies is to maximize connectivity of open spaces to allow for the movement of water and wildlife, as well as to connect trail systems. This is important for environmentally sensitive areas and populations, as connectivity between habitats allows for metapopulations; if one habitat is not suitable one year, individuals of a species may freely move to another area that is not too far or too dangerous to move to, in order to survive and reproduce successfully. Policies to preserve the character of Langford's lakes are quintessential to preserving environmentally sensitive areas and include updating the guidelines for development permits as new and relevant data and best management practices become available, limiting access to ESAs through sensitive design, and negotiating with developers, encouraging volunteers, and supporting government agencies to maintain and/or enhance ESAs.

The Official Community Plan encompasses the values and ideals that are desirable in the future of Langford. The beauty of Langford is in the ecosystems and biodiversity it contains within its parks, privately conserved properties, wilderness areas and Streamside Protection and Enhancement Areas; the protection, maintenance, and enhancement of the environmentally sensitive areas are interwoven throughout the OCP and remain important integral components of good development in Langford.

6. Lake Characteristics

6.1 Glen Lake, Langford Lake, Florence Lake

Langford, Glen, and Florence Lakes all lie within the Coastal Douglas Fir biogeoclimatic zone. Only 4% of the Coastal Douglas Fir biogeoclimatic zone is protected, yet it is the only area in all of Canada that supports Garry oak ecosystems, one of the most diverse and endangered ecosystems in British Columbia. Only 5% of the Garry oak ecosystem remains in its natural condition, as invasive and exotic species dominate the ecosystem (Auditor General of British Columbia, 2010).

6.2 Langford Lake

Langford Lake covers an area of 0.6 km^2 and has a perimeter of 4.8 km. The average depth is 6.4 m, with a maximum depth of 16 m. Although the average depth is 6.4 m, about half of the area is comprised of littoral zones, with a depth of less than 3 m. Langford Lake does not typically freeze in the winter; the lowest temperature the lake water reaches is 4°C. The maximum water temperature is 24°C, with an average temperature of 18°C. A strong thermocline at a depth of about 7 to 8 m exists from about May-October, with de-stratification beginning in September. Due to the relatively shallow depth and warm temperature of the lake, an aerator was originally installed in 1984 and upgraded in 2012. It operates every year from May to September in an attempt to increase the concentration of dissolved oxygen and prevent eutrophication. Water flows into the lake from the southeast and flows out towards the northwest; both the inflow and outflow areas are slowed by vegetative growth and are characterized by poorly drained organic soils. Significant riparian vegetation follows the northwest shoreline.

Langford Lake is popular for a variety of recreational activities. It has four established swimming areas, which locals frequent during the summer. Many people enjoy boating and angling; however, gas-powered motors are prohibited due to the shallowness of the lake and to prevent further pollution of the lake. The presence of boardwalks and trails attracts walkers and runners, many of whom often bring dogs. A relatively new boat dock exists at the northwest end, where dogs are permitted to be off leash. Langford Lake is also a popular fishery, as it contains stocked and non-stocked fish. The stocked varieties include rainbow and cutthroat trout, and the non-stocked varieties include smallmouth bass, pumpkinseed, and yellow perch.

In recent years, Langford Lake has attracted a substantial amount of new development. The new City Centre Park recreation facility at the southeast end of the lake was recently completed. A gravel pit is located near the northwest end where the new boat launch was installed. The site was intended for residential development but no recent advancements have been made; it is currently used as a storage site and parking lot for the company that owns it. Additionally, 105 ha of land between Glen Lake, Langford Lake, and Skirt Mountain are being developed in phases. The Westhills residential area includes housing, trails, parks, a new high school, and the YMCA which is nearing completion. Future plans for a pub and kayak rental center on the lake have not been received by the City of Langford yet but are being planned (J. Waters, pers. comm., 2015).

6.3 Glen Lake

Glen Lake is relatively small, with an area of only 0.169 km^2 and a perimeter of 2.1 km. The mean depth is 6.4 m with a maximum depth of 14 m. The lowest temperature the water reaches is 6.09°C, and the warmest is 21.9°C. The water drains at the east end through Colwood Creek. The lake is typically mesotrophic, but occasionally becomes eutrophic. To prevent eutrophication, an aerator was installed in 1985 and replaced in 2005. The aerator typically runs annually from May to October.

Glen Lake is a popular destination, especially during the warmer months. A boardwalk is located on the southern shore and Glen Lake Beach Park is situated along the northern shore; in the summer, locals and tourists frequent both the boardwalk and Glen Lake Beach Park. The park has a swimming area, playground, spray park and boat launch, and is accessible to dogs year round. Glen Cove, a small beach and swimming area adjacent to the Galloping Goose Regional Trail, experiences mostly local traffic. During the colder months, Glen Lake is not completely ignored; rather, the boat dock and boardwalk attract anglers year round. Glen Lake is stocked with rainbow and cutthroat trout and has non-stocked brown catfish, smallmouth bass, and pumpkinseed.

As Glen Lake is central amongst the neighborhoods of Langford, much of Glen Lake is already developed. There are 58 properties surrounding the lakefront at Glen Lake. Much of the property on the shoreline is owned privately, and the majority of that property has already been developed.

6.4 Florence Lake

Out of Langford, Glen, and Florence Lakes, Florence is the smallest and shallowest. The mean depth is 1.9 m, with a maximum depth of 4.3 m. Florence Lake covers an area of 0.084 km^2 and has a

perimeter of 1500 m. With a maximum temperature of 22°C and a minimum temperature of 5.4 °C, Florence Lake is relatively isothermic and only a weak thermocline exists in the summer. The water flows in from the northeast and out from the southwest.

Boating is the main recreational activity at Florence Lake. The City of Langford installed a boat launch in the southern area of the lake, with plans to enhance parking and picnic areas around the launch. Historically, Florence Lake was stocked with cutthroat and rainbow trout; however, due to concerns regarding water quality and a lack of interest in fishing in the area, stocking of the lake ended in 2007. Interestingly, there have been reports of freshwater jellyfish in Florence Lake.

Development surrounding Florence Lake has been increasing. Urban residences cover 75% of the perimeter of the lake; the remainder is privately owned but presently undeveloped. Developers own portions of the slopes facing south and west, which happen to be located within the watershed. Additionally, the Spencer Interchange was recently completed, and concerns about the prevailing winds dropping sediments from the construction and use of the interchange into the lake have been expressed.

6.5 Water Quality in Langford, Glen, and Florence Lakes

The quality of the water in a lake is important in that it determines the health and diversity of the species that it supports. Langford, Glen, and Florence Lakes are not deep lakes, and because they exist in a moderate climate, they are often in danger of eutrophication. The warmer the water temperature, the lower the ability of the water to dissolve and maintain dissolved oxygen. As well, the metabolic rates of organisms increase with increasing temperature. Coupled with increased nutrients, the number of organisms increases causing the amount of oxygen-consuming metabolism to increase. Dissolved oxygen is an indicator of the overall health of an aquatic ecosystem.

The concentrations of nutrients such as nitrates and phosphates have increased with the production and widespread use of fertilizers for both agricultural and aesthetic purposes. Additionally, the dumping or seepage of wastewater into lakes may introduce a greater concentration of nitrates and phosphates. As with most ecosystems, nitrates and phosphates are typically growth-limiting in lakes. When nutrients are added to lakes, the growth, which was normally limited, is able to increase substantially. Nitrate and phosphate loading cause algae blooms, which leads to a decrease in dissolved oxygen in that body of water. The increase of biomass and decrease in dissolved oxygen often results in eutrophication of the lake.

The depth to which light reaches and the concentration of chlorophyll a in water may be used as indicators of the relative biomass in a lake. The depth to which light reaches is often measured using a device called a Secchi disk, which is composed of black and white quadrants, and is lowered into a water column until the quadrants are no longer distinguishable. Greater depth to which light reaches indicates fewer sediments suspended in the water and lower numbers of algae, which means higher clarity of the water. Water clarity is important so that light may reach aquatic plants, which require visible light to perform photosynthesis. Lesser water clarity results in reduced photosynthesis and therefore reduced dissolved oxygen in the water.

Both Langford Lake and Glen Lake have aerators that run from May through to October. The aerators prevent the extensive anoxic conditions experienced prior to installation and have been effective in significantly increasing water clarity. They improve oxygen levels during summer months when lake temperature increases but were not designed to remove nutrient load. Internal loading of nutrients occurs when the sediments release adsorbed nutrients, contributing to a higher concentration of those nutrients in the waters. Internal loading increases as the lake water becomes more anoxic. Since the installation of the aerators, the Secchi depths have increased from 3.8 metres in 1983 to 4.3 metres in 1986 to 2006 (British Columbia Ministry of Environment (BC MOE), 2007). Though the aerators have not made a difference of statistical significance, the difference is difficult to quantify, as it is not possible to estimate the conditions of the lake if the aerators had not been installed. Elevated temperatures during summer in Florence Lake cause decreased levels of dissolved oxygen. During periods of stratification, the concentration of dissolved oxygen is not adequate for aquatic life at depths greater than 2.5 m (BC MOE, 2011), although it is believed that this situation has improved since the installation of the aerator in Langford Lake in 2012. Since the aerator was installed, oxygen levels meet water quality guidelines for fishery health and survival (J. Waters, pers. comm. August 26, 2015).

All three lakes of interest have been subject to algal blooms and eutrophication. In the past, Hull's Field, which was agricultural land to the south of Langford Lake, was altered so that it drained into Langford Lake (BC MOE, 2007); this drainage was loaded with nutrients such as nitrates and phosphates from fertilizers and animal wastes. Additionally, wastewater high in phosphorus and nitrates from the residential septic systems surrounding the lakes often seeped into the lakes (BC MOE, 2007). Since the elimination of agricultural practices in Hull's Field, the total phosphorus (TP) and total nitrates (TN) levels have decreased in Langford Lake. Additionally, a large number of homes surrounding each lake were connected to a centralized sewage service in Langford, reducing the seepage of wastewater from

septic systems into the lakes (BC MOE, 2007). This reduction in wastewater seepage has also led to a decrease in TN and TP in all three lakes. Regardless of these reductions, the TP concentration in the past has been generally higher than the guideline of 5 to 15 µg/L for the protection of aquatic species, and the guideline of 10 µg/L for recreational purposes in each lake (BC MOE, 2007). The source of phosphate may be improper fertilization practices or internal loading, since internal loading typically increases in anoxic conditions. In the hypolimnion of Langford Lake, the concentration of TN and TP peaked at 560 µg/L and 2,300 µg/L, respectively, from summer through fall in 2005 (BC MOE, 2007). The high concentration of TN and TP in Langford Lake during 2005 caused the lake to be classified as eutrophic that season (BC MOE, 2007). Relatively high concentrations of TN and TP, if not controlled, can continue to contribute to eutrophication of the lakes; however, the installation of aerators in Langford and Glen Lakes prevents oxygen depletion to levels that are harmful to fish and other aquatic organisms.

Chlorophyll a levels are typically low, and Secchi depths are acceptable in each lake, but tend to vary depending on the season. In late spring and early summer, chlorophyll a levels are low and Secchi depths are relatively high in each lake, but reverse as the summer matures. During summer, increased temperatures and light cause increased algal and aquatic plant growth, which increases the chlorophyll a concentration. However, the increased growth of algae causes a decrease in light penetration. As the chlorophyll a levels and Secchi depth invert, the dissolved oxygen decreases and the lakes often experience eutrophication. In Florence Lake, the chlorophyll a levels are typically low in spring and early summer, ranging from 1.5, 4.8 and 4.6 µg/L in March, May, and June of 2008 (BC MOE, 2011). The chlorophyll a levels increased during mid-summer to 7.9 µg/L on July 22 and further to 17.2 µg/L in September of that same year (BC MOE, 2011). Corresponding to the increase in chlorophyll a, the Secchi depths decreased from 3.83 m during March, May, and June of 2008, to 1.82 m in July, August, and September. Based on this data, Florence Lake was considered eutrophic during late spring to early July of 2008 (BC MOE, 2011). Using the same parameters, Glen Lake is classified as primarily mesotrophic but may occasionally experience eutrophication (BC MOE, 2009). Eutrophication is detrimental to all organisms in the lake.

Fecal coliform units are a measure of pollution to lake by human, animal, and/or waterfowl excrement, or the presence of agriculture practices, which often use excrement as a fertilizer or allow livestock to graze near water bodies (Vancouver Island Health Authority (VIHA), 2006). This pollution presents health risks to people who swim in the lakes, in the form of gastrointestinal illness. The Vancouver Island Health Authority (VIHA) guidelines rate the amount of fecal coliform units per 100 mL

according to their level of risk for human health. VIHA considers 0 to 50 fecal coliforms per 100 mL of water low risk, 51 to 200 fecal coliforms per 100 mL of water moderate risk, and greater than 200 or fluctuating dramatically as high risk (VIHA, 2006). At Langford Lake, fecal coliform sampling between April 11 and August 26, 2006 produced low results, and did not exceed the water quality guidelines (BC MOE, 2007). The bacteriological data for Glen Lake from 1999 to 2008 had values ranging from less than 1 cfu/100mL to 1800 cfu/100mL, with the guideline only being exceeded (and temporary warnings issued) on a few occasions when single samples had high counts (BC MOE, 2009). In Florence Lake, sampling was performed from May until September 2006, in which the coliform count was averaged at 3 fecal coliforms per 100 mL, producing very low risk to human health (VIHA, 2006). VIHA conducts weekly tests for coliform at all swimming beaches in the Capital Regional District during summer. Glen Lake has had two closures in 2014 and 2015 due to increased numbers. Coliforms are expected due to Canada goose populations visiting the beach (J. Waters, pers. comm., August 27, 2015).

Fecal coliform units are an indicator of pollution in a lake. It does not appear as though sewage, animal excrement, or agricultural wastes or by-products were an issue in all three lakes, at least in 2006. Continual monitoring of fecal coliforms will give an idea of the relative amount of pollution in a lake, which will not only affect the health of humans using the lake, but the overall health of that lake.

To summarize, eutrophication has been documented in Langford, Glen, and Florence Lakes. Total nitrogen and total phosphorus concentrations are high in each lake, even with the presence of an aerator in Langford and Glen Lakes, and the elimination of agricultural waste or by-product seepage into Langford Lake. In all three lakes, the Secchi depths and amount of chlorophyll a varies seasonally, with chlorophyll a levels low and Secchi depths high during the spring and early summer, but inversing mid-summer to early fall, supporting the notion that the lakes occasionally experience eutrophication. Recent records of fecal coliform data collection do not indicate that sewage, animal wastes, or agricultural by-products are major sources of pollution in all three lakes. The eutrophication and associated concentration of dissolved oxygen in Langford, Glen, and Florence Lakes are a cause for concern, and practices should be implemented to subvert eutrophication and increase dissolved oxygen.

6.6 Weed Harvesting

The City of Langford owns an aquatic vegetation removal machine known as “the weed harvester” which is rotated between the lakes from June to September around the fish window. The weed harvester is kept at Florence Lake in June, then moved to Glen Lake for July, Langford Lake for

August, and back to Florence Lake for September due to the density of aquatic plants in that lake. Volunteers clean the weed harvester and conveyor belt before moving them between locations but the actual weed harvesting is completed by volunteers. A volunteer coordinates the schedule at each lake; residents call the coordinator to request use of the harvester on their desired date and time. Operators are required to receive training (J. Waters, pers. comm., January 13, 2015) but at least one volunteer felt the level of training was inadequate (pers. comm., April 27, 2015), and we are aware that the harvester has been tipped more than once. The weeds are disposed into a bin which is removed by Alpine Disposal & Recycling but the actual disposal method is unknown. Residents are only supposed to clear the area immediately adjacent to residential docks and to allow weed-free access for swimming or boats from beaches to the central portion of the lake, leaving plenty of aquatic plants for turtle food and protection.

7. Limiting Factors and Threats

Based on low adult recruitment, delayed maturity, and high adult survival, it is feared that increased pressure on western painted turtles could eliminate local populations (COSEWIC, 2006). Our review of the literature and observations at the lakes themselves indicate that lack of nesting habitat, general habitat degradation, and disturbance are the primary threats to the survival of the western painted turtle populations at Langford, Glen and Florence Lakes. These threats are described more fully below, as are additional issues, which may factor into the survival of the Langford populations.

7.1 Habitat Threats

Seventy-five percent of the wetlands near Victoria at the time of European settlement have disappeared (Capital Regional District, as cited in COSEWIC, 2006). Degradation is prevalent in landscapes such as Langford, where human activity is extensive, intensive, and/or frequent (COSEWIC, 2006), as detailed in the background section on the lakes, leaving minimal natural habitat intact.

Human activities on, in and around water bodies result in water pollution (including eutrophication), bank erosion, soil compaction, native riparian vegetation loss, habitat fragmentation, in-filling or drainage, and altered wetland hydrology (COSEWIC, 2006). The proliferation of impervious surfaces promotes runoff, potentially carrying nutrients and contaminants into the lakes, and the reduction of tree cover reduces the ability of the ground to absorb and retain precipitation. Glen Lake has a weir (J. Waters, pers. comm., January 13, 2015) and Langford Lake used to drain to the south (into Glen Lake) before an embankment built for the E&N Railway obstructed the flow in this direction (BC

MOE, 2003). It is not known whether these hydrological alterations have affected the western painted turtle populations at these lakes.

7.2 Lack of Nesting Habitat

Engelstoft and Ovaska have identified availability of suitable nesting habitat as a limiting factor for turtle populations at most sites on Vancouver Island. This is partly natural, in that forest cover frequently reaches to the shoreline (Engelstoft & Ovaska, 2014), but also artificial. Unfortunately, humans and turtles enjoy the same sun-exposed sides of the lakes and virtually all of the northern shore of each lake is developed residential, with many properties protected by retaining walls which prevent access by turtles to potential nesting sites (Engelstoft & Ovaska, 2009). As a result, turtles have been frequently observed using driveways and lawns in residential areas (Engelstoft & Ovaska, 2014). Grassy and sandy sites in residential, commercial and industrial areas, though inferior choices, can attract nesting turtles but result in an altered sex ratio of the population due to unnatural temperature regimes (J. J. Kolbe & Janzen, 2002). The presence of private property in the ideal nesting and basking habitat locations limits the ability of the City of Langford to enhance prime turtle habitat and may require the development of long-term relationships with property owners who will make a commitment to western painted turtle habitat protection and enhancement, perhaps in cooperation with the Habitat Acquisition Trust.

7.3 Disturbance

Turtles are most vulnerable while nesting or traveling to and from nesting sites (COSEWIC 2006). At the three lakes in Langford, it is expected that humans provide the greatest source of harassment to turtles, given the popularity of the recreation sites and the abundance of dogs that are under questionable control at times. Capture for pets is another direct human disturbance, as well as angling when the bottom of the jaw is torn open by a hook, which prevents them from feeding (COSEWIC, 2006).

7.4 Weeds and Other Vegetation

Engelstoft and Ovaska stated that encroachment of grass and weeds on turtle nesting grounds is one of the main problems for WPTs at sites on the Saanich Peninsula (Engelstoft & Ovaska, 2011). Maltby has found nests and hatchlings penetrated by weed roots at a site near Revelstoke, BC. It is not

clear whether the roots penetrated living or dead eggs and hatchlings, but it is possible that the roots could impede the emergence of hatchlings (Maltby, 2000).

7.5 Weed Harvesting

Engelstoft and Ovaska report that at Langford Lake in 2008, an operator of the weed-harvesting machine reported as many as six turtles per hour caught in the machine in some areas of the lake. The turtles seemed to be unharmed and were immediately released. They recommended that a biologist be present when the weeds are harvested to confirm with a trained eye that the turtles are unharmed (Engelstoft & Ovaska, 2009).

7.6 Predation

Turtles are most vulnerable during the embryonic stage of their life cycle. Nests are not defended and eggs are easily dug up. Nesting sites are typically along the shoreline or roadsides, which also provide easy access for predators (COSEWIC, 2006). COSEWIC reports that up to 90% of eggs are preyed upon, although Engelstoft and Ovaska have noted higher hatchling success, ranging from 46% to 78%, at sites they have been observing on the Saanich Peninsula from 2009 to 2012 (Engelstoft & Ovaska, 2014). Nests further from shore are safer from predation (J. Kolbe & Janzen, 2002). Predators of eggs include raccoons, coyotes, mustelids (fishers, badgers, otters, mink and weasels), red foxes, skunks, black bears, squirrels, ground squirrels, chipmunks, ravens, crows, and domestic cats and dogs (COSEWIC, 2006), (Marchand & Litvaitis, 2004), (Maltby, 2000). These species also prey on hatchlings and small juveniles at the water's edge (COSEWIC, 2006). Additional predators of small turtles within the water include bullfrogs, great blue herons, gulls and large fish (COSEWIC, 2006). Coyotes, raccoons and some mustelids also feed on larger juveniles and adults when on-shore (COSEWIC, 2006). While most of these predators are natural enemies of western painted turtles, higher populations of mammals such as raccoons resulting from denser human populations are impacting turtle populations (COSEWIC, 2006). As well, land-based predators can take advantage of human-built pathways and roadways to increase their opportunities for predation.

Introduced American bullfrogs (*Lithobates catesbeianus* or *Rana catesbeiana*) have been reported at all three lakes (S. Orchard, pers. comm., May 12, 2015). Jancowski and Orchard confirmed that bullfrogs do prey on western painted turtle hatchlings with the discovery of turtles in the stomach contents of Southern Vancouver Island bullfrogs (Jancowski & Orchard, 2013), and since 2007, Orchard has reported removal of approximately 6500 bullfrogs from Glen Lake alone (S. Orchard, pers. comm.,

April 27, 2015). Bullfrogs are the most critical predator species at the lakes and it is essential to western painted turtle survival that the annual bullfrog eradication program is continued.

7.7 Similar Introduced Species

Introduced red-eared sliders (*Trachemys scripta*) co-occur with western painted turtles at all three lakes and may be a threat by competing for food and nesting and basking sites. They may also spread diseases and parasites (COSEWIC 2006). In the past, red-eared slider populations were maintained by the continual release of unwanted pet turtles. Several nests have survived in the wild almost to the point of hatching, but even mild coastal winters were too cold to ensure the survival of hatchlings. However, in the spring of 2015, six live hatchlings were found near western painted turtle nests at Reifel Island Bird Sanctuary in Delta, BC during routine monitoring of the painted turtle nests, providing the first record of fully hatched, viable red-eared sliders in British Columbia (Hanke, 2015). The Coastal Painted Turtle Project found another successful nest in April 2015 (Coastal Painted Turtle, Project, 2015).

Since eggs incubated at temperatures below 27°C produce males, it is possible that BC red-eared slider nests will only produce male hatchlings. Hanke has observed that most sliders in the wild are female, likely due to their larger size which makes them more challenging as a pet. We may face a red-eared slider population boom until all of the abandoned females die off or are removed (Hanke, 2015) (assuming fewer new turtles are abandoned as communication improves and the public comes to understand the impact of their release in the wild). With the projected temperature increase of 2°C by 2050, slider recruitment by reproduction is likely to become a much more serious threat to western painted turtles (Coastal Painted Turtle Project, 2015).

7.8 Roads

While the roads around Langford, Glen and Florence Lakes are expected to be low risk to turtles due to slow speeds and relatively low traffic volumes, roads can be a major source of habitat loss and degradation in addition to direct mortality. Side effects of roads include toxic run-off, sedimentation, increased predation, altered drainage patterns, and increased likelihood of invasive species (COSEWIC, 2006).

7.9 Climate Change

Climate change has a variety of detrimental impacts on the Greater Victoria region, including warmer surface temperatures, increased precipitation, and increased lake water temperatures. These climate change impacts will negatively affect the western painted turtle population, which is already threatened by many other factors. Ambient temperatures are very important for the health of the western painted turtle population, which rely on the sun to keep nests warm over winter, determine the sex of the developing embryos in the nest, and to raise their internal temperatures to provide energy for foraging, mating, and ridding themselves of parasites.

Langford and the rest of the Greater Victoria area have a historically moderate climate, with wet, cool winters and warm, dry summers. The increase in greenhouse gases (GHGs) in the atmosphere causes the entrapment of infrared heat that normally is re-radiated from the Earth's surface to escape into the atmosphere. The increase in temperature is largely evident in the west and north of North America (Bush et al., 2014), which means that the temperature in Langford has been and will continue to increase. Increased temperature causes variability in precipitation events and ocean-atmosphere circulation (Bush et al., 2014). The direct effect of increasing temperature is a change in the vegetation, affecting the growth rates of all plants including invasive species. Dry seasons will cause the soil and other substrates to dry out, potentially increasing the frequency of nest collapse due to a lack of suitable substrate. Increased temperature will directly affect the western painted turtle by skewing the temperature-dependent sex determination, likely resulting in a greater proportion of female hatchlings.

The Pacific Coast has been experiencing an increase in the average surface temperature (Bush et al., 2014). Warmer temperatures during both winter and summer result in the increased temperature of the lakes, causing the inability of the lake to maintain an acceptable level of dissolved oxygen necessary for aquatic species. The ability of water to maintain dissolved gases decreases with an increase in temperature (Sakiyama, 2014). Decreases in dissolved oxygen affect all species in the lake and may impact the overall health of the lake. In terms of the health of the western painted turtle, in extreme temperatures the turtles are typically able to prevent themselves from overheating by re-entering the lake. Increased temperature of the lakes may reduce their ability to cool off and slow their metabolism. The increased metabolism may last throughout the year, preventing the turtles from brumating, and possibly resulting in behavioural changes such as altered mating and nesting seasons.

Increased atmospheric temperatures have been associated with changes in precipitation events, which have been observed in British Columbia. Increased precipitation events cause flooding, especially in regions with bedrock as the underlying geology, and erosion in regions where unconsolidated glacial till is the underlying geology. Additionally, the increased temperature affects the evaporation of water. There is a surplus of water during the winter and a shortage in the summer. Water availability is already an issue on Vancouver Island; the increased duration of longer, warmer summers will further decrease the amount of available water. The effect of warmer temperatures and more extreme precipitation events include extreme wet and dry seasons. The effect of more extreme dryness will affect the volume of freshwater considerably; because the lakes present in the Greater Victoria region are not fed by melting snowpack or glaciers, the water level is subject to decrease with the changes in precipitation and temperature (Bush et al., 2014). The increased freshwater and surface temperatures, combined with changes in precipitation and water availability, are expected to degrade the health of the western painted turtle population and the ecosystem they inhabit.

8. Management Strategies for Western Painted Turtle Habitat

There is a wealth of literature regarding management strategies for western painted turtles in urban and suburban settings. The focus of this section is to outline applicable strategies and include the reasoning behind those strategies to justify our recommendations for the City of Langford in their endeavor to manage western painted turtle populations in Langford, Glen, and Florence lakes. Management strategies for western painted turtles target the enhancement, restoration, and construction of nesting sites, aquatic habitat enhancement and creation of basking sites, road mortality mitigation, and inter-species impact alleviation. These strategies are especially important given the growth of Langford and the highly developed shorelines of the three lakes.

A key factor that contributes to the overall success of management strategies is proper inventorying and monitoring for distribution and abundance of the western painted turtles. This information is important for long-term goals regarding turtle proliferation and will be valuable for deciding the most effective implementation of the management strategies. Additionally, it is useful to observe the success of these strategies so they can be adjusted, modified, expanded, or re-prioritized (Barela & Olson, 2014).

8.1 Nesting Sites

The presence (or absence) of suitable nesting sites is a major limiting factor for turtle proliferation. Adult turtles can often be present at a lake, but without suitable nesting sites to lay eggs, they are unable to produce viable offspring to regenerate and strengthen the existing population. Therefore, targeting the creation and enhancement of suitable nesting sites in upland areas adjacent to the wetland habitat is likely the most important aspect of managing turtle populations in an area. Ideal nesting sites consist of minimally vegetated bare ground with loose, well-drained soil. These sites should have abundant sun exposure and be close (≤ 150 m) to the wetland habitat in areas where human traffic and the potential for disturbance are minimal. However, the turtles must be able to access the nesting site, so thick aquatic or terrestrial vegetation between the wetland and the nesting site that may prevent turtle access should be taken into consideration.

Presence of vegetation cover was found to correlate negatively with both summer and winter nest temperatures (Weisrock & Janzen, 1999). In the summer, nest temperatures influence hatchling sex determination, and in the winter, temperatures below -8°C can result in hatchling mortality (Weisrock &

Janzen, 1999). Winter temperatures that result in hatchling mortality are unlikely to occur in Langford, but cooler nest temperatures in the summer may result in fewer female turtle hatchlings. Additionally, heavy vegetation has been found to contribute to mortality of eggs and hatchlings due to root networks encroaching on the nest cavity, and the roots can also increase the difficulty of digging nests. However, females have been shown to select more vegetated portions of nesting areas as a response to human disturbance (Maltby, 2000). Therefore, management of vegetation is important when enhancing or creating nesting habitat. Native vegetation can be used on the borders of a nesting area to restrict human and dog access, but invasive plants capable of rapid encroachment into the nesting area should be controlled. Experimentally tilled plots showed that turtles consistently and preferentially nested in newly tilled plots, suggesting that tilling is an effective method for nesting habitat enhancement (Engelstoft & Ovaska, 2013). Although nesting sites with loose soil are preferred, sandy substrate that is too soft can make nest construction difficult, resulting in collapsed nests.

The creation or enhancement of suitable nesting sites will involve first selecting ideal locations in upland habitat adjacent to the wetland. These sites should be away from trails and difficult for humans and dogs to access. It is preferable to enhance already established nesting sites since there is no guarantee turtles will use created sites, but in the absence of current nesting sites, nest creation is necessary. Once a site is selected, invasive grasses and shrubs should be removed to make the soil relatively bare. The addition of gravel or sand to adjust the soil consistency and to create a sun-exposed south facing slope may benefit some sites. Tilling the soil where the invasive grasses are removed makes it easier for female turtles to dig nests. Tilling could be done with a small spade or hand-tiller. Removal of reed-canary grass and other wetland plants may aid the turtles in accessing the nesting sites, and the planting of native grasses and shrubs on the perimeter of the site can provide minimal shading and stabilize the soil while leaving bare patches for nesting. Finally, continual monitoring and upkeep of nesting sites is required to determine the effectiveness of the enhanced areas, and to determine the presence of disturbances or evidence of predation. Additionally, observing natural nesting sites in the area is important to determine turtles' local preference for nesting and to identify potential barriers to nesting in enhanced or created sites.

Nest enhancement should occur between May and June, after the overwintering hatchlings have emerged (if the site has been previously used), and before female turtles start nesting. Correct timing is dependent on observation and varies from site to site. Time-lapse cameras may be ideal for

monitoring enhanced nesting sites and determining timing for enhancement activities (Engelstoft & Ovaska, 2013). Cameras can be hidden in a birdhouse or similar structure to prevent vandalism or theft.

Protecting nesting sites with a perimeter fence or individual nest cages may be required if predation and other forms of disturbance are identified as problems; however, nesting sites that are out of the way and naturally protected are much more effective at preventing human disturbance. Signage identifying a nesting area is not recommended to keep human traffic to a minimum, but interpretive signage displaying the lifecycle of turtles along a footpath or viewpoint may serve to increase turtle awareness and galvanize community support for turtle habitat restoration. When creating tilled plots or enhancing nesting areas, it is recommended to cause minimal disturbance to the surrounding area. Subtle and ongoing enhancements are preferable since cleared sites are quickly invaded by weeds and invasive species. Continual monitoring and annual nest enhancement activities are required to sustain ideal nesting plots.

Use of created nests by western painted turtles is not guaranteed. In many cases, the creation of new nests may be a required course of action. If monitoring shows the nests are unsuccessful, additional more drastic measures can be taken such as relocating eggs to these created nesting sites, establishing them in the turtle population and allowing for future generational use.

8.2 Basking Sites

Basking sites allow western painted turtles to raise their body temperature to gain energy to forage, mate, and lay eggs (COSEWIC, 2006). Basking also aids digestion and other vital processes such as reducing parasite load. Basking sites are typically logs or other sun-exposed objects in the wetland that offer a surface on which to bask. Moderate protection from predators is also desirable to ensure the safety of the basking turtles. Removal of logs from wetlands is a primary cause of the loss of basking sites in turtle habitat.

Aquatic habitat enhancement through the creation of basking structures is relatively straightforward. Basking structures can consist of full-sized logs (with a diameter over 30 cm, and a length of at least 3 m), or mill-end slabs (see Figure 17 in Appendix II), where a log fragment is cut lengthwise so one side has bark attached and the other is milled flat. A composite board designed by students from Camosun College was successful as a basking structure (Umphrey, Kletchko, Desrosiers, & Burgess, 2012), but durability over the winter was an issue. Turtles were found to preferentially use basking structures immediately adjacent to shoreline as opposed to farther away (>5 m) (Engelstoft &

Ovaska, 2013). Natural logs are recommended as they are long lasting, provide basking opportunities for many turtles on each log, and require little or no maintenance once in place. Mill-end slabs are cheaper and easier to carry and install, but are less durable and need more frequent replacement. Natural logs should be used where possible and, if secured properly, will become ingrained in the surrounding ecosystem, making them a more sustainable and aesthetically natural solution.

It is recommended that basking structures be installed in quiet, sun-exposed areas adjacent to the shoreline, located away from trails and land access points. Structures should be secured or anchored to the shore and slope downwards into the water to accommodate water level fluctuations and turtle access (Engelstoft & Ovaska, 2011). Basking structures can be anchored in place by drilling a hole through the structure on the end facing the shore and placing a 1.5 m or longer rebar through the hole to secure the structure to the shore, bottom substrate, or matted vegetation. Larger logs can be secured to trees along the shore, or firmly anchored to the substrate (Capital Regional District Species at Risk, n.d.). Large groupings of logs can be secured in pairs to one another and anchored both to the shore using rebar or rope, and to the substrate under the water using anchors, as seen in Swan Lake (Engelstoft & Ovaska, 2015). Care should be taken to ensure the logs are firmly in place, do not provide hazards for other lake activities and that water level fluctuations and seasonal weather are accounted for. Placement should be hard to access and away from potential disturbances, but ideally in visible areas where visitors and surveyors can easily observe turtles.

Logs and mill-end slabs can be obtained in a number of ways. Ideally, fallen logs in the vicinity of the water body should be used, but logs can also be harvested by the City of Langford. Partnerships within the community could be established for a source of logs or mill-end slabs. Logs can be transported by trucks and released into boat launches or other accessible points of entry into the lake. From there, they can be towed by boat to the desired location, and then secured from the shore. Logs can also be installed from the shore, although movement and placement may be more difficult. A fetching arch (see Figure 18 in Appendix II) was successfully used to transport logs in Swan Lake in January, 2014, and could be a viable solution for on-land transport of larger logs (Engelstoft & Ovaska, 2015). Finally, successful basking structures not only provide necessary basking sites for western painted turtles, but can also provide platforms for a variety of other wildlife such as herons and waterfowl, enhancing viewing opportunities for lake visitors.

8.3 Road Mortality Mitigation

Turtles often migrate away from wetlands to find suitable nesting sites, and can be exposed to traffic and subject to road mortality. Road mortality can affect both adult turtles (typically females looking to lay eggs) and emerging hatchlings making their way to the wetland. Nesting areas located across the road from water bodies present the greatest hazard. Techniques to mitigate turtle road mortality include preconstruction road planning and creating underpasses with drift fences. Strategic road planning considers biological "hotspots" where road mortality potential is high (Wisconsin Turtle Conservation Program, 2012), and drift fences involve continuous fencing, approximately 60 cm high and flush to the ground, to direct turtles to the corridor where they can safely cross. More practically, turtles should be encouraged to nest closer to the wetland through the creation of nesting habitat. Unfortunately, turtles can be persistent in attempting to reach traditional nesting areas, which if located across the road require turtle-proof fencing to prevent crossing. In areas where road mortality in turtles is identified as a problem, more permanent fencing and properly accessible culverts should be considered. Turtles typically avoid small and dark passages, but have been known to use large-diameter square culverts (180 cm x 180 cm) as passageways (Kaye, Walsh, Rulison, & Ross, 2005). Tunnels and culverts can be improved by increasing their width, adding natural substrates, ensuring guide fencing sits flush with the entrances and exits of the culvert, and if possible planting natural vegetation at the mouth of the culvert (Wisconsin Turtle Conservation Program, 2012). Grates that allow light into the culvert are also effective ways for making passages more attractive for turtles (Canadian Amphibian and Reptile Conservation Network, 2012).

Seasonal road closures during peak turtle crossing times may be viable for smaller roads where road mortality is identified as an issue. Turtle hatchlings emerge from overwintering around April, and adult females lay eggs mostly in June. These timings are variable however, and road closures can be impractical. Signage can also be used to alert road users of the presence of turtles crossing. These are most effective on small side–roads with low traffic, where drivers are most able and likely to slow down. While drivers may be able to spot and avoid adult turtles, it is unlikely that hatchlings and juveniles can be avoided.

The most effective solution for road mortality mitigation is preventing the turtles from crossing roads by creating suitable nesting habitat closer to their wetland habitat. If road crossing cannot be avoided, underpasses or large square culverts with exclusion fencing should be used. As with other

management strategies, continuous monitoring is required to determine the effectiveness of any implementation.

9. Methods

An extensive review of the literature on western painted turtle life cycle, habitat requirements, and management strategies was completed prior to forming the Western Painted Turtle Management Plan. Information from the literature review was used to structure the report and guide the recommendations. To more fully understand the project objectives and the life cycle of the western painted turtle, several experts on western painted turtles and one expert in community engagement were interviewed (see Appendix IV for interview questions). The first interview was with Ann Matteson from Enkon Environmental. Ann Matteson originally suggested to Jane Waters, Park Planner for the City of Langford, that the population of western painted turtles present in Langford Lake was significant, and that a project focusing on the protection and enhancement of the turtles should be initiated. Habitat Acquisition Trust (HAT) biologists Christian Engelstoft and Kristiina Ovaska have spent several years working on projects to protect and enhance western painted turtle habitat on southern Vancouver Island. It was decided that an interview with Christian and Kristiina would prove very valuable to the project recommendations. To gain insight into engaging the public and what communication has occurred in the past regarding western painted turtles in Langford, Jill Robinson from HAT was interviewed. All of the interviews provided a wealth of information that made a significant contribution to this project.

The collection of local knowledge about western painted turtles from the residents at Langford Lake was determined to be a crucial contribution to the development of the Western Painted Turtle Management Plan. Going door-to-door was selected as the best way to communicate with Langford Lake residents. The intention was to target residents on the northern shore of Langford Lake, as that shoreline provides the most suitable turtle nesting habitat and consequent nesting attempts. Times to go door-to-door were chosen to minimize disturbance to residents but also to grant the opportunity to speak with as many people as possible. A questionnaire was used as an outline and starting point for conversations with residents (see Appendix IV for the questionnaire). Important information regarding the western painted turtles was recorded in hand-written format and was then discussed between team members and incorporated into the recommendations as deemed appropriate.

To determine the ideal locations for basking site and nesting site enhancement/creation, field observations were completed by foot, canoe, and kayak. The following procedure was implemented in the field observations by canoe and kayak:

1. At the beginning of each field day, the canoe and kayak were transported as necessary and launched into Langford, Glen, or Florence Lake.
2. Following launch, the note-taker began taking field notes, beginning with the time, date, location, weather conditions, and lake conditions.
3. The location and characteristics of each potential nesting and basking site were recorded. Photos were taken at each location, and each location was marked on a map. A note was made after each photo was taken, including the time and approximate location.
4. The location of any potential access points for turtles exiting the lake in search of nesting sites was described. If possible, a photo was taken of each access point.
5. When sighted, turtles were counted and identified (if possible). The number and species of the turtles, as well as the location, date, and time of sighting were recorded.
6. The perimeter of each lake was paddled to observe potential nesting or basking sites, as well as other species that may interact with turtles.
7. Once the perimeter of the lake had been paddled and all observations had been documented, the canoe and kayak were docked.
8. An electronic copy of field notes was compiled and photos were uploaded on the day that each lake was observed (when time permitted). The photos of each lake were added to a folder specific to that lake.

The combination of the literature review, interviews with experts, going door-to-door to connect with residents, and completing observations in the field by foot, canoe and kayak allowed a comprehensive understanding of the habitat requirements for turtles, the potential for engaging the community and fostering stewardship over Langford's population of turtles, and the best locations for habitat enhancement/creation.

10. Recommendations

As mentioned previously in this report, the major loss of wetlands and the impacts of population increase and consequent development are a major threat to the western painted turtle. The completion of the Westshore Parkway, the Kettle Creek development, and the lakeside restaurant by Westhills Land Corporation will each place additional significant pressures on western painted turtles and the Langford Lake ecosystem. Impacts from these developments include increased urban runoff entering the lake; increased foot traffic, which brings associated impacts such as litter and degradation of natural areas; and the potential for highly damaging incidents such as the tanker spill of 2011 in Goldstream River. As it stands, there are limited suitable areas for turtles to nest around Langford Lake (and none known around Glen or Florence Lakes) and there are very few optimal basking locations around any of the three lakes. These issues can be remedied with some simple shoreline alterations that are detailed below.

Habitat Acquisition Trust (HAT) has been stewarding western painted turtles on Southern Vancouver Island since 2008; based on their extensive and ongoing experience, it is our hope that the City of Langford will develop a close working relationship with them. They have expressed a strong interest in working with the City of Langford to enhance turtle habitat in the three lakes in Langford, especially Langford Lake since it has a known viable population.

Retaining walls are a major hindrance to egg-laden turtles attempting to access suitable nesting habitat. As the shoreline is regulated provincially, no new retaining wall structures may be constructed. By our estimation, no less than 80% of the developed shoreline of Langford Lake has some kind of retaining wall structure in place. Providing an incentive for landowners to actively remove retaining walls on their property and to replace them with riparian vegetation would be a great way to improve shore access for nesting turtles and further naturalize the shoreline.

Bullfrogs have been identified as a major threat to the long-term viability of western painted turtles in areas where their occurrences overlap, and fortunately, the City of Langford is already working to control this problem with the help of Stan Orchard and his company BullfrogControl.com Inc. It is important that this bullfrog eradication work continue so that new generations of painted turtles have a higher chance of reaching maturity.

Some of the most significant barriers the western painted turtles face are a lack of suitable nesting and basking habitat. To successfully propagate the western painted turtle population at

Langford, Glen and Florence Lakes, suitable nesting and/or basking habitat should be created or enhanced. Community engagement and stewardship over the western painted turtles in Langford may be fostered through a Communications Plan. Community involvement and enhancement of suitable habitat for the western painted turtle will also provide opportunities for future projects in each lake. The protection of an endangered species such as the western painted turtle habitat will provide the lake ecosystems and the community with many ecological and economic benefits.

10.1 Recommendations for Nesting Sites

10.1.1 Rationale

Nesting site creation has been identified as the top priority in the Western Painted Turtle Management Plan for the City of Langford. Small western painted turtle populations have been recorded at Glen and Florence Lakes, while a significant population has been documented at Langford Lake. Multiple recent nesting attempts on public beaches at Langford Lake have been observed. All of the known nests were abandoned, perhaps due to disturbance or poor substrate material, or trampled by visitors, highlighting the need for suitable nesting habitat that provides the turtles with safe nesting grounds protected from human recreation. Nesting sites should be created at specified locations on Langford and Glen Lakes according to the following procedures, and Florence Lake may benefit from similar activity in the future if a significant western painted turtle population is observed.

10.1.2 Locations

Figure 4 – Locations of potential nesting sites at Langford Lake

Potential locations for nesting site creation at Langford Lake are marked on Figure 4. Each location is ranked by priority; the rationale for the order of priority is as follows:

1. Site 1 (48°27'10.75"N, 123°32'20.00"W) has a south-facing aspect that allows for prolonged sun exposure and is located fairly close to the well-used turtle basking site by the boat launch to the south and a moderate distance from the Ed Nixon Trail. The site is fairly marshy and may require some vegetation removal and soil enhancement along the shore for nest creation.

Figure 5 – Photo facing north overlooking Site 1's location across the water. The mini boat launch can be seen to the right

Figure 6 – Photo facing west of the vegetation along Site 1's bank

2. Site 2 (48°27'11.73"N, 123°32'18.85"W) is nicely protected from human disturbance, but is heavily vegetated with willow trees which could make the nest site selection problematic.

Figure 7 – Photo facing southwest overlooking Site 2 along the north bank of the peninsula

Figure 8 – Photo facing south looking directly at Site 2 to the right of the willow tree

3. Site 3 (48°27'4.86"N, 123°32'19.83"W) is located closest to the boat launch and the well-used turtle basking area. It has a south-facing aspect that allows for prolonged sun exposure, but its close proximity to the boat launch and human recreation may discourage nesting attempts.

Figure 9 – Photo facing north looking at Site 3 along the south bank of the peninsula (photo taken from boat ramp dock)

Figure 10 – Photo facing east showing vegetation and soil along Site 3

4. Site 4 (48°27'15.36 N, 123°32'9.7"W) has potentially great nesting habitat potential with a south-facing aspect, but would require collaboration with the property owners along Lake End Road.

Figure 11 – Photo facing north of Site 4, located to the left of the gazebo

Figure 12 – Locations of potential nesting sites at Glen Lake

Only one nesting site location is suggested for Glen Lake, as shown in Figure 12 (48°26'26.42"N, 123°31'31.72"W), and its necessity is conditional based on future observed turtle populations. The site is located northeast of the recreational beach in a privately owned (with city access) wetland area that is protected from human disturbance. The shore may require significant vegetation removal and soil addition.

Figure 13 – Photo facing north overlooking Site 1, located to the left of the dock with the patio chair

10.1.3 Materials

The following materials are recommended for nesting site creation and enhancement activities:

- Soil
    - Loamy soil and/or fine gravel should be used to prevent excess silt from entering the water body.
    - Volume is site specific and is calculated by multiplying the area of the site by the depth (30 cm).
- Fence materials if applicable
- Native plants
    - Clumping grass: Blue fescue (*Festuca glauca*)
    - Tall native plants: Woolly sunflower (*Eriophyllum lanatum*), Hardhack (*Spiraea douglasii*) etc.
- Time-lapse camera, camera box, post

10.1.4 Equipment

The following equipment items are recommended for nesting site creation and enhancement activities:

- Gloves, rakes, shovels, tamper, spades, hand-tiller, and wheelbarrows
- Clippers, broom pullers and loppers for invasive plant species removal
- Fence post auger

10.1.5 Procedure

The procedure for creating and enhancing nesting habitat is modified from the *Plan for Nesting Habitat Rehabilitation for the Western Painted Turtle at Swan Lake Nature Sanctuary* by the Habitat Acquisition Trust (Engelstoft & Ovaska, 2010).

Site Preparation

1. Select a suitable location for nest creation.
2. Remove invasive plants and grasses, as well as shading vegetation to make the soil relatively bare.

3. Turn over the soil to loosen it using a spade or hand-tiller for smaller sites, or a backhoe or tilling machine for larger sites, if necessary.
4. Ensure the site is accessible from the aquatic habitat. This may require removal of reed-canary grass or other wetland plants that block turtle access to the site. Care should be taken to prevent substantial sediment disturbance to avoid excess sediment loading into the water body.

Nesting Area Construction

5. Add soil/sand as needed to the nesting site to adjust the soil consistency. Soil on or near the site should be used if available. The soil should be loose enough for the female turtle to dig, but firm enough to prevent nest collapse.
    a. Determine a 5-10 m^2 area to be enhanced.
    b. Acquire enough soil/sand to cover the site to a depth of up to 30 cm. Loamy substrate suitable for nest construction should be used and may require the addition of fine-grained gravel (2-4 mm diameter) to adjust the consistency.
    c. Compact the nesting area moderately to form a gentle and south-facing slope for maximum sun exposure.
6. Plant clumping native grasses such as blue fescue (*Festuca glauca*) and other low, slow-spreading native shrub plants around the perimeter of the site to help stabilize the soil. Taller native plants such as wooly sunflower (*Eriophyllum lanatum*) may be useful around the perimeter to create a visual barrier and mitigate disturbance.
7. Fence the nesting area to prevent disturbance if necessary. Temporary mesh fencing or more permanent split rail wooden fencing may be used depending on the area being enhanced.
8. Install a basking log near the entrance of the site from the lake to encourage turtles to utilize the new nesting ground.
9. Activities for creating new nesting sites can occur at any time since the sites have not been previously used. Nest construction time may vary from 2-20 person hours depending on the site and the level of work required.

10.1.6 Site Monitoring and Maintenance

10. Install a pole in an appropriate location overlooking the enhanced site on which to attach a time-lapse camera. The camera may be hidden in a bird-house like structure, and should operate on a time-lapse setting of 10-15 minute intervals during daylight hours throughout May,

June, and July. A motion activated setting may be beneficial as well to monitor predation and disturbance. The Bushnell 'Trophy Cam HD' ($200), Wingscapes WildlifeCam ($120) and other similar cameras with the necessary features may be used.

11. Monitor hatchling emergence from April to June to determine usage of the created nesting site. Note that hatchling emergence cannot be detected by the time-lapse camera and requires physical inspection of the site for emerged nest holes on weekly basis.
12. Maintain the area annually to ensure that invasive grasses and plants do not invade or shade out the site. Site access from the aquatic habitat should be maintained to ensure turtles are able to utilize the nesting area. The site may benefit from tilling prior to nesting (typically around the end of May, but weather-dependent in any given year), after turtle hatchlings have emerged (if the site had been used successfully the previous year). Timing of maintenance activity is highly dependent on monitoring to ensure activities do not interfere with egg laying and hatchling emergence.

10.2 Recommendations for Basking Sites

10.2.1 Rationale

Due to a current lack of basking sites, it is imperative to increase the number of basking structures for western painted turtles in Langford, Glen, and Florence Lakes. Increasing the number of basking structures, especially in areas protected from human interference, will provide additional platforms which turtles can use to raise their internal temperatures. Because each of these lakes is used for recreational purposes, it is not practical to install large numbers of basking logs. By phasing in a small number of logs each year, the habitat will become increasingly suitable, and park users will be able to enjoy viewing turtles at many locations in each lake. The following procedure, modeled after the *Western Painted Turtle Habitat Restoration and Management Guidelines, Swan Lake and Christmas Hill Nature Sanctuary* (Engelstoft & Ovaska, 2013), is likely to result in the most successful enhancement of basking sites in Langford, Glen and Florence Lakes.

10.2.2 Locations

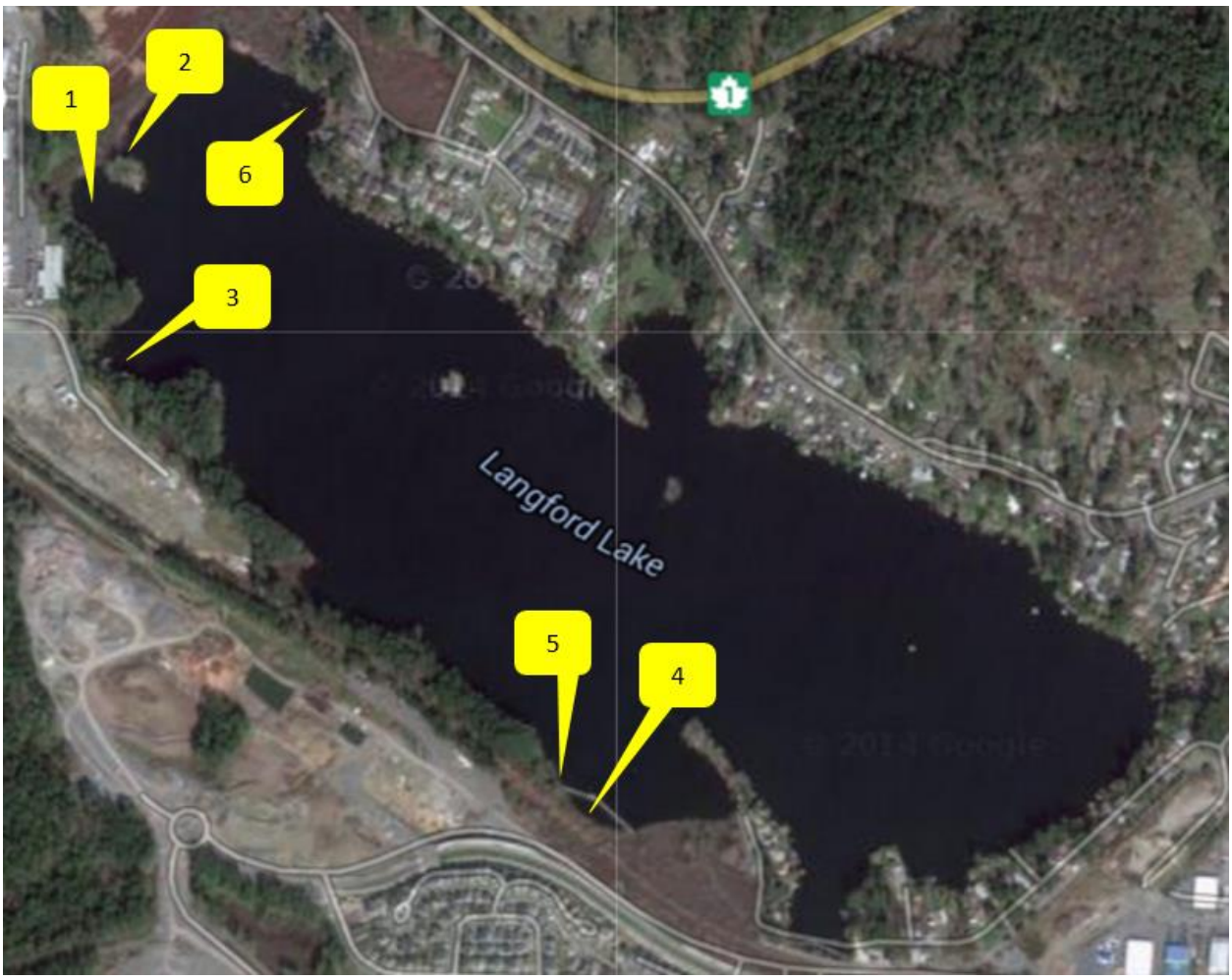

Figure 14 – Locations of potential basking sites at Langford Lake

Each location suitable for basking site enhancement at Langford Lake is marked on Figure 14. Each location is ranked by priority; the rationale for the order of priority is as follows:

1. Site 1 (48°27'9.75"N, 123°32'20.49"W) is not accessible by foot, therefore human disturbance is minimized. The trees surrounding this bay shade the area from wind; therefore, the basking logs will not be disturbed by wave action.
2. Site 2 (48°27'12.14"N, 123°32'18.23"W) is also relatively inaccessible by humans; however, this area is slightly more susceptible to wind and wave action.
3. The existence of a well-used basking site and the length of daily sun exposure create an ideal basking area at Site 3 (48°27'4.23"N, 123°32'19.70"W). This area is heavily used by park users and their dogs. While any disturbance to the turtles is unwelcome, the park users enjoy being

able to see the turtles and the turtles seem to be relatively undisturbed by the presence of both humans and dogs.

4. Site 4 (48°26'45.36"N, 123°31'50.77"W) is inaccessible to humans. The turtles can be easily viewed from the boardwalk and remain undisturbed; however, this area is not within the proximity of any known basking sites and is close to an area with active development.
5. The boardwalk near Site 5 (48°26'47.12"N, 123°31'52.9"W) will allow park users to view the turtles without getting too close and causing disturbance; however, this location may be accessible for humans by foot, possibly promoting disturbance to any basking turtles.
6. Basking logs, if installed at Site 6 (48°27'13.95"N, 123°32'7.91"W), would receive adequate amounts of sun exposure. This location would remain undisturbed by foot traffic as there is no major pathway in this area and the vegetation prevents anyone from accessing this location by foot. However, installing basking logs in this area would not likely promote any awareness of or stewardship over the turtles, as it has no vantage point from which the public would be able to view the turtles.

Figure 15 – Locations of potential nesting sites at Glen Lake

Each location suitable for basking site enhancement at Glen Lake is marked on Figure 15. Each location is ranked by priority; the rationale for the order of priority is as follows:

1. Site 1 (48°26'25.11"N, 123°31'31.23"W). The City of Langford has previously considered buying the piece of land containing Site 1 (J. Waters, personal comm., 2015). Basking logs in this area would be inaccessible by foot, but observable from the public park area. This location would also receive optimal sun exposure.
2. Basking logs to the east of the boardwalk at Site 2 (48°26'9.70"N, 123°31'3.28"W) would remain undisturbed by both foot and boat traffic, but allow observation by the interested public; however, this area may not receive an optimal amount of sunlight.
3. Vegetation around Site 3 (48°26'8.43"N, 123°31'7.11"W) may prevent foot traffic from reaching the basking logs; however, this area is not south-facing and would not receive an optimal amount of sunlight.
4. Vegetation in the area of Site 4 (48°26'6.29"N, 123°31'12.24"W) may dissuade foot and swimmer traffic from disturbing the basking logs; however, this area is relatively close to the beach, so the likelihood of interference to any basking turtles by dogs and/or humans is relatively high. Additionally, this area would not receive an optimal amount of sunlight.

Figure 16 -– Locations of potential nesting sites at Florence Lake

Each location suitable for basking site enhancement at Florence Lake is marked on Figure 16. Each location is ranked by priority; the rationale for the order of priority is as follows:

1. Site 1 (48°27'37.90"N, 123°30'49.66"W) is proximate to the observation dock, so it will allow park users to view the turtles without disturbing them. It is also south-facing, so it will receive optimal sunlight.
2. The vegetation in the area around Site 2 (48°27'29.26"N, 123°30'39.20"W) will help prevent park users from attempting to reach the basking logs, and this area will receive an adequate amount of sunlight. However, this area may be less visible to the public, so the appeal of the basking turtles may go unnoticed.

3. Site 3 (48°27'23.80"N, 123°30'46.22"W) is proximate to a wetland and is therefore protected by vegetation. It is also observable from the boardwalk. This land is for sale, so Site 3 may become less suitable pending future development.

10.2.3 Materials

The following materials are recommended for basking site creation activities:

- logs > 30 cm in diameter, 3 m in length, bark still attached (the larger the log the better)
- Rope – braided polypropylene, ¾ inch diameter
- Rebar/anchor (buckets or 4 L milk jugs filled with rocks/sand)

10.2.4 Equipment

The following equipment items are recommended for basking site creation activities:

- Fetching arc - if logs need to be transported overland by foot
- Motor boat and permission to boat on the lake
- Drill that can penetrate log (optional)
- Power or hand saw to notch log for attachment of stabilizing cross boards
- Heavy gauge nails/screws, hammer/drill (if using stabilizing cross boards)
- Sledgehammer (if using rebar)
- Means of transporting logs

10.2.5 Procedure

1. Map the locations in which basking structures will be installed.
2. Source logs as required:
    a. Logs felled directly from the edge of the water will likely already be at a natural angle into the water; these logs may simply be felled and secured to the shoreline; no other procedural steps need apply.
    b. Propose a partnership with Westhills Land Corp. Deforestation of the lakeside property prior to development could provide a source of logs. Note that the larger the logs are, the better they are for basking structures. Logs should not be de-branched (unless transportation is required) nor sawed down to a smaller size.
3. For each location, determine whether it is more suitable to attach the log to land or to anchor it. The attachment site depends on the location of the installation.

a. If the land is difficult to reach from the water for the attachment of the log (i.e., the location is reedy or has shrubs), anchoring both ends of the log will be more suitable. If anchoring, the logs may be positioned parallel to the shoreline, against the reeds, as with the Swan Lake project by the Habitat Acquisition Trust (See Appendix II for an image of the basking structures at Swan Lake).
b. If the logs are being entered into the water from land, the logs may be attached to the shoreline by rebar or secured to on-land structures by rope.

4. Prepare for delivery of the logs to each lake and obtain permission for the use of a motorboat for the day of installation.
5. Deliver the logs to the best point of access to the lake, which is typically the boat launch.
6. Prepare logs for installation.
    a. One log method:
        i. If attaching to the ground via rebar (best for areas with stable substrate), drill a hole through the log or notch the ends to secure a rope that will be tied to the rebar.
        ii. If anchoring, notch both ends of the log so that stabilizing cross boards may be attached (see Figure 19 in Appendix II). Notching may be accomplished by sawing off a portion of the end of the log so that the stabilizing cross board can be easily attached. Attach each end of the log to the stabilizing cross board via heavy gauge nails/screws. Ensure the stabilizing cross boards are long enough and wide enough so that the log may be attached and the board supports the log in the water.
    b. Two log method: Tie the rope around both logs and on each end, securely wrapping the rope around both logs a few times and tying the ends of the rope either to the anchor or to rebar on land.
7. Prepare anchors if required. Anchors can be buckets filled with cement or rocks, or sealed milk jugs filled with sand. A polyethylene rope should be used to securely attach the anchor to the log.
8. Tow the logs to each location. Ensure an adequate amount of rope, an anchor and a knife to cut the rope is present on the boat.

9. Once the log is in the proper location, measure the depth by tying the anchor to the rope and dropping it down into the water. Cut the rope to a length that will allow it to be secured around the log(s) and stabilizing cross boards (if used), and attached to the anchor.
10. Attach the rope to the logs. Ensure the logs are securely fastened to each other (if using two log method). Position the basking log in the proper location, ensuring that it will not roll with the waves (Engelstoft & Ovaska, 2013).
    a. Logs installed in wetland areas may be positioned parallel to shore and near the vegetation to reduce the amount of space required for the basking structures.

This work could be completed at any time of the year, provided the nesting grounds of native populations of amphibians are not disturbed.

10.2.6 Site Monitoring

The logs should be observed once a year to ensure they have not become water-logged or detached from the shore/anchors.

10.3 Recommendations for Communications

Communication about western painted turtles in Langford is essential due to their status as an endangered species in an area that is heavily impacted by human activity. The lakes are generally surrounded by private residences which often include retaining walls that block turtle access to the shores. Additionally, recreational use of the water and surrounding trails, especially for off-leash dog walking, can negatively impact turtle activities. Considering the urban environment surrounding Langford, Glen, and Florence Lakes, a Communications Plan regarding the Western Painted Turtle Management Plan is essential. Community engagement will increase public understanding of the challenges western painted turtles face, enabling the public to make decisions and take actions that can have a positive effect on turtle proliferation. Additionally, community engagement will strengthen the relationship between the City of Langford and its residents and will communicate the City's environmental protection initiatives and its overall environmental responsibility. The goal of the Communications Plan is to explore methods of communication and to define the messages that will effectively reach lakeshore residents and the entire community.

Speaking with lakeside residents has revealed that locals are keenly interested in the turtles inhabiting their lakes and have more knowledge of the two species than was anticipated. It is expected

that many residents will be open to receiving additional information on habitat enhancement activities and the changes they can make in their own activities to protect the turtles. Most residents were open to receiving physical or electronic mail regarding information on the western painted turtle, which could include turtle-friendly homeowner tips, as well as notices informing them of turtle habitat enhancement initiatives. Key messages in the Communications Plan include fostering stewardship of the lake, minimizing disturbance and providing information about enhancement activities.

10.3.1 Fostering Stewardship

Most of the Langford Lake-side residents we spoke to responded enthusiastically when asked if the presence of turtles enhanced the quality of their lake experience. It is possible that some residents are unaware that their practices and activities on their property can impact the turtles; building on their enthusiasm for the turtles could result in small changes in behaviour that could have larger impacts for lake quality in general and turtle habitat in particular. We encourage lakeside residents and park visitors to:

- Learn to distinguish the native western painted turtle from introduced red-eared sliders
- Reduce run-off from driveways and other hard surfaces by re-directing it into lawns or choosing permeable surfaces such as paving blocks
- Avoid the use of chemicals on lawn and gardens
- Maintain septic systems in good working order
- Increase exposure of the shore to sunlight by trimming trees or shrubs (this also helps with bullfrog control)
- Plant native shoreline or aquatic plants
- Remove excessive aquatic vegetation with the input of a registered professional biologist
- Install slanted basking platforms or logs in sunny areas and anchor them into the lake bottom or shoreline vegetation
- Reduce the grade of steep banks; consider removing portions of retaining walls
- Minimize disturbance to turtles by being mindful of activities near turtle habitat (Capital Regional District, n.d.).

If nesting activities are observed on their property, residents are encouraged to call Habitat Acquisition Trust (HAT) so that knowledge of the reproductive efforts of western painted turtles may be documented. They are additionally encouraged to work with HAT to:

- Maintain good exposure to sunlight in nesting areas
- Maintain sparse ground cover in nesting areas
- Protect nesting sites from disturbance by human and pet activities (Capital Regional District, n.d.).

If turtles are observed on paths or roads, it is requested that the observer stays with the turtle until it has reached the far side of the path or road to warn any passersby of its presence. It is illegal for anyone without an animal care certificate to handle endangered species, so returning the turtle to the lake is not advised; if the turtle is heading away from the lake, it may be in search of a suitable nesting site. Signage needs to be placed on public trails and at the boat launch to explain this.

10.3.2 Minimizing Disturbance

Western painted turtles are quite tolerant of human activities as long as they do not feel threatened; however, females are quite sensitive to disturbance when nesting and will abandon a nest if disturbed. It has been noted that park visitors are not abiding by signs that prohibit dogs at Scout Point on Langford Lake. This is especially critical during the evenings of May to July when turtles may be using the beach for nesting. On June 9, 2015, Kristiina Ovaska observed a female turtle on the beach but the turtle returned to the water due to the presence of humans and their pets (K. Ovaska, pers. comm., June 10, 2015). While this beach is not ideal for nesting habitat due to its heavy use by humans, it is vital to contain the disturbances to heavily used areas to balance the recreational opportunities the lake provides with the habitat requirements of turtles and other native species. Dogs are required to be under control in all public areas around the lake but this does not always happen in practice. Educating dog walkers to ensure their pets remain under control will provide a sense of safety for the turtles, minimizing the possibility of free-roaming dogs harassing turtles or digging up nests.

10.3.3 Enhancement Activities

Lakeshore residents that are interested in participating in habitat enhancement activities are encouraged to work with HAT and the City of Langford to construct nesting habitat on their property, and/or to install basking structures on the water in front of their property.

10.3.4 Methodology

Sample posters have been created to communicate messages about nesting site enhancement, basking site enhancement, and guidelines for landowners who have turtle activity on their properties (see Appendix III). These can be printed on Rite-in-the-Rain paper (using standard copiers and printers) and tacked in appropriate places or posted as pdf documents on the City of Langford website. By printing posters as needed, costs can be reduced since the cost and time of replacing posters is minimized and the impacts of vandalism are negated. In addition, it is recommended that a sign similar to the one posted by the City of Langford and HAT at the boat ramp be installed at Scout Point. There is some debate as to whether enhancement activities should be identified with a sign or not. Ideally, nest creation or enhancement should be located away from publically visible areas in order to prevent disturbance, but it may benefit some enhancement efforts to fence off the restored area with a cedar-stacked fence and include a sign explaining that disturbance will negatively affect turtle hatchlings.

The City of Langford could increase their social media presence by creating a Facebook page or a Twitter account. Social media could be useful in communicating messages with lake users. A concerned citizen has created a Facebook page for each of the three lakes; the City of Langford could consider passing messages to lake users via these pages, for example, lake quality reports and information about enhancement activities. Should the City of Langford wish to get creative in promoting knowledge and stewardship of western painted turtles, a Turtle Day could be hosted. This would be a fun community event emphasizing the sharing of knowledge about turtles by having biologists present (possibly with captive turtles or turtle shells and eggs) to discuss the life cycle of the turtles, and presenting information on suggested stewardship actions and current enhancement activities. Additional activities could include puppet shows about turtles, face painting, turtle games, and turtle-shaped cookies. The Fish and Wildlife Compensation Program and the Rocky Mountain Naturalists have hosted successful Turtle Days at Elizabeth Lake in Cranbrook, British Columbia (Crowley, 2015).

Community engagement is an essential facet of any project that a city may want to put forth. The residents of the City of Langford can be a driving force in the protection of the western painted turtle population in each lake. The overwhelmingly positive response from the residents of Langford to the efforts put forth regarding the turtles is a testament to their interest in protecting this population of endangered species. Given the correct information regarding the protection and enhancement of suitable habitat for western painted turtles, the prevention of activities that threaten the overall health

of each lake, and the actions to be taken to minimize disturbance to the turtles, Langford residents can play a significant role in the proliferation of the local western painted turtle population.

10.4 Recommendations for Future Projects

To ensure western painted turtle proliferation and greater overall ecological stability in the City of Langford, WPT Ecological Consulting recommends a series of studies and management plans that may be conducted over the coming years.

Royal Roads BSc Environmental Science students are required to complete an applied consulting project that has relevance in the environmental sector. A continuation of WPT Ecological Consulting's 2015 major project could include future projects as described below.

10.4.1 Invasive Species Inventory and Invasive Species Management Plan

Invasive species are capable of causing a great deal of harm by destabilizing ecosystems. A prime example is the American bullfrog, with its voracious appetite, lack of competition, and absence of control by predator. Invasive plants alter soil chemistry and out-compete native plants, reducing the amount of available forage material for herbivores. An invasive species inventory will catalogue the extent of their spread in Langford, and ideally inform the creation of a comprehensive invasive species management plan for the whole city. By protecting native species throughout Langford, local ecosystems will thrive, providing further benefits to painted turtles in the process.

10.4.2 Western Painted Turtle Population Characterization

To fully understand the state of western painted turtles in Langford, a comprehensive study to characterize the populations of western painted turtles with a focus on geographical, age and sex distribution should be carried out. Such a study should be carried out every five years to definitively measure population dynamics and to assess the effectiveness of turtle protection activities.

10.4.3 Habitat Connectivity Study

A study on the habitat connectivity between Langford, Glen and Florence Lakes may provide insight into how Langford could improve the resilience of the western painted turtle population in Langford. Langford Lake originally drained into Glen Lake, at which time turtles would have been able to travel freely between the two lakes. Florence Lake is in a separate watershed from the other two lakes, making migration of turtles between any of the three lakes in this study improbable.

10.5 Additional Recommendations

10.5.1 Retaining Wall Removal Incentives

As retaining walls around the lakeshores prevent turtles from accessing land for nesting, their removal would allow turtles to reach additional suitable nesting grounds. At the present time, residents are not allowed to build new retaining wall structures on their lakefront properties, meaning that retaining walls will be effectively phased out as they deteriorate over the coming years. If the City of Langford could devise a way to incentivise residents to remove their retaining walls and plant riparian vegetation, turtle access to nesting habitat would increase.

10.5.2 Amendment of Bylaw 550, 2001

Bylaw 550, 2001 prohibits the discharge of substances harmful to fish, aquatic plants or animals in any body of water (District of Langford, 2001). The section of the Local Government Act (s. 725.1) that provides the legislative backing for this bylaw was repealed in 2003, and since that time, no amendment has been made to update the bylaw (British Columbia, 1996). As it is written, section 3 of the bylaw states “No person shall discharge silt or other substance harmful to fish, or to aquatic plants or animals on which fish depend, into any stream, creek, waterway, watercourse, ditch or drain” (District of Langford, 2001). We recommend that this bylaw be amended, or a new bylaw be drafted to restrict the use of lawn fertilizers containing phosphorus in the City of Langford to reduce the amount of nutrient loading in local water bodies. The municipality of Greater Sudbury, ON has such a bylaw to draw from (Greater Sudbury, 2012). The District of Saanich Watercourse and Drainage Regulation Bylaw, 1996, No. 7501 provides a list of prohibited waste products, sets out provisions to protect watercourses and may serve as a local example of a comprehensive watercourse protection bylaw (District of Saanich, 1996). It should be noted that the Saanich bylaw does not restrict usage of fertilizer at this time.

10.5.3 Annual Review of Turtle Management Strategies

As Langford’s development continues, increasing levels of care will need to be taken to ensure that damaging effects to the lake ecosystems are reduced as much as possible. As such, we recommend that the Parks and Recreation Board mandate an annual review of turtle management activities that considers the successes, failures, and future plans for the coming years. This will ensure long-term implementation of habitat protection and human impact management.

10.5.4 Involve Habitat Acquisition Trust (HAT)

It is recommended that the City of Langford establish a working relationship with HAT who have the means to record and document western painted turtle reports from citizens, and allow them to post signs where appropriate (e.g. prompting people to report turtle sightings to HAT, such as turtles on the road). Additionally, the City of Langford should consult with HAT in the implementation of nesting and basking habitat improvements. As mentioned in Section 7.5 of this report, it would be prudent to facilitate the observation of weed harvesting activities by a professional biologist to determine if any harm is caused to painted turtles that are picked up by the harvester.

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Appendices

Appendix I – Identification Guide

Western Painted Turtle

IDENTIFICATION GUIDE

The **Western Painted Turtle** (*Chrysemys picta bellii*) is native to B.C. Two populations are recognized. The Pacific Coast population, found on southeastern Vancouver Island, some Gulf Islands and the Pacific Coast mainland, is designated as **Endangered**. The Intermountain-Rocky Mountain population found in interior B.C. is designated as **Special Concern**.

The **Western Painted Turtle** is difficult to tell apart from an introduced turtle, the Slider (*Trachemys scripta*). The Slider has been introduced into many areas of southern B.C. including Vancouver Island, Fraser Valley, and the Okanagan. Most Sliders are "released" pets.

From a distance Sliders and Western Painted Turtles appear similar and are easily mistaken for one another because:

- they occupy similar freshwater habitats and both bask on floating logs in ponds or lakes;
- they are active at similar times of the year (April – September);
- they are similar in size although Sliders grow larger, reaching 28 cm (11") compared to Western Painted Turtles which grow to 25 cm (9.8");
- their upper shells (carapace) are similar in colour, ranging from blackish green to olive (young turtles appear lighter but as the turtles age their shell darkens);
- the shape of the shell can also appear similar although Painted Turtle's carapace looks smoother and flatter.

The two turtles can best be identified by the **colour of their underside** (plastron). The underside of the Painted Turtle is red or orange while that of the Slider is yellow. Both species often have black markings on the plastron. It is, however, often difficult to see the plastron and it is recommended not to disturb the turtles by catching them. Instead, use binoculars to look for the characteristic **red ear mark** of the Slider behind the eye. Sometimes this mark may be yellow so look for other clues to confirm your identification, specifically colours on the side below the carapace or glimpses of the plastron (see ID key). If turtle does not appear to be either a Painted Turtle or a Slider, it may be the native Western Pond Turtle, or another introduced turtle. Several other species, including the Common Snapping Turtle and Asian Pond Turtle have also been introduced to B.C.

Native turtles are protected under the B.C. *Wildlife Act* and may not be held in captivity without a permit. Please do not release aquarium pets into the wild, they are harmful to our native species.

BRITISH COLUMBIA
The Best Place on Earth

Ministry of Environment

(BC Turtlewatch, 2008)

Appendix II – Photos and Maps

Figure 17 – Mill-end slab (top section of the log with bark retained) (© Karen K. Will, 2011)

Figure 18 – Fetching arch used to transport logs by hand and over land (© Maurice Pyle, n.d.)

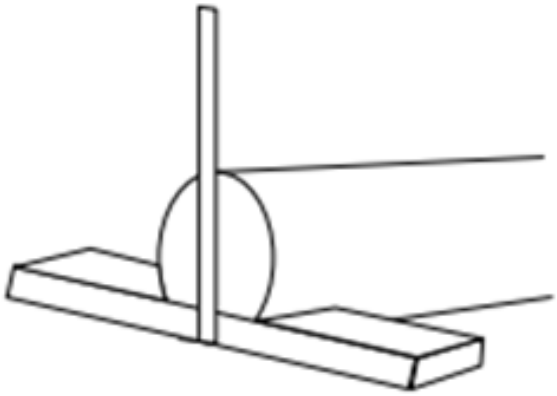

Figure 19 –- Basking log with stabilizing cross board (horizontal) and camera mount (vertical). Camera mount is optional (Ovaska & Engelstoft, 2013)

Figure 20 - Basking log structure at Swan Lake Nature Sanctuary

Appendix III – Sample Posters

What's with all the logs?

Photo Courtesy of Grace Brouwer

Western Painted Turtles are the only native pond turtles on Vancouver Island. They need surfaces such as logs on which to bask in the sun. Turtles bask to raise their internal temperature, to provide energy for digestion, and to rid themselves of parasites.

Please enjoy the turtles quietly from a distance. Being able to warm themselves in the sun is essential for their survival.

City of Langford

I have turtles on my property!

What can I do to help them?

- Learn to distinguish the native Western Painted Turtle from introduced red-eared sliders
- Reduce or re-direct run-off from your property into the lake
- Avoid the use of chemicals on your lawn and gardens
- Maintain septic systems in good working order
- Increase exposure of the shore to sunlight by trimming trees or shrubs
- Plant native shoreline or aquatic plants
- Remove excessive aquatic vegetation
- Install slanted basking platforms or logs in sunny areas and anchor them into the lake bottom or shoreline vegetation
- Reduce the grade of steep banks; consider removing portions of retaining wall
- Minimize disturbance to turtles
- If you observe nesting activities, you are encouraged to call Habitat Acquisition Trust
- Maintain good exposure to sunlight in nesting area
- Maintain sparse ground cover in nesting area
- Protect nesting sites from disturbance by human and pet activities

For further assistance, contact Habitat Acquisition Trust at 250.995.2428 or hat.bc.ca

City of Langford

Turtle habitat enhancement in progress!

Western Painted Turtles are the only native pond turtles on Vancouver Island. They need sunny places near water where the soil is easy to dig to lay their eggs. Nests are dug into the ground and are usually not visible. Hatchlings stay in the nest over the winter and emerge in the spring.

Please stay out of this area to avoid trampling the nests and hatchlings.

City of Langford

Appendix IV – Interview Questions

Questions for Turtle Experts

- What experience with or awareness of nest habitat creation do you have?
- Do you know of any instances when an artificial nesting habitat was successful/unsuccessful? Where? How? What substrate was used in constructing nesting habitat that was successful/unsuccessful?
- Do you know if red-eared sliders compete with western painted turtles? If so, do you believe it is possible they could displace the population of WPT?
- Would the proximity of installed basking logs to constructed nesting sites be advantageous for the turtles? Why?
- Would a shallow lake be suitable habitat for WPTs? Why?
- Would it be worthwhile to construct nesting habitat on such a lake to provide the opportunity for a turtle that has migrated there? Why?
- What is ideal surface area required for nesting ground (min-max)?
- What would you recommend as the minimum depth of substrate for nesting habitat?

Questionnaire for Public (done in the form of a conversational interview)

Script: Hello… my name is _____ and I'd like to invite you to be part of a research project that we are conducting as part of the requirement for a Bachelor's Degree in Environmental Science at Royal Roads University. The objective of our research project is to devise a management plan regarding the western painted Turtle habitat for the City of Langford. The survey should take no more than ten minutes, and I will not be collecting any information that could identify you as the source of the data.

Would you be interested in answering a few of our questions?

- How long have you lived on the lake?
- How often do you use the lake? For what purposes?
    - How many times a week? Per month?
    - Do you frequently walk or jog around the lake?
- Since you began living at the lake, have you ever seen turtles in this lake or in your backyard?
    - How many turtles have you seen at once? Lots or only a few?
    - How often do you see turtles? Where?
    - Which seasons/months do you see turtles?
    - If you've seen turtles recently, what time of day did you see them?
    - Where do you typically see the turtles?
    - Have you seen any nesting sites in your backyard, or heard of neighbors finding nesting sites on their property? Where?
- Have you noticed the signs at the Langford boat launch which illustrates turtles and their life cycles? Every time, sometimes, almost never, what signs
    - Do you find them effective in conveying their message or changing the behaviour of park users?
- Do turtles in the lake mean anything to you?
    - Do seeing turtles in the lake enhance the quality of your lake experience?

  - Do you have any concerns regarding the health of the lake?
  - Have you ever used the weed harvester? (Y/N)
    - If so, have you noticed or heard of it picking up turtles or other aquatic life? (Y/N)
    - If so, do you know how many or whether they were injured?
  - Would you be willing to volunteer time to maintain/enhance the health of the lake?
- Would you participate in volunteering to enhance turtle habitat? (Y/N) Why or why not?
  - Would you be interested in providing a portion of your property as a safe nesting or basking site for turtles?
  - What kind of activity would appeal to you? (nesting site creation/enhancement, public awareness…)
- How do you think the City of Langford could best communicate with its citizens about turtles?
  - What forms of media would you prefer the City of Langford use to communicate with you, (TV/radio/Facebook/Twitter/Newsletter/newspaper)?
  - How often do you keep up with the City of Langford's website?

Appendix V – Summary of Door-to-Door Interviews

On Saturday, May 2, 2015 and Sunday, May 23, 2015, WPT Ecological Consulting went door-to-door along the northern shore of Langford Lake to learn if any lakeside residents could provide any further insight to western painted turtle presence in Langford Lake, in particular, nesting activities. The number of responses in summarized in Table 2 and the responses from the residents we spoke to are summarized below.

Table 2 – Summary of door-to-door interview responses

Date	Responded/Provided Information	No Response	Declined/No Information
May 2, 2015	8	9	3
May 23, 2015	5	11	0

Saturday, May 2nd, 2015 (10 am – 12 noon)

- 2845 Lake End Road
    - (older man)
    - Lived on the lake over 40 years
    - Turtles used to lay eggs at neighbors, haven't recently
    - Cited a willingness to work with HAT
    - Communication preference: email
    - Mentioned 'Langford Lake Improvement District' as a potential method to communicate with residents
- 2843 Lake End Road
    - (older man – possibly multiple houses on property)
    - Lived on lake for 24 years
    - Seen turtles at the Warf sitting on the weeds outside
    - No nesting on property (retaining wall)
    - Communication preference: physical mail
- 2839 Lake End Road – no answer
- 2833 Lake End Road – declined (I think we woke her up)
- 2827 Lake End Road

    - Just moved in (September), hadn't seen turtles
    - Communication preference: physical mail (said she deletes all emails not work-related)
- 1321 Lake Vista – no answer
- 1317 Lake Vista – not home – spoke to gardener who hadn't seen turtles
- 2817 Lake End Road – no notes…
- 2815 Lake End Road
    - Hasn't seen turtles
    - Communication preference: letter in the mail
- 2811 Lake End Road
    - Lived on lake 9 years
    - Moving away soon
    - (showed us his back yard & dock)
    - Turtles don't often come up on property (mostly retaining wall fortified)
    - Said he's seen (or heard of) turtles laying eggs along bike trail (south side of lake)
    - Water level doesn't fluctuate much in Langford Lake
    - Seen some turtles in abandoned dock west of property (I think we took a pic of this from the canoe)
    - Large bass have reds (nests) right by his dock – may interfere with turtles
    - Communication preference: physical mail
- 2807 Lake End Road
    - Lived on lake for 6 years
    - Sees turtles 3-4 times a year
    - Showed us his back retaining wall & dock
    - Part of the Langford Lake Protection Society
    - Wants to get involved with weed harvester (cited Jeff Hett?) as contact
- 2823 Lakeshore Place – didn't have time to talk (politely declined)
- 2819 Lakeshore Place – no answer
- 2815 Lakeshore Place
    - Lived on lake for 15 years

  - Turtles lay eggs on his lawn
  - Said he had contacted HAT before and they sent him pamphlets
  - He's willing to work with them in the future to enhance nesting site
- 2811 Lakeshore Place – no answer
- 2807 Lakeshore Place – no answer
- 2805 Guyton Way – no answer
- 2797 Guyton Way – no answer
- 2793 Guyton Way – no answer
- 2789 Guyton Way – no answer

Sunday, May 23rd, 2015 (12 noon – 1:30 pm)

1253 Goldstream Ave.: Turtles nesting all the time, not sure that they are WPT

Nest in the gravel in their backyard. Has fencing to keep out geese, try to lift fence higher for turtles to be able to access.

Nesting each year in their backyard. Has basking structures. Turtles come up each day, for about a month. Will email us if they see turtles.

1217 Goldstream Ave.: Concerned the lake is becoming more weedy.

Development, health concerns

Development not caring about lake

Seeing turtles at the lake does enhance their experience

1215 Goldstream Ave.: Husband runs the weed harvester.

Trying to hire someone to run the weed harvester

Health concerns: low nitrogen

Development: nitrogen on grass.

Worried about nutrient loading

Building change

More weeds

Turtles on their beach

Mink lives under dock

Eagles

District 49: across Goldstream (tst.eclipsecreative.ca/district/)

Turtles not nesting on their property.

Turtles enhance their experience at the lake

1207 Goldstream Ave.: never seen turtles, lived there for 32 years.

1194 Goldstream Ave.: less fish, more algae. Less fish since aerator.

See turtles swimming, not nesting.

Does enhance experience at lake, kids love the turtles.

Appendix VI – Field Notes

Table 3 – Turtle Sightings at Langford Lake from March 31 to June 30, 2015; all observations made at the basking log adjacent to the boat ramp

Date	# of Turtles	Species	Weather	Time
March 31	2	WPT	7°C, mostly sunny	9:51
April 11	2	1 RES, 1 unidentified	7°C, 80% cloud cover	11:44
May 28	14	WPT	20°C, 0% cloud cover	13:51
June 30	7	WPT	0% cloud cover, light, intermittent winds, hot & humid	9:00

RES: Red-eared slider
WPT: Western painted turtle

Langford Lake – Locating Potential Nesting and Basking Sites for Creation/Enhancement

Saturday, April 11, 2015

10:30: Launched canoe from 2880 Leigh Road into Langford Lake. Overcast, cold, consistent, medium-intensity winds. Temperature around 7°C. Feels colder. Current in lake fairly strong, apparently difficult to paddle against. Water is quite choppy.

Near about 15 m from launch point, we located a potential basking site, which I marked on the map. There is no housing in this particular area, but houses to the left and the right. Trees shade the area, which is infested with blackberry. There are lily pads in front of the shoreline area. There is a chain link fence bordering the west side of the property, which is on the North bank of Langford Lake. GPS coordinates: 10 U 0416403 UTM 5366204. Elevation: 61 m. North.

10:42: We are just passing by the beach inlet and floating dock, with the aerator to the left of us, just off of Goldstream Avenue. This would be the first point of access to the lake from Goldstream, which I believe may be called Shelby Place. The sun is shining through behind us, as it is less overcast now. There is only about 30% cloud cover now.

10:56: We have landed at the east side of the first island. There is not much sun exposure to this side of the island, which is thickly vegetated. There is a Canada goose nest just 4 feet into the island, Dan says. GPS: 10 U 0460875 UTM 5366388. Elevation: 64 metres. North.

The south facing side is more sun exposed, but also thick with vegetation. There are many swallows sitting on the branches of the bushes. Above us, there are no clouds now. There are still clouds to the

north-west and to the south of us. The AccuWeather application on my phone states that the temperature is 8°C.

11:05: We have now entered the NE inlet, which is shaded from the wind and has less of a current. The water is much smoother here. The inlet is completely surrounded by housing, some of which have retaining walls bordering the shoreline. Photos were taken here. GPS coordinates: 10 U 0460809 UTM 5366593. Elevation: 69 metres. North.

11:17: There are clouds to the northwest, which appear to be grey stratocumulus clouds. We are heading towards the second, more western island. It is windy still. On the western side of the island, there are some areas without vegetation, but this is the least sun-exposed area on the island. It appears to be quite inhabited by geese. A Canadian goose just hissed at us. We've just spotted a female which appeared to be sitting on her nest.

The south-facing and east-facing sides of the island are more sun-exposed, but still highly vegetated and rocky. As we are now downwind of the island, we realize that the island smells awful. There is English ivy on the south side, which appears to be covered in some sort of white dust, potentially from the construction sites on the south portion of the lake, as Dan has pointed out. The smell coming from the island is extremely potent; the smell could be ammonia from the geese wastes.

11:24: I've taken photos of the NW side of the island.

11:26: I've taken photos of the northern shoreline at the western end of the lake.

11:32: The clouds have rolled in, with approximately 60% cloud cover. The clouds still appear to be grey stratocumulus clouds. We may be in for more rain. The western end of the lake is thickly vegetated by emergent aquatic plants and lily pads. It is "not very turtle friendly," – Dan B.

The clouds appear to be approaching from the south.

11:37: I've taken more photos of the western end of the lake. We are now in a little bay in between the boat launch and the fishing dock. It is more sheltered from the wind, but is reedy and thickly vegetated. Dan had a question about the age distribution of the turtles in the lake.

This bay would potentially be a decent spot for a basking log, as it has limited public access.

11:44: On the south western side of the lake, it feels less windy. The winds are cool, intermittent, and fairly light. We may be more shaded from the wind at this end. There is a huge amount of algae on the

plants in the water, however none on the surface of the lake. We are now approaching the public boat launch. There is 80% cloud cover, with dark grey stratocumulus moving quickly from the south. We have spotted one turtle on the basking log that exists to the east of the boat launch. After using binoculars and trying to get closer, Will and Dan believe it is a red-eared slider, not a western painted turtle. There is no red on the plastron, and there is a faint red stripe behind its ear. An avid fisher that is just getting off the lake says that he and his friend are out there all the time, but that is the first time that he has seen a turtle. He also says the fishing "sweet spot" is on the southern side of the island. I didn't catch which island he was talking about. We've just seen another turtle as we approached the basking log. The turtle was under the log, and we accidently spooked it. It appeared to be a WPT, but we could not positively identify it in time.

11:57: I have taken photos of the south end of the lake. There is one potential access point along the south shore, about 50 m to the east of the dock.

12:02: I have taken pictures of another potential access point along the south shore. There is a fairly sun-exposed potential basking site to the east of it.

There is another log along the south shore, which may be a potential basking site. However, it is not as sun-exposed (it is north-facing), is covered in algae, and it relatively thin. The land is thick with vegetation. Location: 10 U 0460583. UTM: 5366186. Elevation: 65 m.

12:04: it has begun to rain again. It is a steady, medium-intensity rain. It is overcast with very light, cool, steady winds.

12:12: The rain and wind have picked up. We are underneath the boardwalk along the south shore, nearer to the east end of the lake. This portion of the south shore is thickly vegetated and there are quite a lot of algae on the surface of the water. The algae appear to be attached to the lily pad stems. The water on south side of the boardwalk is almost completely covered in algae.

12:17: It is now completely overcast and the rain is fairly intense. We are on the south-facing side of the peninsula in that juts out into the lake. It does not appear to be very good turtle habitat, as it has lots of vegetation in some areas. There are some potential access points.

12:21: I have taken photos of the north side of the peninsula.

12:29: We saw a river otter, which was quite large – potentially over a half a meter long. It was on the east side of the lake on the shore, close to where we launched the canoe.

We just saw a small weasel, or it may have been a young otter.

There are big waves and the wind has picked up.

12:34: I have taken a picture of the first potential nesting site we located.

Glen Lake – Locating Potential Nesting and Basking Sites for Creation/Enhancement

Tuesday, April 28, 2015

11:33 – Launch from Glen Lake Beach. Overcast, light, intermittent rains and light, cool, steady winds. 14°C according to AccuWx application on phone. Paddling to the east.

11:39 – Invasive pond lilies to the east, also iris.

11:42 – Picked sample of emergent aquatic plants. Also took pictures. Tangled emergent branches.

11:44 – Pictures of possible nesting sites at east shores. Rain intensity has increased to steady, light rains. Retaining walls present for four house stretch, then none for one house, then resumes for the next house. None after that.

11:51 – Potential nesting site located 3 houses north of floating boardwalk. Log right by the floating boardwalk. Potential basking site. Photos taken of potential nesting site.

From 11:33 – 11:53 – Photos of east shore.

11:53 – Reached south end of lake by Galloping Goose Trail. Very thick emergent aquatic vegetation. Invasive yellow pond lily. Potential basking site in at south end, due to inaccessibility by humans.

12:00 – Potential basking site at the south end. Log not overly sun-exposed, picture taken. Dan mentioned that there is less *Daphnia* than when we visited earlier in the spring. South end thickly vegetated. Will noticed many insects associated with the vegetation surrounding the shoreline.

12:04 – Passing by public beach at south end, photo taken, potential nesting site. Retaining wall at property at the SW shoreline. Photos taken. Property beside thickly vegetated. Log sticking out of water, photos taken, potential nesting site.

12:11 – Potential nesting site on property. Easily accessible, appears to be recently tilled. Photos taken.

12:12 – Log beside dock, potential basking site. Photos taken, log has vegetation growing out of it, does not appear to be frequently used.

12:14 – Potential access point, potential nesting site. Sounds like we're passing where the water comes in.

12:15 – Property looks like a good potential nesting site. Photos taken, easily accessible, and thickly vegetated. Appears sandy.

12:18 – Fallen log right in front of us. Tree is already quite submerged, with the base and the tip being the only parts sticking out. May be good for basking, should get decent sun exposure.

12:21 – Approached a log beside a dock. It is anchored to the dock/shoreline, may be decent basking site.

12:24 – Docking boat. No longer raining, still overcast. Light winds.

Florence Lake – Locating Potential Nesting and Basking Sites for Creation/Enhancement

Tuesday, May 12, 2015

9:26 – Observing the south end of the lake. Lake is heavily vegetated with both native and invasive pond lily species. There are large sediment mounds that reach the surface; some plants are using them as root bases. Turtles may enjoy basking on the vegetation mats.

9:31 – Photos taken of the SE end of the lake and vegetation/sediment mounds.

9:34 – Photos of the boardwalk and sediment mounds. Grass and small bushes can be seen growing on the mounds.

9:38 – Paddling around the west side of the lake. Many potential access points onto the residential properties. Doesn't appear to be many waterfront retaining walls.

9:41 – Photos taken of potential basking site, which is a log along the shore that may get a decent amount of sun exposure during the earlier half of the day.

9:43 – Photos taken of area with tree debris, where sun would reach in the morning. Undeveloped area, also not thick with invasive pond lily. However, there doesn't appear to be any good potential nesting sites close by.

9:45 – Paddling around the north shore. Photos taken.

9:52 – Picture taken of log on east shore, may be a potential basking site.

9:54 – Photo taken of potential access point, which is used as a public access from which people can swim to a floating dock.

9:56 – Return to boat launch.

Wx conditions: overcast, light, cool intermittent winds. About 12°C according to AccuWeather application on the phone.