7.0 RECOMMENDATIONS

7.1 Foreshore Protection

The following provides a list of recommendations for foreshore protection. Some of the recommendations below are similar to other recent FIM reports that were completed for the North and South portions of Okanagan Lake. In cases of similarity, credit to the work should be given to the original authors. The following are recommendations for development of foreshore protection policies:

1. **A Shoreline Guidance Document (Step 3) should be developed by local government, the Province, First Nations bands, and Fisheries and Oceans for Okanagan Lake that includes the results of this analysis.** This inventory and cumulative analysis of Okanagan Lake provides a basis for a risk based approach to lake shore management and the framework for development of integrated management policies. The shoreline guidance document will facilitate inter governmental cooperation for lake shore management. Funding should be sought to complete this next step. A staged approach in the development of this guidance document may be required, with a series of interim measures developed to allow sufficient effort in the development of long and short term goals (see recommendations below regarding a lakeshore management plan). In the Shuswap, development of guidance documents such as this are being developed and they are considering the numerous different layers of data, including sensitive shore spawning sites. For these reasons, it should be relatively simple to incorporate both the aspects of the Okanagan Region Large Lakes Foreshore Protocol and results from this assessment into one shoreline guidance document.

2. **A clear set of objectives for the future need to be set and the objectives need to present desired objectives that are achievable.** The review of the 2004 and 2010 data indicate that change is occurring and it is potentially occurring at a fast rate. Clear objectives need to be set because it will help inform future management. Examples of clear targets include identifying the amount of natural and disturbed shore line that is a desired future condition and then using this methedology to determine if this goal has been met.

3. **Historical habitat impacts should be restored during development and re-development activities, with measures in place to ensure successful completion**. This analysis addressed habitat potential where restoration activities will benefit habitat quality. In review of development applications, existing modifications should be addressed with restoration or enhancement of foreshore areas affected by past modifications required if restoration or enhancement is likely to benefit habitat quality. Also, further modification to foreshore areas affected by past modifications should be prevented or mitigated. Examples include dismantling of groynes, placement of large woody debris, live staking and re-vegetating shoreline regions, riparian restoration, etc. Restoration objectives should be set higher in Low rated shoreline areas during redevelopment. There is significant opportunity

for partnerships (i.e., multi agency partnerships with stewardship groups) to be formed to help facilitate habitat restoration around the lakes. Further, it is strongly recommended that local governments develop restoration policies and objectives for disturbance areas to reverse the trends of impacts observed along the lake.

4. **The Very High and High shoreline areas are considered the most important areas around the lake and mechanisms to protect these key habitat features need to be developed.** This analysis highlights the importance of conserving important natural areas that remain and prioritizing habitat improvements where feasible. In review of development applications, the protection of critical and natural areas should be addressed. The data in this report should be utilized to identify shoreline areas that should be protected.

5. **Key shore line linkages to sensitive terrestrial habitat have been identified by this assessment. These habitat linkage areas are extremely important to maintain and should be identified as early as possible in the development process.** These linkages should be incorporated into the Okanagan Biodiversity Strategy and the Regional Growth Strategy that is currently being developed. Core habitat areas are larger scale areas[4] have been mapped and these areas should be considered during development. These areas typically contain or are associated with red listed ecosystems or habitats for species at risk and the shoreline areas Detailed assessments and identification of core habitat areas for conservation should be done as early in the development process as possible to reduce potential impacts from land use decisions (e.g., zoning a property for commercial purposes without understanding what values are present may result in a obligations for a minimum build-out that has significant impacts that are difficult to mitigate later on in the process). Numerous different possibilities exist for areas identified as sensitive, including Section 2.19 No Build / No Disturb Covenants, creation of Natural Areas Zoning bylaws (i.e., split zoning on a property), or by other mechanisms (donation to trust, etc.). Finally, these linkages should be incorporated into the proposed Okanagan Biodiversity Conservation Strategy, the RDCO Regional Growth Strategy that is currently being developed, and other local government planning documents as appropriate.

6. **Environmental information collected during this survey should be available to all stakeholders, relevant agencies, and the general public.** Environmental information, including GIS information and air photos, are an extremely important part of the environmental review process because they provide extensive information regarding the current condition of an area. This information should be available to the public.

[4] These habitat linkages are difficult to identify on a property basis through a simple setback assessment like the Riparian Areas Regulation assessment)

7. **Compliance and enforcement monitoring of approved works is required, with consequences for failure to construct following standard best practices or failure to apply for necessary permits.** There were numerous examples of historical and recent poor practice observed during this survey and other surveys of interior lakes have identified similar problems. An increase in compliance and enforcement monitoring at all levels of government is required because current practices do not appear to be working effectively (i.e., there were numerous, recent examples of construction inconsistent with BMPs). There is the potential to investigate a coordinated enforcement protocol with all levels of government to respond to foreshore habitat impacts.

8. **Habitat losses and gains should be monitored to measure success.** This would include the development of indicators, actions and timelines and initiation of a detailed habitat monitoring program on Okanagan Lake. Results of the monitoring program should be compared to the original inventory data to determine compliance with best management practices and effectiveness of protection activities.

9. **Development and use of best practices for construction of bioengineered retaining walls is required.** Bioengineering has many different meanings. Concise guidelines and best management practices should be developed that is consistent with standard practices of bioengineering. During the assessment numerous examples of recently constructed walls that were not compliant with standard BMPs were observed.

10. **A communication and outreach strategy should be developed to inform stakeholders and the public of the findings of this study and improve stewardship and compliance**. Initially, it is recommended that notice of the availability of this report and associated products are available on the Community Mapping Network and the Okanagan Conservation Planning website atlas's. The outreach strategy is required because many people are not aware of the impacts of their activities and are also not fully aware of appropriate and governing legislation for development activities adjacent to shoreline areas. . Funding should be sought to address outreach activities and address local government implementation.

11. **Lake shore erosion hazard mapping should be conducted for private lands to identify areas at risk, which will stream line the review process and reverse the damaging trend of unnecessary hard armoring and construction of retaining walls along the shoreline.** This methodology would be helpful to identify areas that are sensitive to boat wake erosion. The province has formalized methodology for lakeshore hazard mapping and this methodology, or some adaptation of it (Guthrie and Law, 2005). This mapping should be integrated with the FIM data, and be completed for each segment. Flooding, terrain stability, alluvial fan hazard mapping should also be considered for developing areas along the lakeshore. Until lakeshore erosion hazard mapping is completed, it is advisable to only consider shoreline protection works on sites with demonstrated shoreline erosion. To accomplish this, reports by engineers or biologists should accompany proposals for

shoreline armoring to ensure that works are required to minimize impacts and use bioengineering techniques. It may be possible to utilize the existing FIM map base, plus other associated data (e.g., SEI or others) to identify areas more prone to shoreline erosion.

12. **Storm water management plans need to be more adequately considered in all development applications.** There are numerous examples of local storm water concerns from adjacent land development related impacts. Recent works conducted by the District of West Kelowna have indicated that the Smith Creek corridor is experiencing rapid erosion due to storm water discharge. Other examples include the accidental release of pollutants to Mill Creek during a fire at a commercial complex in the City of Kelowna. Each of these examples highlights how, even non adjacent storm water has the potential to influence water quality, fish and wildlife populations, and human health (because most storm water is associated with increased levels of fecal coliforms and potentially other contaminants). In urban areas, focus of storm water plans should be to correct historical systems that have little detention and result in direct release to either a stream or the lake.

13. **Local, provincial, and federal governments should only approve proposed developments with net neutral or net positive effects for biophysical resources.** Developments on Okanagan Lake have generally only been considered individually. This is likely the first assessment that has looked at development related impacts on a lake wide scale. The results indicate that cumulative impacts are measurable and that trends are pointing towards increased or further impacts if management is not revised. This is analogous to the saying "Death by a thousand cuts" and local governments should ensure that development proposals do not add to the ongoing impacts observed around the lake.

14. **Compensatory works resulting from projects or portions of projects that could result in harmful alterations, destruction, or disruption of fish habitat must follow the DFO Decision Framework for the Determination and Authorization of Harmful Alteration, Disruption or Destruction of Fish Habitat[5]. The works must be consistent with the "No Net Loss" guiding principle of The Department of Fisheries and Oceans Policy for the Management of Fish Habitat.**

15. **Habitat enhancements should not be considered in cases where incomplete or ineffective mitigation or compensation is proposed.**

[5] Note that the Riparian Areas Regulation does not address habitat compensation requirements because they fall under the jurisdiction of Fisheries and Oceans Canada.

16. **Habitat mitigation and compensatory efforts of biophysical resources should occur prior to, or as a condition of any approval of shoreline-altering projects.** To ensure that works are completed, estimates to complete the works and bonding amounts should be collected. These bonds will ensure performance objectives for the proposed works are met and that efforts are constructed to an acceptable standard.

17. **Development of land use alteration proposals should only be approved if the compromises or trade-offs will result in substantial, long-term net positive production benefits for biophysical resources.**

18. **Low impact recreational pursuits (biking, non motorized boating, etc.), pedestrian traffic and interpretive opportunities should be encouraged**. These activities should be directed to less sensitive areas, and risks to biophysical resources should be considered. Only activities that will not diminish the productive capacity of biophysical resources should be considered.

19. **Helical screw anchors should be utilized as a first choice for mooring buoy anchors.** The significant numbers of mooring buoys with concrete anchors has been identified as a measurable loss of productive habitat. All current mooring buoys and any new mooring buoys should be installed using screw anchors and should follow other applicable legislation.

20. **A lakeshore management plan developed jointly by all three levels government and First Nations is required to ensure an integrated shoreline management approach across jurisdictions is achieved.** There has been a dramatic increase in the desire to live and recreate on or near Okanagan Lake. The increased development pressure is resulting in a significant number of moorage applications (either public or private) and development proposals to increase density along the shoreline. The analysis of historical data indicates that change is occurring and in some cases at a fairly fast pace. Local, provincial, and federal agencies need to identify what the maximum proposed build out for Okanagan Lake will be and develop a cross jurisdictional plan to achieve this goal. The management plan should incorporate the clear set of objectives recommended above to provide guidance on whether management measures are achieving success. The development of this document should be made sooner rather than later, because it is probable that there will be a continued incremental loss over time as rural properties are proposed for increased density. Although the specific rates of changes cannot be accurately predicted at this time using data currently available, nearly all metrics for rates of change (e.g., Percent Natural Shoreline, Number of Modifications, etc.) indicated that the state of the shoreline is declining. If the build out on the lake does not occur with coordination at all levels of government, the impacts identified in this report cannot be effectively mitigated (i.e., it is better to work as part of a larger regional initiative than as solitary jurisdiction). Further, if the build out occurs without implementation of appropriate measures, it is possible that some of

the rates of change documented here could occur on similar orders of magnitude. Items to consider when developing more long term management objectives include:

- **a.** addressing substrate alteration occurring around the lake to prevent further degradation of important kokanee spawning habitats, remaining wetland areas, and important floodplains. Substrate modification occurred along 47% of the shoreline and was, by far, the most significant impact observed around the lake;
- **b.** implementing sufficient measures, including ensuring adequate budget, to provide for a long term watershed management approach. The Okanagan Basin Water Board is currently an agency that has taken a leadership role in this aspect and is developing valuable tools for better water management;
- **c.** addressing construction of moorages in Very High and High value areas by identifying areas where moorage is not appropriate. Appropriate alternatives should be developed to address moorage shortages that may arise in areas deemed unsuitable for moorage. Ultimately, a moorage plan for the lake as a whole should be developed that considers habitat sensitivity, recreational carrying capacity, and other identified factors;
- **d.** adjusting terms of occupation to ensure foreshore protection measures are incorporated (e.g., shorter moorage tenure terms with renewal based upon foreshore condition) and that public resources are appropriately protected (e.g., kokanee stocks).
- **e.** providing sufficient moorage and boat access (e.g., boat ramps, parking, etc.) in appropriate locations to offset concerns in Very High and High value areas;
- **f.** incorporate on land storage facilities for boats with good boat access facilities;
- **g.** consideration should be given to inclusion of public moorage in all private moorage facilities as a mechanism to offset demands in areas where moorage is not favoured;
- **h.** identifying and preserving key linkages to areas identified as Core Conservation Areas, Wildlife Corridors, or Other Important terrestrial areas;
- **i.** addressing the presence of critical kokanee spawning areas;
- **j.** addressing the presence of important waterfowl, including identifying appropriate boating and recreational best use practices that will help avoid impacts to Western Grebe nesting areas in the North Arm;
- **k.** ensuring that the lakeshore management plan considers the Biodiversity Conservation Strategy currently being developed for the Okanagan Basin;
- **l.** identifying important drinking water intakes and incorporating appropriate buffers to avoid potential impacts with associated land development activities;
- **m.** include allowances to address known data gaps (some have been identified in this report), including identification of other key habitat elements around the shorelines of Okanagan that are not included in this analysis. Key linkages not considered include herptile access locations, rare plant communities, etc.; and,

n. identifying the most appropriate mechanisms for compliance and enforcement monitoring. Consistent and easily enforceable compliance mechanisms are required because it is apparent that substantial works have occurred that are not in compliance with standard best practices;
o. include regulations and guidelines for new development, re-development and management of existing development;
p. designate protection of critical areas;
q. explore a memorandum of understanding with all levels of government regarding foreshore management roles and responsibilities;
r. consider other shoreline development guidelines and foreshore plans completed or currently being developed for Okanagan Lake.

7.2 Future Data Management

Future data management is extremely important to ensure that data collected during this survey is available, accurate, and up to date. Future data collection should be integrated into this concise GIS dataset. The following are recommendations for future use of the FIM dataset:

1. **One agency should take the lead role in data management and upkeep**. This agency should be responsible for holding the "master data set". Although the data may be available for download from numerous locations, one agency should be tasked with keeping the master copy for reference purposes. The Community Mapping Network is currently publishing many of the data sets that have been collected. Sufficient funding must be allocated to CMN to keep up with management of the data because as there becomes more datasets costs of management will increase. Formal data management may however, be best achieved by the Okanagan Basin Water Board, which has funded most of the GIS inventory works. Another possibly more feasible, local option is the OCCP through the Okanagan Habitat Atlas program. Again however, sufficient funding needs to be in place to appropriately manage and keep the data.

2. **A summary column(s) should be added to FIM GIS dataset that flags new GIS datasets as they become available.** Examples of this include new location maps for rare species, fish, etc. Other examples include the addition of appropriate wildlife data. Where feasible, these new data sets should reference the shore segment number (see below).

3. **The Segment Number is the unique identifier. Any new shoreline information that is provided should reference and be linked to the shore segment number.**

4. **Review and update of FIM/AHI and mapping should occur on a 5 year cycle.** Review and update of the FIM will be required to determine if shore line goals and objectives are being achieved. The analysis within this report have identified that 6 years is a sufficient period of time to document change. For this reason, the timing of inventory cycles should be around 5 years. In a perfect world, changes to the FIM data set would be done as projects are approved (i.e., real time). However, at this time, it is unlikely that capacity exists to establish such a system.

7.3 Future Inventory and Data Collection

The following are recommendations for future biophysical inventory that will help facilitate environmental considerations in land use planning decisions:

1. **Data regarding shore spawning locations for resident fish species is limited.** Numerous resident fish species, including burbot, lake whitefish, and rainbow trout have been identified within the lake system. In our review, there is only limited data regarding shore or stream spawning locations for these fish species. Future inventory of important areas for these species should be conducted. This is one of the operational management recommendations for Okanagan Lake (Redfish Consulting, 2007).

2. **The Juvenile Rearing Suitability Index should be field confirmed**. The rearing index that was developed for this project is based upon surveys in Shuswap Lake and a rearing index developed for Mabel Lake. There are differences between the Mable Lake and Okanagan Lake and the index utilized for this assessment should be adjusted according to results of a field program that samples different shore line areas and types during different seasons. This type of analysis could also be replicated across different lake types to better assess the relative value of different shoreline areas to juvenile salmonids. Similar investigations into utilization and importance of the different shore types by resident fish stocks may also yield information regarding the relationships between juvenile rearing suitability, fish stocks, and shore type.

3. **A field sampling program of the different shoreline areas should be developed to confirm the results of the AHI**. The AHI has been developed based upon information that is currently available for Okanagan Lake, upon review of other studies, and air / GPS stamped still photo / GPS Video. However, numerous assumptions have been built into the index and a field sampling program should be developed to confirm the results of the assessment and to test assumptions of the index.

4. **In addition to the Western Ridged Mussel mentioned in this assessment, other bivalves are present in Okanagan Lake and should be inventoried to identify any species of significance and their importance with the lake system.** Bivalves are good species to use as indicators. By mapping known locations, and identifying their spatial extents, it will be much easier to monitor future change in the populations. Further, monitoring of these populations may point to early warnings if the lake system is not functioning properly.

5. **The Sensitive Habitat Inventory and Mapping (SHIM) is a GIS based stream mapping protocol that provides substantial information regarding streams and watercourses and should be conducted on all watercourses around the lake**. Most of the streams in the Central Okanagan have been mapped using the SHIM protocol. However, there are still numerous important waterways that have not been mapped. These include some of the important source water streams. Continued mapping should focus on significant salmonid rivers and streams first, on smaller tributaries containing less fish habitat, followed by non fish bearing waters. This mapping protocol provides useful information for fisheries and wildlife managers, municipal engineering departments (e.g., engineering staff responsible for drainage), and others. This information is also extremely useful for Source Water Protection initiatives because it identifies potential contaminant sources in an inventory.

6. **Future shore spawning enumerations should identify the spatial locations of spawning activity for other fish species in a spatial fashion.** Shore areas are critical habitat features necessary to the maintenance of healthy populations. Spatial data regarding the locations and numbers of individuals will allow for species other than kokanee and will help managers to track changes over time and better relate changes in the watershed to changes in fish production. GIS enumeration will be a key component of any successful, long term fisheries management project. This is one of the operational management recommendations for Mable Lake (Redfish Consulting, 2007).

7. **Wetlands are extremely productive and important components of our ecosystems and these features should be inventoried**. Numerous low flood and mid flood benches and shore marshes were mapped during this survey. Detailed Wetland Inventory and Mapping (WIM) of these features are recommended. Detailed mapping of terrestrial wetlands is also important to ensure that linkages between foreshore and upland areas are achieved.

8. **An inventory of high value habitat islands in urbanized areas should be conducted in areas of concentrated settlement.** In many cases, small sections of higher habitat quality were observed in segments ranked Moderate to Low. These areas were typically areas that had well-established native vegetation or relatively natural shorelines. Development applications proposed in these "islands" of higher habitat quality should avoid disturbance to these "islands" as much as possible. A survey of these small "islands" would clarify which segments contain "islands" and would help aid planning objectives. This could form part of a riparian mapping exercise, where all shoreline vegetation is mapped and coded appropriately (e.g., coded and lawn, landscaped, coniferous, riparian, etc.).

9. **A carrying capacity analysis of the lake should be completed.** In this case, the carrying capacity refer's to a lakes ability to accommodate recreational use (e.g., boating) and residential occupation without compromising adjacent upland areas, biological resources, aesthetic values, safety, and other factors. Biological systems are extremely difficult to predict and manage. Currently, these fish and wildlife ecosystems are experiencing rapid changes due to a variety of factors including, but not limited to land development (e.g., water consumption may be exceeding the capacity of some streams, etc.) and climate change. At this point, it appears that the significant biological resources around the lake are maintaining viable populations. Determining the threshold upon which cumulative effects will have measurable and noticeable impacts is very difficult and therefore a conservative or precautionary approach is required. Determining carrying capacities on our large, interior lake systems is currently one of the most significant challenges to lakeshore management because it impacts many cultural, social, and environmental values of residents.

10. **A survey should be conducted on a home by home basis to help educate home owners.** A home owner report card could be prepared that would provide land owners with a review of the current condition of their properties. The assessment should provide them with sufficient information to assist land owners work towards improving habitats on their property. This assessment is not intended to single out individual owners, but rather to help owners understand the importance of habitat values present on their properties.

11. **The addition of new segment breaks in long segments should be assessed in the future.** Some segments, predominantly in more natural areas, are quite long. Future mapping updates may wish to assess some new segment breaks on longer segments as more information is collected. Features should be considered as part of more detailed segment mapping include the locations of small tributaries, seepages, streams in natural areas, etc.

12. **Native beds of submergent and floating vegetation should be mapped in detail.** Native beds of submergent and floating vegetation were extremely rare on Okanagan Lake. More detailed mapping, maybe as part of a Wetland Inventory and Mapping project, would help better classify and described these rare, sensitive features. A good example of these communities is located in *Segments 93 and 84.*

13. **Conduct a more detailed analysis of habitat restoration opportunities, including riparian restoration.** An Aquatic Restoration potential analysis (AHI_POT) which was completed by removing instream features from the AHI results. This analysis provides a summary of potential locations where habitat improvements are possible along the shoreline. This analysis *does not consider improvements to riparian vegetation*. A more detailed analysis of habitat restoration opportunities, including riparian restoration is advised in the future because riparian restoration activities will provide substantial habitat benefits to the lake.

14. **Further research on the extents and magnitude of AHI devaluation due to construction of modifications is required.** The common modifications that were observed that could be easily quantified were added to the habitat index. The devaluing effects of modifications were determined through a series of iterations and are consistent with other large lakes. Further research is needed to confirm the approach taken and the weightings applied to different factors in the analysis.

8.0 CONCLUSIONS

The following report documents the current condition of 289 km of shoreline on Okanagan Lake. The assessment provides substantial background information summarizing the current condition of the upland and terrestrial zones and foreshores of Okanagan Lake. An Aquatic Habitat Index (AHI) was developed that used biophysical information collected during the survey to rank the relative environmental sensitivity of the shore zone areas around the lakes. Recommendations are presented to help integrate this information into local land use planning initiatives.

Approximately 43% of the shoreline that remains in natural condition and represents approximately 125 km of shoreline. In total, 30% of the shoreline is ranked as Very High Value and these very high habitat value areas tended to occur stream confluences, or their associated floodplains, or on gravel and rocky shores with suitable kokanee spawning habitats. Approximately 1.1% is ranked very low value and these areas tended to be on low gradient gravel and sand areas that have been severely impacted.

The most notable shoreline modifications that were observed were docks, retaining walls and groynes. In total, approximately 47% of the shoreline has had substantial substrate modification from groynes, beach grooming or construction of retaining walls. These impacts, along with riparian vegetation disturbance, are considered the most significant habitat degradations observed around the lake.

REFERENCES

Adams, M.A., and R. Haycock. 1989. Shuswap Lake Mointoring Program. Completed by ECL Envirowest Consultants Ltd. Prepared for: Fisheries and Oceans Canada. Draft Report.

Bison and Associates, 1991. Population and Habitat Characteristics for Spawning Lake Char (*Salvelinus namaycush*) in Shuswap lake. Prepared for Ministry of Environment.

Burger, Alan. 1997. Status of the Western Grebe in British Columbia. Minstry of Water, Land, and Air Protection. Wildlife Working Report WR-87.

Carrasquero, J. 2001. Overwater Structures: Freshwater Issues. Prepared by: Herrera Environmental Consultants. Prepared for: Washington Department of Fish and Wildlife. April 12, 2001.

DFO, 1995. Salmon Escapement Data System. Unpublished data.

Haney, A. and K. Iverson. 2009. Conservation Analysis and Updated Ecosystem mapping for the Central Okanagan Valley: Central Okanagan, South Slopes, Kelowna Ellison, and Joe Rich Project Areas. Prepared for the Okanagan Collaborative Conservation Program.

Iverson K. and P. Uunilla. 2006. Sensitive Ecosystems Inventory: Lake Country, 2005. Volume 2: Terrestrial Ecosystem, Terrain, Terrain Stability. And Surface Erosion Mapping and Expanded Legend. *The Lake Country 2005 SEI data was also used in the assessment of the Study Area.*

Iverson, K. and J. Shypitka. 2008. Sensitive Ecosystem Inventory (SEI) Based on Terrestrial Ecosystem Mapping: Bella Vista – Goose Lake.

Iverson, K. P Uunila, A. Haney and M. Sarell. 2008. Sensitive Ecosystem Inventory (SEI) Based on Terrestrial Ecosystem Mapping: Vernon Commonage.

Iverson, K. D. Curran, T. Fleming, A. Haney. 2008 Sensitive Ecosystem Inventory Okanagan Valley: Vernon to Osoyoos. Technican Report Series Number 495.

Graham, C.C., and L.R. Russell. 1979. An Investigation of Juvenile Salmonid Utilization of the Delta-Lakefront Areas of the Adams River, Shuswap Lake. Fisheries and Marine Service Report 1508. April 1979. Fisheries and Oceans Canada.

Guthrie, R.H., and P.D. Law. 2005. Lakeshore Erosion Hazard Mapping. B.C. Ministry of Environment, Nanaimo, BC. Technical Handbook No. TH1. 30 pp.

Kahler, T, M. Grassley, D. Beauchamp. 2000. A summary of the effects of bulkheads, piers, and other artificial structures and shore zone development on ESA-listed salmonids in Lakes. Prepared for: City of Bellevue, WA. Prepared by: Tom Kahler, The Watershed Company Kirkland, WA.

Koonce, J.F., V. Cairns, A. Christie, D. Dodge, A. Hamilton, H. Lickers, B.McHattie, D. Roseboom, and C. Wooley. 1996. A commentary on the role of institutional arrangements in the protection and restoration of habitat in the Great Lakes. Can. J. Fisheries and Aquatic Sciences. 53:(Supplemental 1): 448-465.

Mason, B. and J. Booth. 2004.Coastal Shoreline Inventory and Mapping. Community Mapping Network. Vancouver, BC.

Magnan, B. and T. Cashin. 2004. Regional District of Central Okanagan, 2005. Okanagan Lake Foreshore Inventory and Mapping:. Kelowna, BC.

Mason, B., and R. Knight. 2001. Sensitive Habitat Inventory and Mapping. Community Mapping Network, Vancouver, British Columbia. 315pp + viii. M. Johannes, Editor.

Mackenzie, W.H., and Jennifer Moran. 2004. Wetlands of British Columbia - A guide to identification. British Columbia Ministry of Forests, Forests Science Program. 287pp.

McPherson S. and D. Hlushak. 2008. Windermere Lake Fisheries and Wildlife Habitat Assessment. Consultant report prepared for the East Kootenay Integrated Lake Management Partnership. Prepared by Interior Reforestation Co. Ltd., Cranbrook, BC.

MoE, 1998. Field Manual for Describing Terrestrial Ecosystems. BC Ministry of Environment, Lands, and Parks and BC Ministry of Forests. Land Management Handbook 25.

Murphy, S.M. 2001. Development and Assessment of the Effectiveness of Fish Habitat Compensation Plans for infilling projects on Georgian Bay and Lake Simcoe, Ontario. Research and Development Monograph Series, 2001. Prepared by: Azimuth Environmental Consulting Inc.

Nedeau, N., A.Smith, J. Stone. Date Unknown. Freshwater Mussels of the Pacific Northwest. US Fish and Wildlife Service.

Piaskoski, R.M., and R.A. Tabor. 2001. Nocturnal habitat use by juvenile Chinook salmon in nearshore areas of southern Lake Washington. U.S. Fish and Wildlife Service. Lacey, Washington.

RDCO, 2008. Major Lakes Recreational Marine Facilities Study. Prepared by: GDH Solutions. Prepared for the Regional District Central Okanagan.

RDCO, 2007. Central Okanagan Lake Foreshore Plan. Prepared by the RDCO, Development Services Department.

Redfish Consulting, 2007. Okanagan Region Large Lakes Fisheries Operational Management Plan. Nelson, BC

Russell, L.R., C.C. Graham, A.G. Sewid, D.M. Archibald. 1981. Distribution of Juvenile Chinook, Coho, and Sockeye Salmon in Shuswap Lake – 1978 – 1979; Biophysical Inventory of Littoral Areas of Shuswap Lake 1978. Fisheries and Marine Service Manuscript Report No. 1479. Fisheries and Oceans Canada.

Schleppe, J. and D. Arsenault. 2006. The Kelowna Shore Zone Fisheries and Wildlife Habitat Assessment. EBA Consulting Engineers and Scientists. Project File: 0808-8840209. March 2006. Prepared for the City of Kelowna.

RIC. 2001. Reconnaissance Fish and Fish Habitat Inventory: Standards and Procedures. Prepared by: BC Fisheries Information Services Branch. Prepared for: Resources Inventory Committee.

GLOSSARY OF TERMS AND ACRONYMS

Alluvial Fan / Stream Mouth – Alluvial fans are considered to be areas where a stream has the potential to have a direct active influence (e.g., sediment deposition or channel alignment changes) on the lake.

Allocthonous Inputs - Organic material (e.g., leaf litter) reaching an aquatic community from a terrestrial community.

Anadromous – Anadromous fish as sea run fish, such as Coho, Chinook, and Sockeye salmon.

Aquatic Habitat Index (AHI) -The index is a ranking system based upon the biophysical attributes of different shoreline types. The index consists of parameters such as shore type, substrate type, presence of retaining walls, marinas, etc. to determine the relative habitat value based upon a mathematical relationship between the parameters.

Aquatic Vegetation – Aquatic vegetation consists of any type of plant life that occurs below the high water level. In some instances, aquatic vegetation can refer to grasses and sedges that are only submerged for short periods of time.

Biophysical – Refers to the living and non-living components and processes of the ecosphere. Biophysical attributes are the biological and physical components of an ecosystem such as substrate type, water depth, presence of aquatic vegetation, etc.

Best Management Practice (BMP) - Is a method or means by which natural resources are protected during development or construction. For example, the Ministry of Environment have been recently creating documents containing guidelines for work in and around water.

Emergent Vegetation - Emergent vegetation includes species such as cattails, bulrushes, varies sedges, willow and cottonwood on floodplains, grasses, etc. Emergent vegetation is most commonly associated with wetlands, but is also occurs on rocky or gravel shorelines.

Fisheries and Oceans Canada (DFO) – Federal agency responsible for management of fish habitats

Fisheries Productivity - The maximum natural capability of habitats to produce healthy fish, safe for human consumption, or to support or produce aquatic organisms upon which fish depend.

Floating Vegetation - Floating vegetation includes species such as pond lilies and native pondweeds with a floating component.

Foreshore – The foreshore is the area that occurs between the high and low water marks on a lake.

Foreshore Inventory Mapping (FIM) -FIM is the methodology used to collect and document fish and riparian habitats lake corridors and was performed by the Regional District of Central Okanagan and partners. A full discussion of this mapping can be found in Regional District of Central Okanagan (2005)

Georeferencing - Georeferencing establishes the relationship between page coordinates on a planar map (i.e., paper space) and known real-world coordinates (i.e., real world location)

Groyne – A protective structure constructed of wood, rock, concrete or other materials that is used to stop sediments from shifting along a beach. Groynes are generally constructed perpendicular to the shoreline

Instream Features – Instream features are considered to be construction of something below the high water mark. Instream features may include docks, groynes, marinas, etc.

Lacustrine – Produced by, pertaining to, or inhabiting a lake

Lentic - In hydrologic terms, a non-flowing or standing body of fresh water, such as a lake or pond.

Life History – Life history generally means how an organism carries out its life. Activities such as mating and resource acquisition (i.e., foraging) are an inherited set of rules that determine where, when and how an organism will obtain the energy (resource allocations) necessary for survival and reproduction. The allocation of resources within the organism affects many factors such as timing of reproduction, number of young, age at maturity, etc. The combined characteristics, or way an organism carries out its life, is a particular species' life history traits.

Lotic – In hydrologic terms, a flowing or moving body of freshwater, such as a creek or river.

Non Anadromous – Non anadromous fish are fish that do not return to the sea to mature. Examples include rainbow trout (excluding steelhead), bull trout, and whitefish.

Retaining Wall – A retaining wall is any structure that is used to retain fill material. Retaining walls are commonly used along shorelines for erosion protection and are constructed using a variety of materials. Bioengineered retaining walls consist of plantings and armouring materials and are strongly preferred over vertical, concrete walls. Retaining walls that occur below the Mean Annual High Water Level pose a significant challenge, as fill has been placed into the aquatic environment to construct these walls.

Sensitive Habitat Inventory Mapping (SHIM) - The SHIM methodology is used to map fish habitat in streams.

Shore zone - The shore zone is considered to be all the upland properties that front a lake, the foreshore, and all the area below high water mark.

Streamside Protection and Enhancement Area (SPEA) - The SPEA means an area adjacent to a stream that links aquatic to terrestrial ecosystems and includes both the existing and potential riparian vegetation and existing and potential adjunct upland vegetation that exerts influence on the stream. The size of the SPEA is determined by the methods adopted for the Provincial Riparian Areas Regulation.

Stream Mouth / Stream Confluence / Alluvial Fan – Stream mouths are considered to be areas where a stream has the potential to have a direct active influence (e.g., sediment deposition or channel alignment changes) on the lake.

Submergent Vegetation – Submergent vegetation consists of all native vegetation that only occurs within the water column. This vegetation is typically found in the littoral zone, where light penetration occurs to the bottom of the lake. Eurasian milfoil is not typically considered submergent vegetation as it is non native and invasive.