5.3 Aquatic Habitat Index Analysis

A brief summary of the shoreline lengths and shore types is presented. The summary provides information regarding the AHI results (Very High to Very Low) analyzed by shore type, including the percent of the shoreline that is within each of the AHI categories.

6.0 RESULTS

The following section provides an overview analysis of the Okanagan Lake system. Data is presented graphically and summarized text for ease of interpretation. Data tables for the different analyses are presented in Appendix B.

6.1 Biophysical Characteristics of Okanagan Lake

Foreshore Inventory and Mapping was completed on 289,311 m (289 km) of shoreline on Okanagan Lake. The total length of disturbed shoreline was 164,226 m (164 km), which represents 57% total length (Figure 2). The total length of natural shorelines was 125,085 m (125 km) or 43% of the total length (Figure 4).

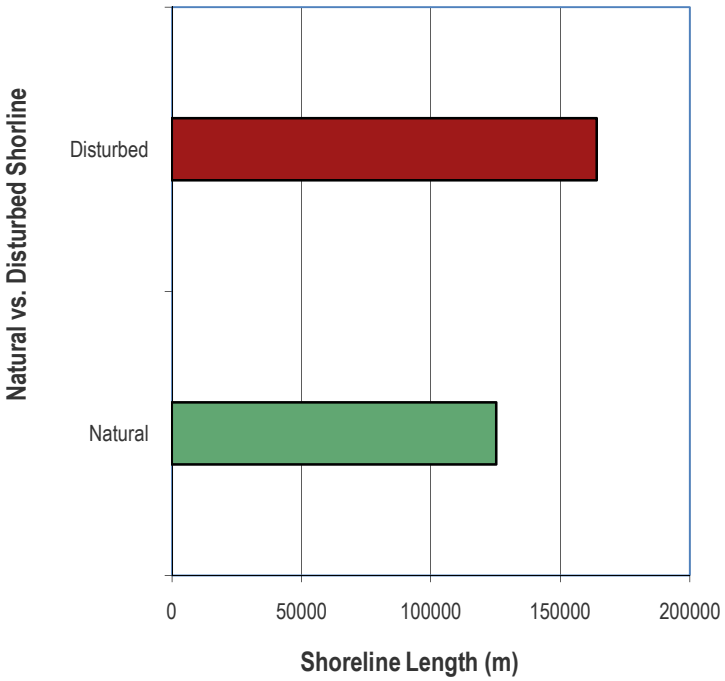


Figure 2 The length of natural or disturbed on Okanagan Lake

The slope analysis is a summary of slope categories (% slope) that occur in upland areas above the high water mark. Not surprisingly, areas of a lower gradient tend to have the highest level of disturbance given their relative ease to develop. A total 104 km of low gradient slopes and these slopes were 86% disturbed. Along steeper shorelines in Okanagan Lake, disturbance only occurred along 32% (27.4 km) and 35% (15 km) of the steep and very steep shore lengths respectively. Benches and Moderate gradient areas on Okanagan Lake were disturbed along 60% (5.2 km) and 58% (26.6 km) of their respective shore lengths within these slope categories.

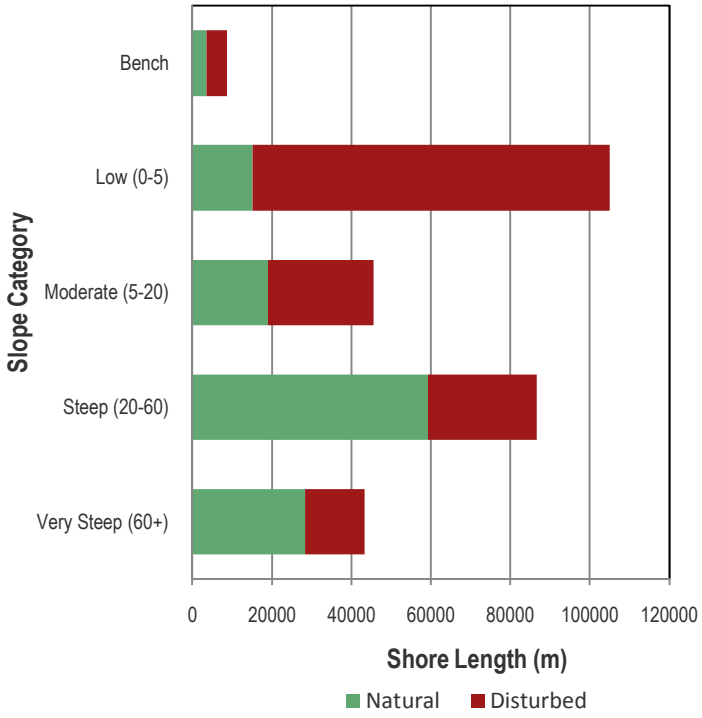


Figure 3 The natural and disturbed shore lengths that are either natural or disturbed within areas of different shore gradients around Okanagan Lake

The following provides a definition of the Land Use categories used in the FIM for easy reference. This wording was taken directly from the FIM methods in the appendices of document.

1. *Agriculture* – The agriculture land use field is the percentage of the shoreline, based upon the shore segment length, which is predominantly used for crop based agricultural or as active livestock range lands (i.e., extensive holding areas, large numbers of cattle etc.). Livestock pastures that are not active rangelands (i.e., a few cows or horses) are typically considered a rural land use and not an agriculture land use (see rural). These lands are typically part of the Agriculture Land Reserve or a provincial range tenure.

2. *Commercial* - The Commercial land use field is the percentage of the shoreline, based upon the shore segment length, which is predominantly used for commercial purposes. Commercial purposes include retail, hotels, food establishments, marinas with fuel, stores, etc. Commercial areas tend to occur along highly impacted shorelines. Where feasibly, significant commercial areas should be part of one segment because the land use on these shore types has a different assortment of potential impacts. Commercially zoned, but yet to be constructed areas, may also warrant there own segment.

3. *Conservation* - The Conservation land use field is the percentage of the shoreline, based upon the shore segment length, which is predominantly used for conservation of critical or important habitats. Examples of conservation shorelines include lands held by the Land Conservancy, biological reserves, etc. Conservation lands cannot occur on privately held shorelines, unless conservation covenants or other agreements are in place to protect areas in perpetuity.

4. *Forestry* - The Forestry Land use field is the percentage of the shoreline, based upon the shore segment length, which is predominantly used for forestry. These areas are typically crown lands that are part of active cut blocks or forestry operations. Log Yards are considered an industrial land use and are not considered a Forestry Land because they tend to have associated industrial infrastructure.

5. *Industrial* - The Industrial land use field is the percentage of the shoreline, based upon the shore segment length, which is predominantly used for industrial purposes. Examples of industrial purposes include log yards, processing facilities, lumber mills, etc. These shorelines are typically heavily impacted by infrastructure, impervious surfaces, buildings, etc.

6. *Institutional* - The Institutional land use field is the percentage of the shoreline, based upon the shore segment length, which is predominantly used for institutional purposes. Examples of institutional land uses include schools, public libraries, etc.

7. *Multi-Family Residential* - The Multi-Family land use field is the percentage of the shoreline, based upon the shore segment length that is predominantly used for multi-family residences. Multi-family developments are typically condominiums, apartments, or town homes.

8. *Natural Areas* - The Natural Areas land use field is the percentage of the shoreline, based upon the shore segment length, which are predominantly undisturbed crown lands. These areas do not occur in provincial or federal parklands and cannot be privately held.

9. *Park* - The Park land use field is the percentage of the shoreline, based upon the shore segment length, which are predominantly natural areas parklands. These parks areas can be provincial, federal, or local government parks. These parks tend to be relatively undisturbed and natural. They differ from urban parks (discussed below), which are used intensively for recreational purposes (e.g., public beaches).

10. *Recreation* - The Recreation land use field is the percentage of the shoreline, based upon the shore segment length, which is predominantly used for recreational purposes. Examples include public or private campgrounds, areas of known cabin rentals, etc. In some cases recreational shoreline may also be referred to as a single family land use, depending upon how much information is known about them. Generally, if a shoreline contains privately held cabins that are rented out occasionally, these should be referred to as single family land uses rather than recreational.

11. *Rural* - The Rural land use field is the percentage of the shoreline, based upon the shore segment length, which is predominantly used for rural purposes. These shorelines are typically large lots, private estates, or hobby farms. Differentiation between rural and single family land use can be difficult when lots are narrow but deep (i.e., buildings appear dense on the shoreline but extend quite far back). When doubt exists between a rural designation and a single family land use, assessors should be consistent in their judgments and refer back to local government zoning or bylaws to help decide on the appropriate land use type.

12. *Single Family Residential* - The Single Family Residential land use field is the percentage of the shoreline, based upon the shore segments length, which is predominantly used for single family residential purposes. Typically, single family residential occurs in more densely developed areas. However, seasonal use cottages or cabins can often be considered single family residential areas if the dwellings have associated outbuildings, docks, and other features consistent with more densely developed areas. In areas where the there are numerous seasonal use cabins and cottages, assessors should consider this single family residential if lots have smaller lake frontages and land uses and buildings are consistent with single family types of development. If lake frontages for seasonal use cabins and cottages are quite large, the land use would be considered rural. The differentiation between

rural and single family in these cases can be difficult and assessors should be consistent in their determination.

13. *Urban Parklands* - The Urban Park land use field is the percentage of the shoreline, based upon the shore segments length, which is predominantly used as an urban park. Examples of this land use include public beaches, picnic areas, etc. Shorelines dominated by this land use tend to have limited riparian vegetation and contain extensive areas of turf in the understory.

14. *Transportation* – The Transportation land use field is the percentage of the shoreline, based upon shore segment length, which is predominantly used for transportation via road or railway. Examples include highways, bridges, or railways that are directly adjacent to the shoreline.

Around Okanagan Lake, the largest land use type observed was single family residential accounted for 32% or 93.3 km of shoreline. Single family developments includes strata style developments that have single family units within the development. Within single family areas, the shore line was approximately 15% natural. Riparian impacts and substrate modification were the most significant impacts observed in these different areas. The next most predominant land use along the shorelines was rural areas, which accounted for 26% of the total shoreline length or approximately 74 km of shoreline. Rural areas had 76% or 56 km km of shoreline that natural while 24% or 17 km remains natural. The next most significant land use occurring around the lake was park areas. Parks occurred along 14% of the shoreline and these areas were generally quite natural (91%).

Transportation, agriculture, recreation (i.e., campgrounds, etc.), and urban parks occupied 17.7 km, 25.5 km, 9.5 km, and 15.5 km respectively. These were similar to single family in terms of the extents of disturbance observed.

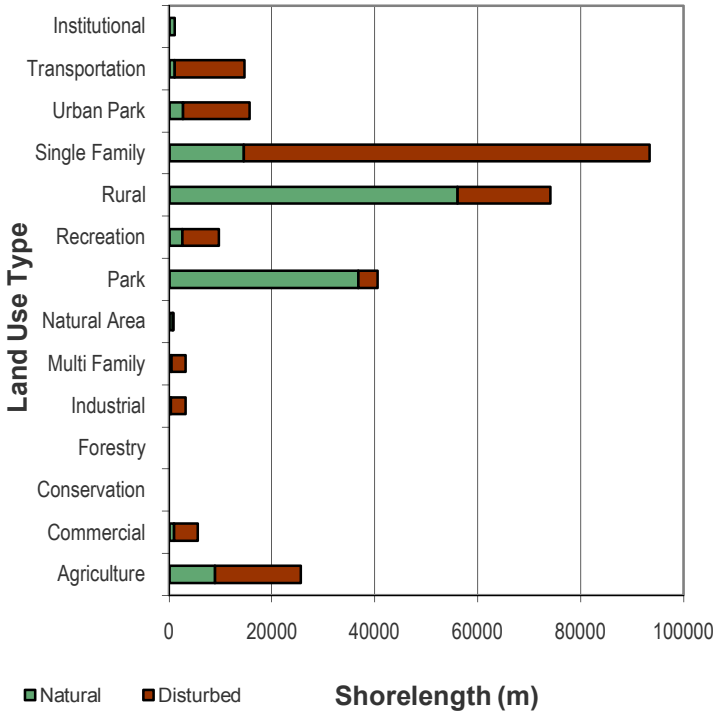


Figure 4 The natural and disturbed shoreline length by the different types of land use occurring around Okanagan Lake.

Fish utilize shoreline areas for a variety of reasons throughout their life cycle. For each species, the importance of shoreline areas depends upon their life stage (e.g., egg, juvenile, adult), their foraging type (e.g., insectivorous (insect eating), plankivorous (plankton eating), piscivorous (fish eating), or some combination thereof, etc.). Given the variability of different life stages and species present within the lake, it is difficult to describe the importance of shore types to species quickly. Despite this, it is currently accepted that areas of high productivity are generally associated with either spawning activities or juvenile rearing. In Okanagan Lake, rocky shores, wetlands, stream mouths, cliff / bluff, and wetlands are considered to be the most important to fish.

The most predominant shore type observed around Okanagan Lake was Gravel, and accounted for 43% or 125 km. Gravel shores were only 32% natural, with only an estimated 39 km of shore natural shoreline remaining. Data was collected documenting current condition of the shoreline and it should be noted that groyne construction along rocky shorelines has created areas of gravel or sand beaches. Cliff / Bluff shore lines were the next most predominant shore type and occurred along 23% or 67.3 km of the shore. In Cliff/Bluff areas the shoreline was 66% natural (44 km). Rocky shoreline areas occurred along 14% (41.9 km) of shoreline and within rocky shore areas the shoreline was 72% natural (30.2 km). Stream mouth and Wetland shore types were not very common around the lake and represented only 2.8% (8.1 km) and 8.3% (24 km) of the total shoreline length.

Within stream mouth and wetland shore areas, natural areas of the shoreline accounted for 26% (2.1 km) and 33% (16 km) respectively.

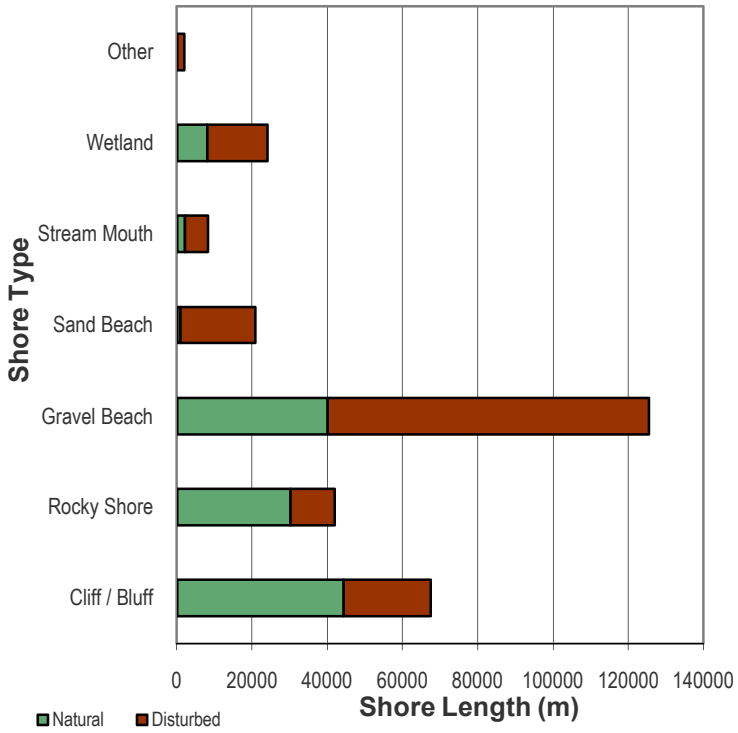


Figure 5 The length of natural and disturbed shoreline along each of the different shore types on Okanagan Lake.

Aquatic vegetation is loosely defined as any type of emergent, submergent, or floating vegetation that occurred below the high water level. Thus, the aquatic vegetation field includes true aquatic macrophytes and those plants that are hydrophilic or tolerant of periods of inundation during high water level. Studies have shown that even terrestrial vegetation provides important food for juvenile salmonids and other aquatic life during periods of inundation and this is why it has been included (Adams and Haycock, 1989). Approximately 56 km of shoreline has aquatic vegetation, which represents approximately 19.5% of the total shoreline length. The total area of both dense and sparsely vegetated areas with aquatic vegetation is 249,398 m^2. Most of the vegetation that was observed was emergent and grass like and occurred along 50 km or 17.4% of the shoreline. Native submergent vegetation and floating vegetation were very rare on Okanagan Lake and were only observed along 2.1% or 6.1 km and 0.3% or 0.9 km respectively. *More detailed mapping of submergent vegetation is recommended because the large littoral zones made it difficult to map all areas.*

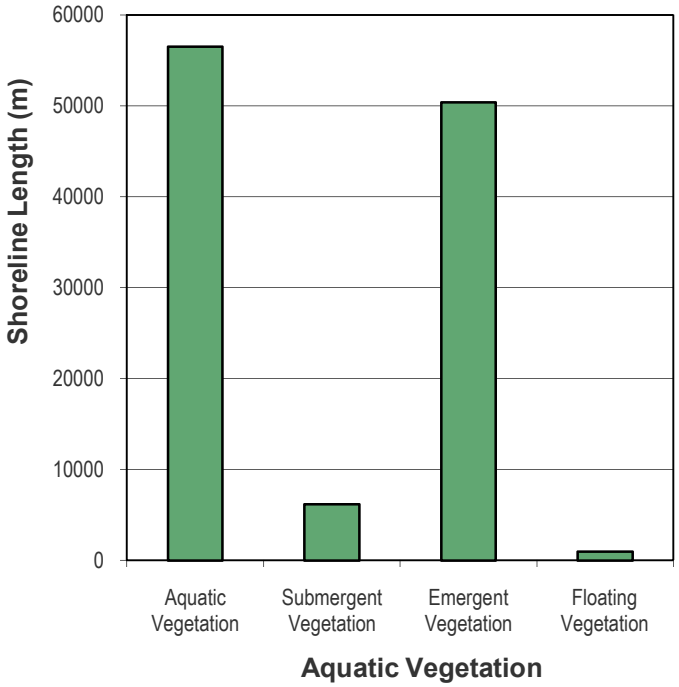


Figure 6 Total shoreline length that has aquatic, submergent, emergent, and floating vegetation along Okanagan Lake.

Docks were the most commonly observed type of shoreline modification. A total of 2,718 docks counted during the assessment. Numerous "dock groynes" were also observed. "Dock groynes" were moorage structures that had lakebed substrates piled underneath, creating a physical structure that was both a moorage and a groyne. Retaining walls and groynes followed docks and totaled 1,799 and 939 respectively. A total of 41 marinas with greater than 6 boat slips and 222 concrete boat launches[2] were observed.

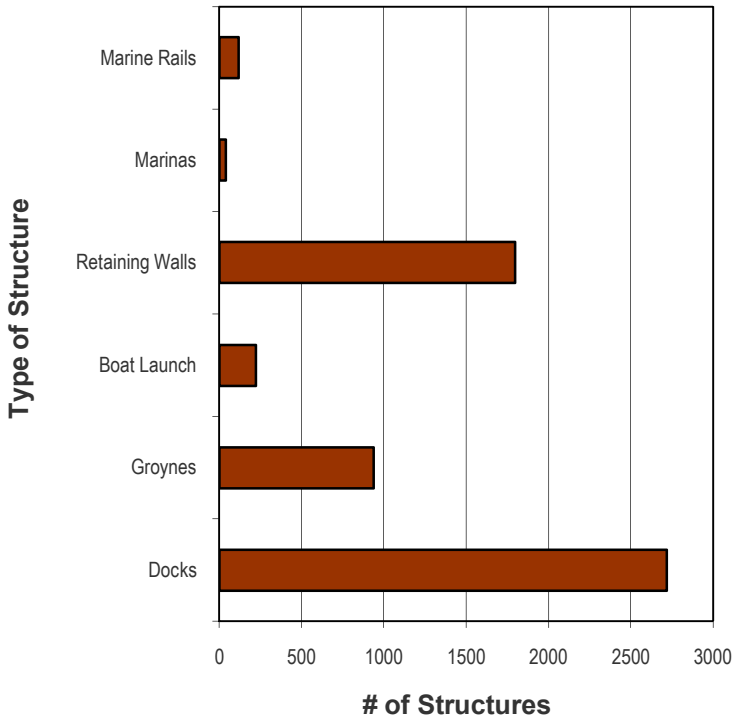


Figure 7 Total number of different shoreline modifications that occur around Okanagan Lake.

[2] Only concrete boat launches were counted during the assessment. This total does not include gravel accesses to the lake.

The percentage of shoreline impacted by roads, railways, retaining walls, and where substrate modification has occurred was recorded. These estimates allowed an approximation of the total shoreline impacted by these different activities (Figure 11). Substrate modification was the most substantial impact that was observed along the shoreline. In total, it is estimated that 137 km or 47% of shoreline has experienced substantial substrate modification. Substrate modification was variable and was most commonly associated with construction of groynes to create gravel beaches, importation of sands, historic fills (e.g., retaining walls below HWL) or associated with road/railways (e.g.., structural fill material, etc.). Retaining walls were the next greatest impact to the shoreline and it is estimated that 58.5 km or 20% has been impacted by retaining walls. Finally, roadway impacts accounted for less than 8% or 22.7 km of shoreline. There were no areas of railway observed along the shoreline.

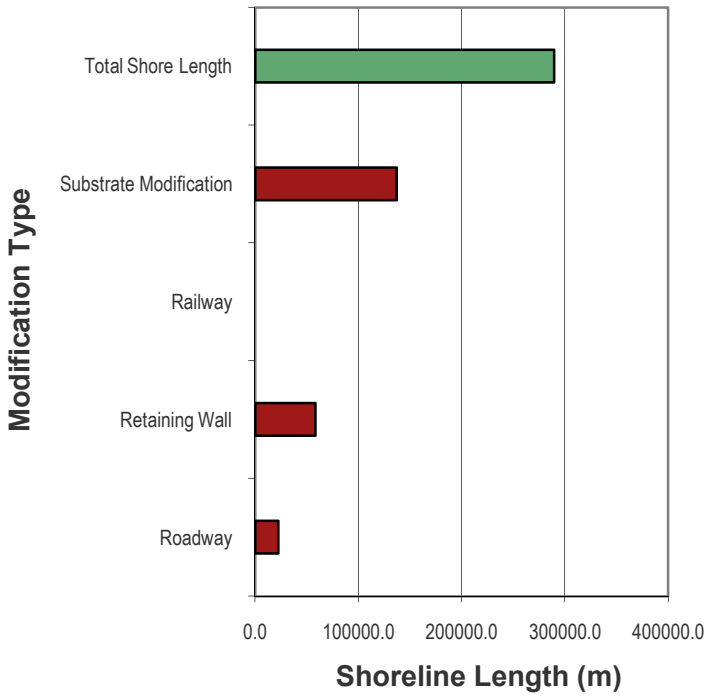


Figure 8 Total shoreline length that has been impacted by substrate modification, road and railways, and retaining walls along Okanagan Lake.

The Level of Impact is a categorical description of disturbance along the shoreline. The following definitions were taken from the FIM methods in the appendix of this document and are included for ease of reference.

1. *Level of Impact* - Level of Impact is a categorical field that is used to describe the general disturbance that is observed along the shoreline. Disturbances are considered any anthropogenic influence that has altered the shoreline including foreshore substrates, vegetation, or the shoreline itself (e.g., retaining walls). Level of impact is considered both looking at the length of the shoreline (i.e., along the segment) and the depth of the shore zone area to between 15 to 50 m back. In more rural settings, typically the assessment area is greater (i.e., 50 m) and in more developed shorelines, typically the assessment area is less (i.e., 15 to 30 m). In cases of roadways or railways, one should generally consider the location of the rail or roadway along the segment (i.e., how far back is it set, is the lake infill, etc.). To facilitate interpretation of this category, air photo interpretation is recommended to better estimate disturbance. Disturbance categories include High (>40%), Medium (10-40%), Low (<10%), or None. Consistency of determination is very important and assessors should use the same criteria to determine the level of impact. The RDCO Foreshore Inventory and Mapping report defines the *Level of Impact* as follows (Magnan and Cashin, 2004):

    a. *Low* - Segments that show little or limited signs of foreshore disturbance and impacts. These segments exhibit healthy, functioning riparian vegetation. They have substrates that are largely undisturbed, limited beach grooming activities, and no to few modifications.

    b. *Moderate* - Segments that show moderate signs of foreshore disturbance and impacts. These segments exhibit isolated, intact, functioning riparian areas (often between residences). Substrates (where disturbed) exhibit signs of isolated beach grooming activities. Retaining walls (where present) are generally discontinuous. General modifications are well spaced and do not impact the majority of the foreshore segment.

    c. *High* - Segments that show extensive signs of disturbance and impacts. These segments exhibit heavily disturbed riparian vegetation, often completely removed or replaced with non-native species. Modifications to the foreshore are extensive and likely continuous or include a large number of docks. Generally, residential development is high intensity. Modifications often impact a majority of the foreshore.

The amount of foreshore modification by these different mechanisms may seem high, but is corroborated by the estimated level of impact observed. It is estimated that 169 km or 58% of the shoreline has a high level of impact. Areas of moderate and low impact occur along 15% or 44 km and 25% or 72 km of the shoreline respectively. *There is an estimated 1.2% or 3.4 km of shoreline that is believed to have little to no impact.*

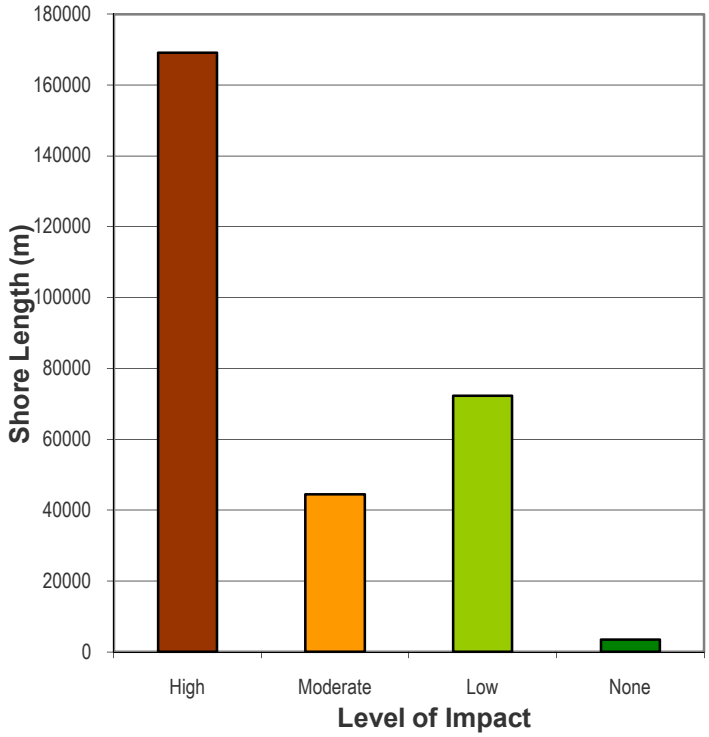


Figure 9 The level of impact (High, Moderate, Low, or None) observed along Okanagan Lake.

Areas classified as having High juvenile rearing values have experienced substantial impacts. The analysis indicates that areas of High Juvenile Rearing value occur along 118 km and have been disturbed along 80 km or 68% of the shoreline. Areas of moderate rearing value occur along 156 km of shoreline and are 51% disturbed. Areas of low rearing value occur along 13 km of shoreline.

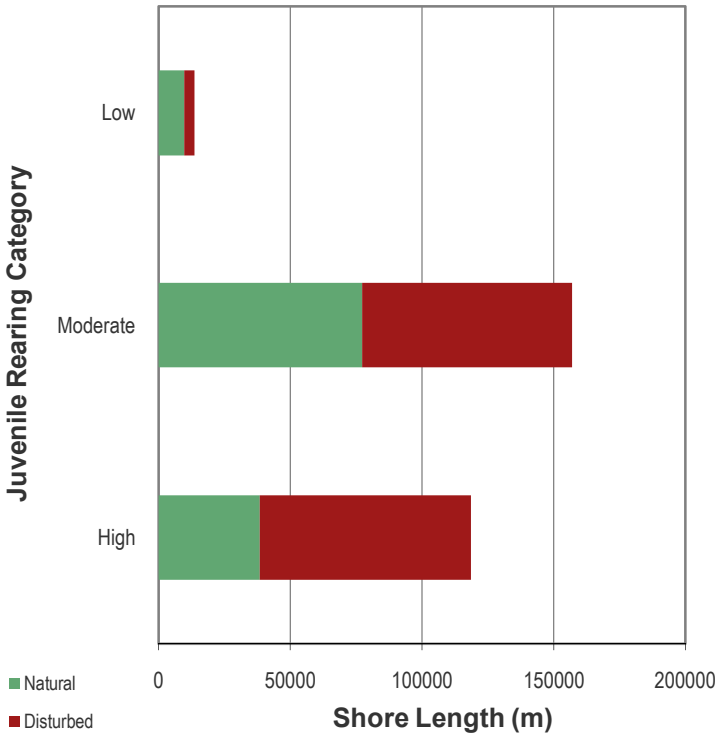


Figure 10 The natural and disturbed shore length within areas classified as having High, Moderate, or Low Juvenile Rearing value along Okanagan Lake.

A review of the natural and disturbed areas within the Okanagan Large Lakes protocol Kokanee shore spawning areas was conducted. This analysis indicated that within Black Zones, shorelines were 80% natural. Within Red Zones, shoreline areas were 61% natural and within Yellow Zones shorelines were 31% natural. In No Colour Zones, shorelines were 35% natural.

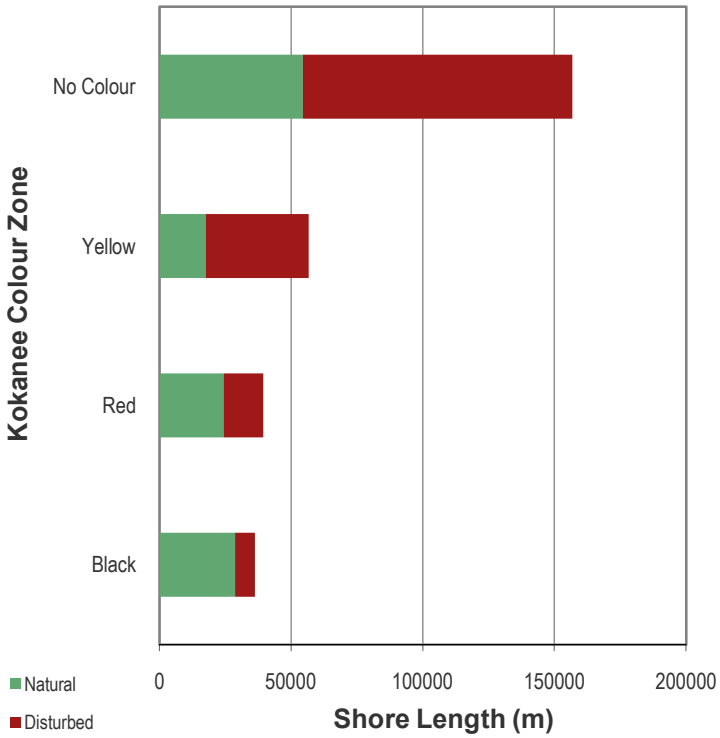


Figure 11 The natural and disturbed shore length within areas classified being a Kokanee Black, Red, Yellow, or No Colour Zone.

6.2 Summary of Foreshore Modifications

The lakeshore of Okanagan Lake contains habitats that are critical for wildlife (e.g., Western Grebe, etc.), rare plants and terrestrial communities, and fish populations (e.g., kokanee, rainbow trout, etc.). The lake provides drinking water for many different local government and First Nation's jurisdictions both around it and downstream. The combination of important fish, wildlife, and water quality considerations make protection the shoreline area a vital consideration. The baseline data collected during this assessment provides much of the information necessary to begin to manage this resource effectively. Further, it provides a baseline upon which goals and objectives can be created and monitored.

The shoreline of this lake is estimated to remain 43% natural based upon the results of this inventory. Much of the natural shorelines occur in Rural areas that are prone to future development. The extents of disturbance observed were of a similar nature to impacts observed in the Shuswap Lake system. The analysis above highlights the importance of to begin to implementing long term objectives in an effort to conserve important natural areas that remain and prioritizing habitat improvements where feasible.

As with other shoreline studies (e.g., Shuswap Lake, Mable Lake, Moyie Lake), lower gradient shoreline slopes tended to have higher levels of disturbance. The most notable disturbances occur in the form of substrate alteration (e.g., boat launches or groynes) and riparian vegetation disturbance. However, even within more intensely developed areas, many natural aquatic vegetation communities remain and many "pockets" of natural shoreline exist.

Although many areas have experienced negative habitat alterations, a few of the floodplains around the lake are still in functioning (at risk) condition and are key critical habitat features supporting numerous fish and wildlife species. Many of these critical areas are susceptible to future land use decisions. The above highlights the need for ongoing and continued management and planning to ensure these important resources are protected.

Varying degrees of foreshore development are present along Okanagan Lake. During the field surveys, numerous observations were made and are summarized in point form below:

- The most significant impact observed below the high water level along the shorelines was substrate modification. The construction of groynes, development of historical wetlands/floodplains, and importation of sands has resulted in numerous impacts including:

  i. the loss of aquatic vegetation (actual loss has not been determined);
  ii. a loss in cover along the shoreline;
  iii. the physical loss of habitat through alteration of shorelines from a rocky shore to gravel or sand beaches;
  iv. loss of structure complexity or habitat diversity;
  v. has resulted in an increased erosion risk around the shoreline;
  vi. increased sediment input that may have reduced shore spawning success for different species; and,
  vii. potentially altered the natural patterns of long shore sediment drift from wind and wave action.

  The extent of habitat related loss associated with substrate modification have not been determined as part of this assessment. In many cases, the construction of groynes may have the use of heavy equipment (or significant manual effort). Many groynes were also part of a dock system. All groynes observed were constructed on Crown lands below the high water level, and it is likely that many, if not all, were not permitted under the BC Water Act or Federal Fisheries Act.

- In many areas, it is apparent that aquatic vegetation[3] has been lost due to foreshore disturbance such as substrate modification. In these areas, emergent riparian vegetation (e.g., willows and cottonwoods), grasses and sedges, and other types of vegetation have been cleared. It is believed that most of this vegetation removal is the result of beach creation (i.e., beach grooming). The loss of soil material that aquatic vegetation grows, particularly in more rocky shoreline areas, will likely take years or decades to naturally regenerate, if ever. The continued loss of vegetation will further impact juvenile salmonids during high water in the spring when they are known to feed upon organisms within the vegetation (Adams and Haycock, 1989).

- Riparian vegetation disturbance has changed the vegetation type from natural broadleaf or coniferous associations to landscaped, lawn, or un-vegetated associations along many shore segments. The substantial losses of riparian vegetation have not been quantified as part of this assessment. There are significant opportunities for riparian habitat enhancements along the shoreline of the lake in disturbed areas. Of particular concern on Okanagan Lake is the extensive riparian

[3] Aquatic vegetation is defined here as any vegetation below the high water level, including shrubs, herbs, and grasses, whether they are true aquatic macrophytes (e.g.,*Potamogeton* spp.) or hydrophilic species (e.g., reed canary grass).

related impacts that were observed on the many low gradient floodplain areas. It is apparent that most large floodplain areas have been impacted or impaired in some fashion.

- The presence of large woody debris was less than expected, particularly in floodplain areas. The losses of this woody debris is likely the result of channelization of the many large stream systems on the lake that have resulted in the need to remove debris jams so they do not pose a flooding hazard. Large woody debris is considered a critical aspect of habitat for juvenile fish, particularly salmonids. Channelization of streams is very apparent in urban areas such as Penticton and Kelowna, where the Penticton Creek, Bellevue Creek, and Mission Creek have all been channelized.

- Several private boat launches constructed out of concrete were observed. These boat launches were almost all associated with vehicular access, which has impacted riparian vegetation. It is conservatively estimated that these boat launches have resulted in the loss of at least 8,658 m^2 of habitat around the lakes (assuming the average boat launch is 3 m wide and 13 m long, which is presumed to be an underestimate). It is likely that most of these private boat launches were constructed without a provincial Water Act, federal Fisheries Act approval or have a Crown land tenure.

- Retaining wall construction around the lake was apparent in nearly all privately held areas, even remote shoreline areas. Retaining walls were constructed out of varying materials, but frequently substrates from the lakebed were used to construct the walls. As mentioned above, it is probable that many of the retaining walls observed have been constructed without a Water Act or Fisheries Act approval.

- Docks were the most commonly observed shoreline modification and it is highly probable that some of these docks have been constructed without appropriate moorage tenures. Many of the docks observed were not constructed following best management practices which require elevated walkways on piles to deeper water zones at low water level. In many areas, these docks were associated with groynes constructed from lakebed materials (i.e., angular cobbles placed in piles under dock), the docks were not elevated, or were simply very large (i.e., one residence with 2 to 3 slips plus seadoo marina rails, etc.). The impact of non compliance is small on an individual scale, but cumulatively the extent of habitat related degradations are noticeable and measureable (i.e., numerous examples of lakebed substrate alteration in kokanee spawning areas) and have affected spawning habitats.

- Boat wake erosion, Crown land trespass, and moorage buoys were observed. Also, evidence of prop scour was present in the some areas. However, detailed assessments and quantification of these impacts was not fully assessed.

6.3 Aquatic Habitat Index Results

The results of the Aquatic Habitat Index are best reviewed graphically. The attached Figure Binder presents the spatial results of the assessment. The figure binder has been prepared to show a summary of all the information contained within this report.

The Aquatic Habitat Index uses biophysical information to assess the relative value of a shoreline area. The AHI indicates that approximately 61.6% of the shoreline is ranked as Very High and High. Twenty eight (28%) of the shoreline length is moderate, and the remaining 11% is ranked Low and Very Low. Areas of high and very high habitat value were typically located adjacent to important kokanee spawning areas, stream confluences, wetlands, areas of suitable Western Ridged Mussel habitat, or were associated with gravel and rocky shorelines with aquatic vegetation in a natural state. Most of the lower value sites were located in more developed areas where habitat function has been severely impaired (e.g., floodplain and wetland areas being converted to dense single family or multi family development) or by anthropogenic impacts.

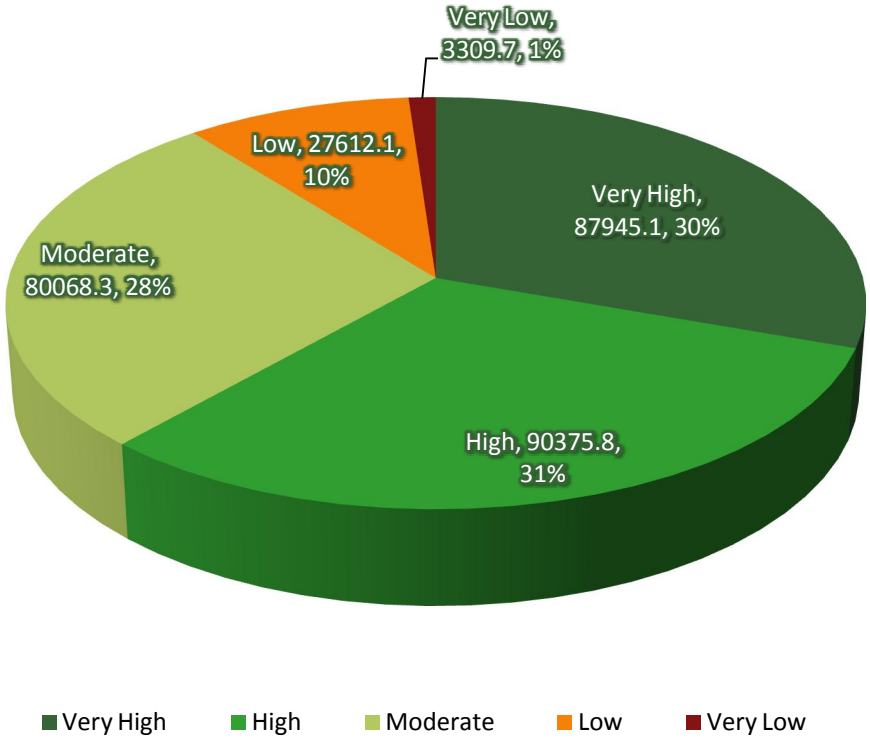


Figure 12 The shore length and percentage of areas classified as being Very High, High, Moderate, Low, and Very Low ranking by an Aquatic Habitat Index along Okanagan Lake.

The table below provides further details on the breakdown of shorelines ranked as Very High through Very Low.

Table 3: Summary of the Current Value and Potential Value shoreline lengths, number of segments, and percentage of the shoreline for the different habitat index categories (Very High to Very Low)

Categories	Current Value			Potential Value		
	# of Segments	Shoreline Length (m)	% of Shoreline	# of Segments	Shoreline Length (m)	% of Shoreline
Very High	84	87945.1	30.4	93	97566.7	33.7
High	95	90375.8	31.2	112	109538.1	37.9
Moderate	91	80068.3	27.7	87	63374.2	21.9
Low	38	27612.1	9.5	19	18045.0	6.2
Very Low	6	3309.7	1.1	3	787.0	0.3
Total	314	289311.0	100.0	314	289311.0	100

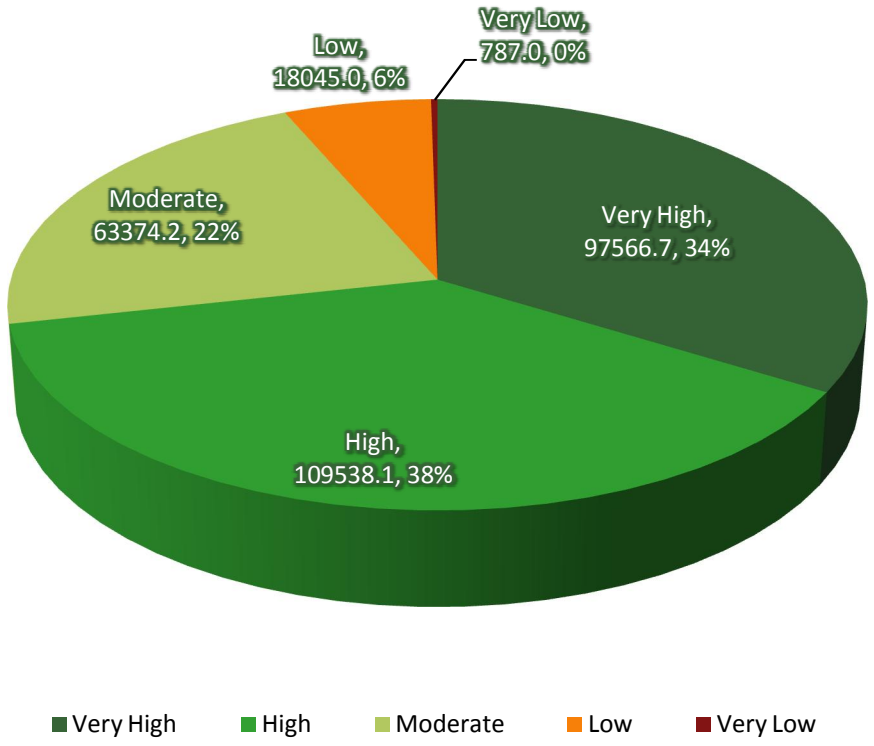
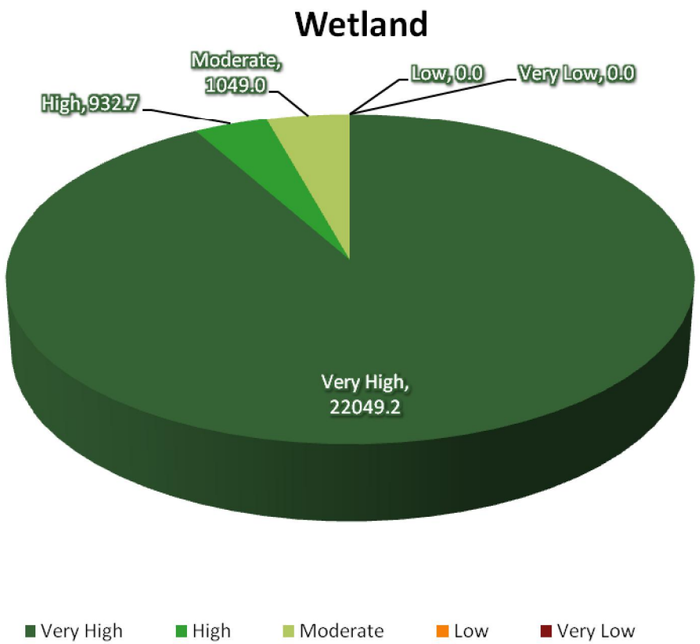
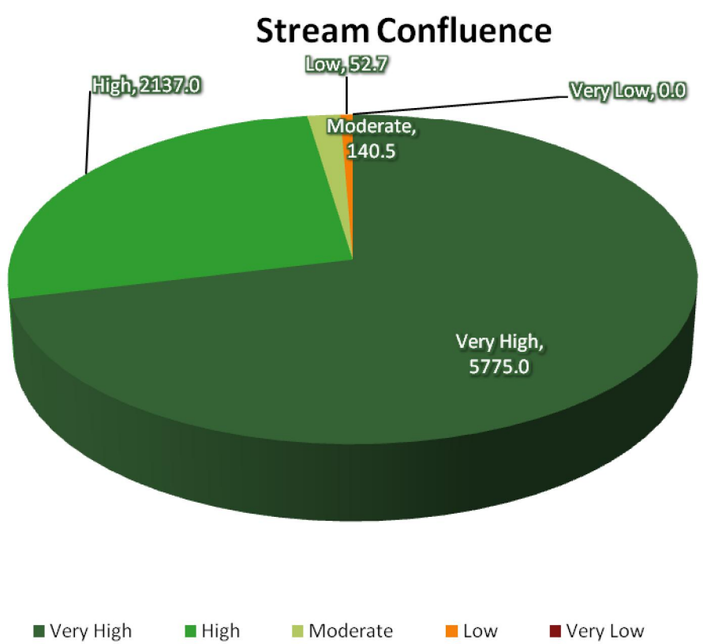
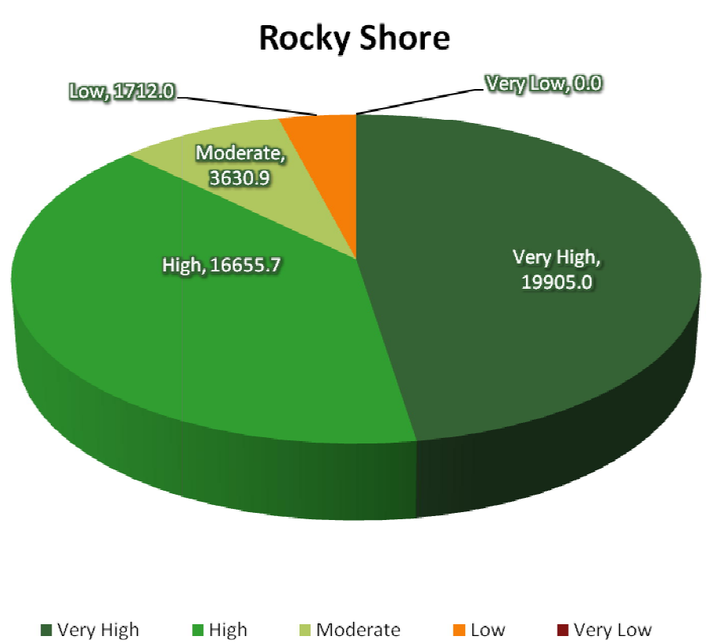


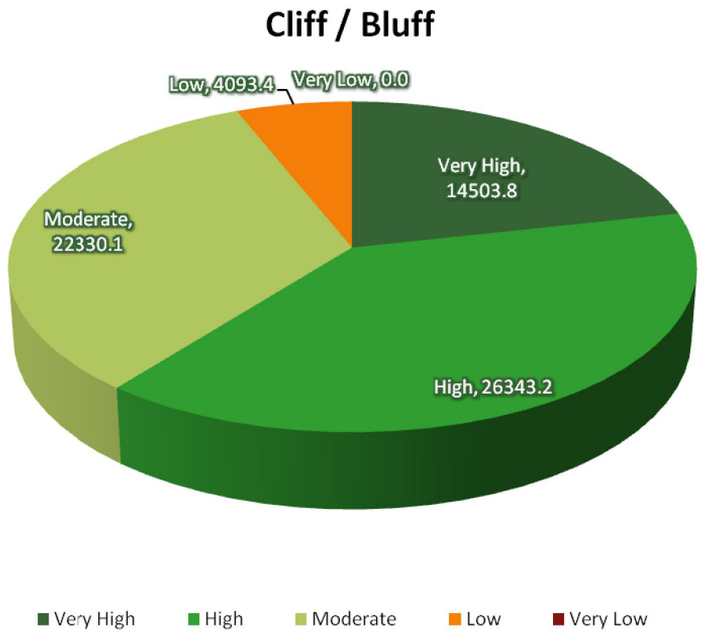
Figure 13 The shore length and percentage of areas classified as being Very High, High, Moderate, Low, and Very Low ranking by an Aquatic Habitat Index in the Potential Value Analysis along Okanagan Lake.

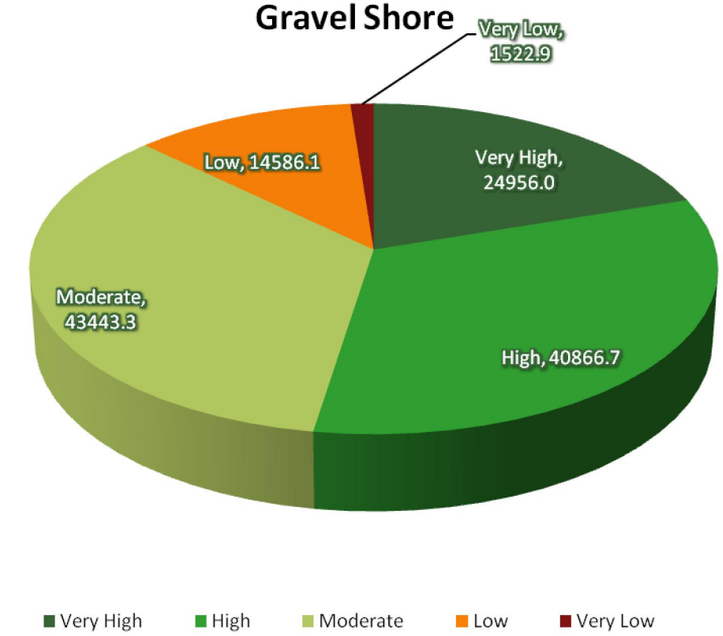
The Aquatic Habitat Index results were analyzed to determine the distribution of habitat values by shore type (Table 4). The analysis indicated that Very High Value shorelines occurred mostly adjacent to stream mouths or wetland areas, with good representation also occurring on rocky, cliff/bluff, and gravel shores. Most of the Very Low value habitat was found on sand or gravel beach areas.

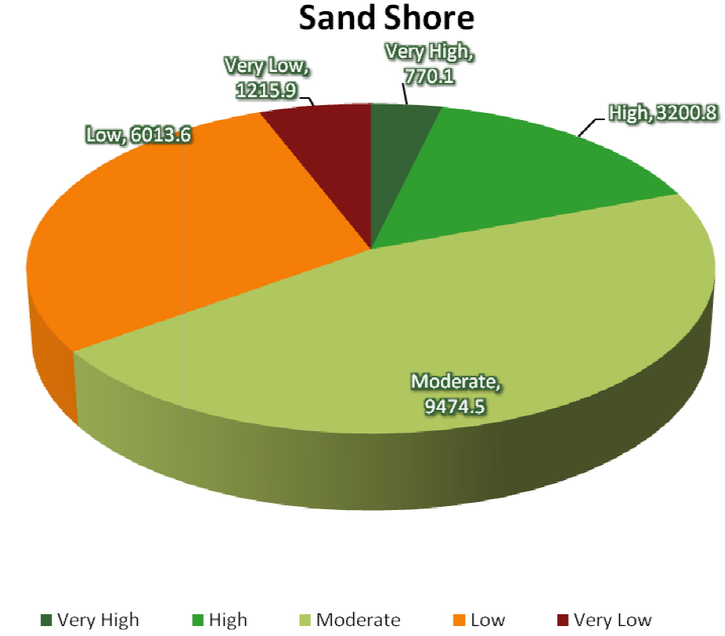

Wetland
Moderate, 1049.0
Low, 0.0
Very Low, 0.0
High, 932.7
Very High, 22049.2
Very High
High
Moderate
Low
Very Low


Stream Confluence
Low, 52.7
High, 2137.0
Very Low, 0.0
Moderate, 140.5
Very High, 5775.0
Very High
High
Moderate
Low
Very Low


Rocky Shore
Low, 1712.0
Very Low, 0.0
Moderate, 3630.9
High, 16655.7
Very High, 19905.0
Very High
High
Moderate
Low
Very Low


Cliff / Bluff
Low, 4093.4
Very Low, 0.0
Very High, 14503.8
Moderate, 22330.1
High, 26343.2
Very High
High
Moderate
Low
Very Low


Gravel Shore
Very Low, 1522.9
Low, 14586.1
Very High, 24956.0
Moderate, 43443.3
High, 40866.7
Very High
High
Moderate
Low
Very Low


Sand Shore
Very Low, 1215.9
Very High, 770.1
High, 3200.8
Low, 6013.6
Moderate, 9474.5
Very High
High
Moderate
Low
Very Low

The Potential Value summary presents what the habitat value would be if the modifications were removed (Table 5). This analysis highlights areas where restoration may result in a benefit. It is important to note that this analysis does not consider riparian improvements. Riparian improvements would also likely result in habitat improvements which have not been accounted for in this analysis. In general, there was a shift from very low upwards. Subsequent analysis may help better interpret where restoration may be more feasible and cost effective.

Table 4: Summary of the Aquatic Habitat Index results for the different shoretypes for the Current Value of the Shoreline.

Categories	Current Value			Cliff_Bluf		Rocky		Gravel		Sand2		Stream Mouth		Wetland		Other	
	# of Segments	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline Length	Shoreline Length	% of Shoreline Length	Shoreline Length	% of Shoreline Length	Shoreline Length	% of Shoreline Length	Shoreline Length	% of Shoreline Length	Shoreline Length	% of Shoreline Length	Shoreline Length	% of Shoreline Length
Very High	84.0	87945.1	30.4	14503.8	16.5	19905.0	22.6	24956.0	28.4	770.1	0.9	5775.0	6.6	22049.2	25.1	0.0	0.0
High	95.0	90375.8	31.2	26343.2	29.1	16655.7	18.4	40866.7	45.2	3200.8	3.5	2137.0	2.4	932.7	1.0	239.6	0.3
Moderate	91.0	80068.3	27.7	22330.1	27.9	3630.9	4.5	43443.3	54.3	9474.5	11.8	140.5	0.2	1049.0	1.3	0.0	0.0
Low	38.0	27612.1	9.5	4093.4	14.8	1712.0	6.2	14586.1	52.8	6013.6	21.8	52.7	0.2	0.0	0.0	1154.3	4.2
Very Low	6.0	3309.7	1.1	0.0	0.0	0.0	0.0	1522.9	46.0	1215.9	36.7	0.0	0.0	0.0	0.0	570.9	17.2

Table 5: Summary of the Aquatic Habitat Index results for the different shoretypes for the Potential Value of the Shoreline.

Categories	Potential Value			Cliff_Bluf		Rocky		Gravel		Sand2		Stream Mouth		Wetland		Other	
	# of Segments	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline
Very High	86	84892.4	35.6	18995.0	22.4	20503.8	24.2	29068.3	34.2	770.1	0.9	6023.9	7.1	22219.6	26.2	0.0	0.0
High	98	71202.8	29.8	25333.5	35.6	17169.9	24.1	58768.0	82.5	5304.2	7.4	1960.5	2.8	762.3	1.1	239.6	0.3
Moderate	72	62163.7	26.1	19225.3	30.9	3042.1	4.9	29126.6	46.9	10607.5	17.1	68.1	0.1	1049.0	1.7	255.7	0.4
Low	13	17305.5	7.3	3716.7	21.5	1187.8	6.9	8412.2	48.6	3777.0	21.8	52.7	0.3	0.0	0.0	898.6	5.2
0	2	2974.5	1.2	0.0	0.0	0.0	0.0	0.0	0.0	216.2	7.3	0.0	0.0	0.0	0.0	570.9	19.2

The following analysis summarizes the natural and disturbed shoreline areas that are within each of the different Aquatic Habitat Index Rankings. Within areas ranked as Very High, the shoreline was 67% natural. In High value areas, the shoreline was 49% natural and within Moderate Value areas the shoreline was 26% natural. Areas of Low and Very Low value only had 4.3% and 0% of the shoreline remaining natural.

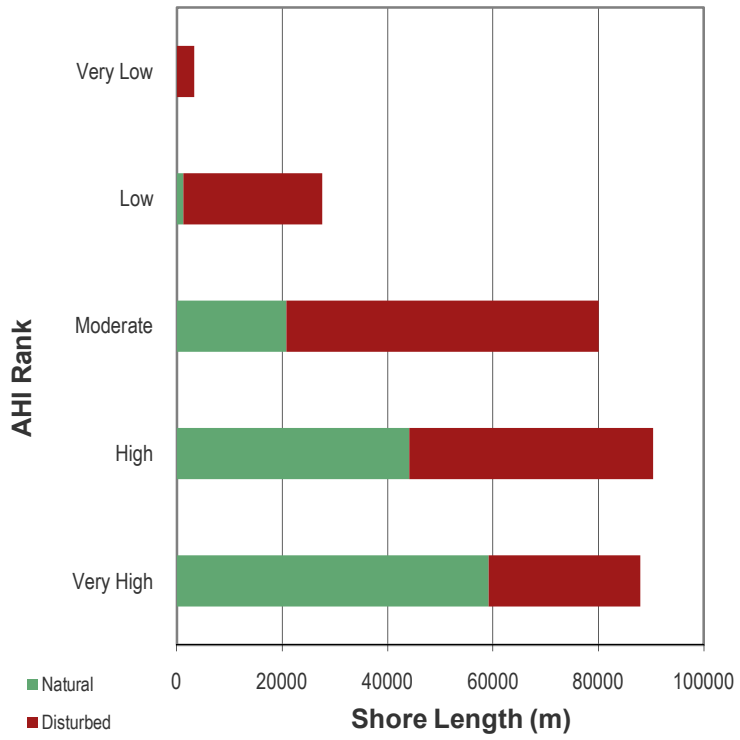


Figure 15 The Natural and Disturbed shore length of areas classified as being Very High, High, Moderate, Low, and Very Low ranking by an Aquatic Habitat Index along Okanagan Lake.

6.4 2004 Foreshore Inventory and Mapping Comparison

In 2004, the shoreline of Okanagan Lake was approximately 48% natural and 52% disturbed within the limits of Central Okanagan. The shorelines of Okanagan Lake in 2010 were 44% natural and 55% disturbed. The rate of change of shoreline along the lake from natural to disturbed was 0.6% per year.

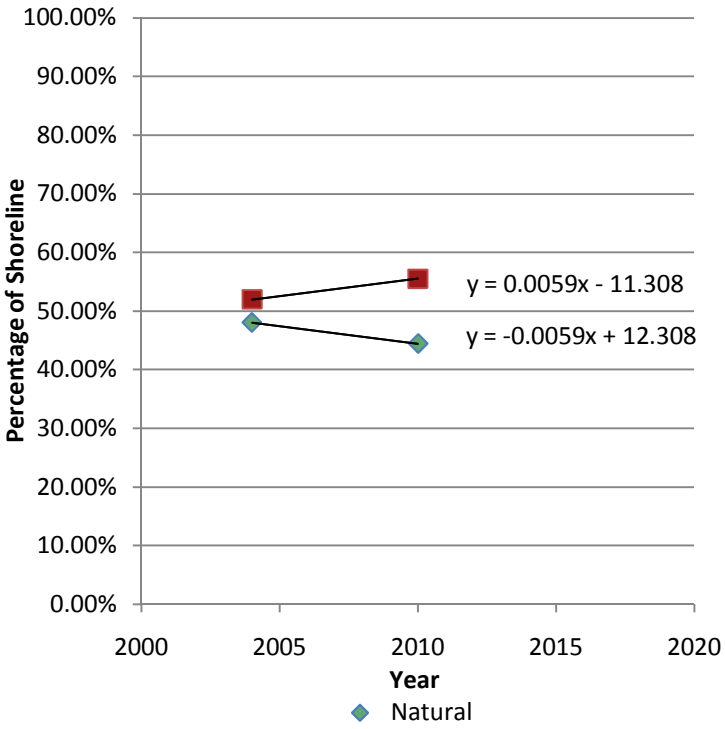


Figure 16 The percentage of Natural and Disturbed shore line in 2004 and 2010 around central Okanagan Lake in.

Table 6: The total shore length of percentage of shore length along Okanagan Lake in 2004 and 2010.

	2010		2004		2020 Projections
	% of Shoreline	Shore Length (m)	% of Shoreline	Shore Length (m)	
Natural	44.47%	57350	48.01%	61916.95	39.00%
Disturbed	55.53%	71618	51.99%	67050.67	61.00%

The loss of natural shoreline along different shore gradients was very similar between the gradient classes. The loss of natural shoreline occurred in a a range between 0.37% (Low) to 0.85% (Steep) per year. The magnitude of change was greatest in steep gradient areas, with very steep (0.5% per year) and steep experiencing the highest rates of change.

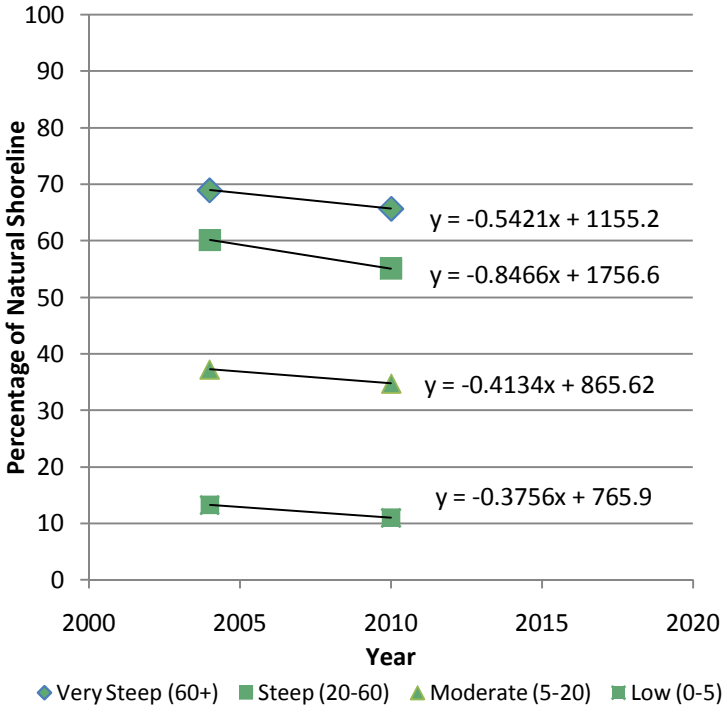


Figure 17 The percentage of natural shore line along very steep, steep, moderate, and low gradient areas in 2004 and 2010 around central Okanagan Lake.

Table 7: The percentage of natural and disturbed shore lengths within each of the different slope categories on Okanagan Lake in 2004 and 2010.

2004							2010						
Slope	% of Total Shore Length	Total Shore Length (m)	Shore Length Natural (m)	Shore Length Disturbed (m)	% Natural	% Disturbed	Slope	% of Total Shore Length	Total Shore Length (m)	Shore Length Natural (m)	Shore Length Disturbed (m)	% Natural	% Disturbed
Very Steep (60+)	25	32497	22402	10094	69	31	Very Steep (60+)	25.2	32497	21346	11151	65.7	34.3
Steep (20-60)	35	45477	27338	18140	60	40	Steep (20-60)	35.3	45477	25028	20450	55.0	45.0
Moderate (5-20)	18	22603	8419	14184	37	63	Moderate (5-20)	17.5	22603	7858	14745	34.8	65.2
Low (0-5)	22	28390	3758	24632	13	87	Low (0-5)	22.0	28390	3118	25272	11.0	89.0
Bench	0	0	0	0	0	0	Bench	0.0	0	0	0	0	0
Total	100.0	128968	61917	67051	48.0	52.0	Total	100.0	128968	57350	71618	44.5	55.5

There was a substantial increase in the number of modifications documented along the shoreline. The total number of docks increased from 1,184 in 2004 to 1,324 in 2010. The most notable increase was the significant number of groynes, increasing from 134 in 2004 to 601 in 2010. The significant increase in groynes may be due to the number of "dock groynes" observed in 2010, which were groynes under moorages. The number of "dockgroynes" was not factored in to the analysis and it is unknown if "dock groynes" were counted in 2004. Although it is not possible to say with certainty how many groynes were newly constructed, it is probable that there were several new groynes added since 2004. Substrate disturbance was readily apparent in numerous locations. There was also a substantial increase in the number of marinas, increasing from 8 to 24 between 2004 and 2010. A few of the marinas counted in 2010 may have been present in 2004 because it is unclear how many slips were considered. Regardless, it is apparent there have been several new moorage constructed since 2004.

The density of modifications and their rates of accumulation along the shoreline were determined. Groynes and docks increased in density from 2004 to 2010 and the rates of accrual ranged from 0.18 docks/km/year to 0.60 groynes/km/year. At this rate, density in 2020 will range from 22.3 docks per km to 15.3 groynes per km. The following tables and figures provide this information for each different habitat modification. The inferences of rates of change for different modifications are subject to numerous different factors, and this simple analysis has insufficient data to accurately predict change. Rather, it is presented to provide at least some level of understanding as to what potential magnitudes of change to expect or have potentially recently been occurring in the last century.

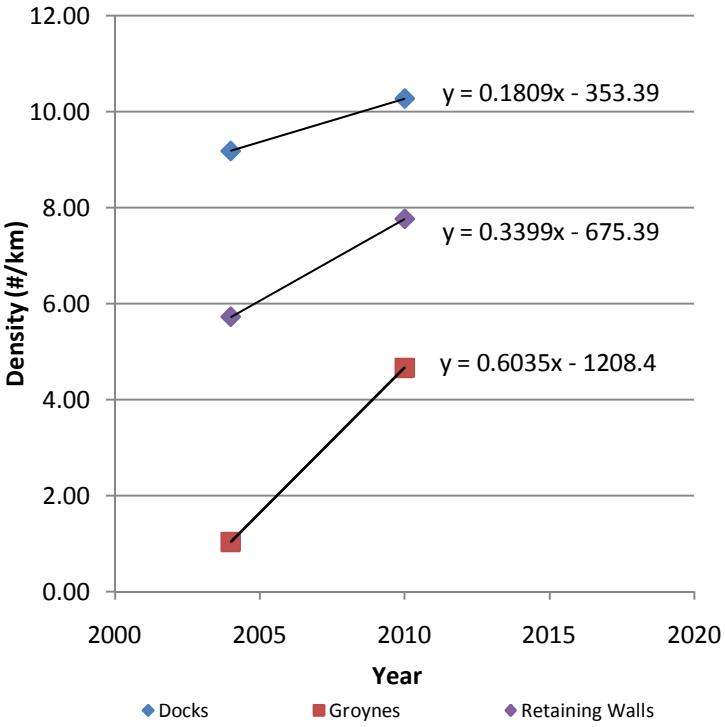


Figure 18 The density (#/km) of docks, groynes, and retaining walls along central Okanagan Lake in 2004 and 2010.

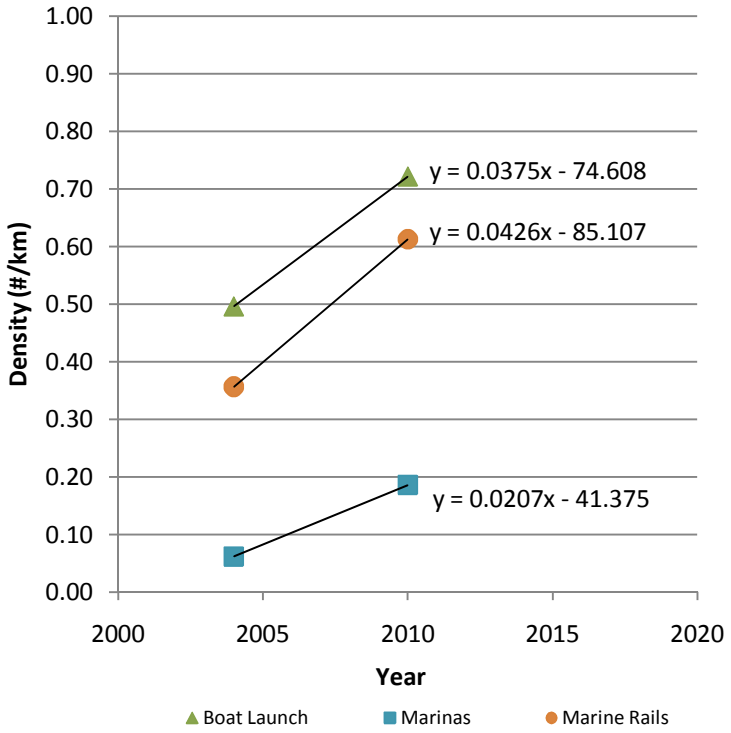


Figure 19 The density (#/km) of boat launches, marinas, and marine rails along central Okanagan Lake in 2004 and 2010.

Table 8: The total number and density (# per km) of different shoreline modifications occurring around Okanagan Lake in 2004 and 2010.

2004			2010			
Type	Total #	# Per km	Type	Total #	# Per km	2020 Density Projections (#/km)
Docks	1184	9.18	Docks	1324	10.27	12.0
Groynes	134	1.04	Groynes	601	4.66	10.7
Boat Launch	64	0.50	Boat Launch	93	0.72	1.1
Retaining Walls	738	5.72	Retaining Walls	1001	7.76	11.2
Marinas	8	0.06	Marinas	24	0.19	0.4
Marine Rails	46	0.36	Marine Rails	79	0.61	0.9

Provided all current patterns continue unchanged, the data indicates that densities of modifications will increase 1.5 to 2 times (e.g., marina will nearly double, increasing in density from 0.19/km to 0.4/km) by 2020.

The RDCO Marine Facilities (2008) study indicates that there is tremendous demand for increased moorage and recreational facilities on Okanagan Lake. The study calls for increases in the number of boat launches, marinas, marine storage locations (both on and off the water), and development of a vision for boating recreation on Okanagan Lake. The rates of change identified within this study should be considered in light of recreational demands. Although demands are substantial, this report identifies a rate of change that will result in significant impacts to Okanagan Lake if not managed carefully. Recreational demand should be considered in light of results from this assessment and more specifically, a carrying capacity analysis focusing on recreation is required prior to consideration of the full spectrum of build-outs recommended in this study.

The analysis of Level of Impact indicates that there will be a loss of low and moderate value shorelines and an increase in the prevalence of shorelines with a high level of impact. The rate of change from low or moderate to a high level of impact is approximately 2.3% per year. Presuming rates of change stay the same, the percentage classified as having a high level of impact could increase from 57% to 89% by 2020. Although this analysis is extremely simple, it is apparent that there will be an increase in the percentage of the shoreline with a high level of impact. This analysis makes no specific inference about what the actual level of impact will be because there is insufficient data to predict with accuracy. Rather, the intent is to provide a "worst case scenario".

Table 9: The Level of Impact around Okanagan Lake (High > 40%, Moderate (10-40%), Low (<10%), None (0%)) in 2004 and 2010.

2004			2010			
Level of Impact	% of Shoreline	Shore Length	Level of Impact	% of Shoreline	Shore Length	2020 Projections (% of shoreline)
High	42.86%	55275	High	56.93%	73426	89.20%
Moderate	19.81%	25551	Moderate	15.32%	19762	4.10%
Low	37.33%	48141	Low	27.74%	35780	6.70%

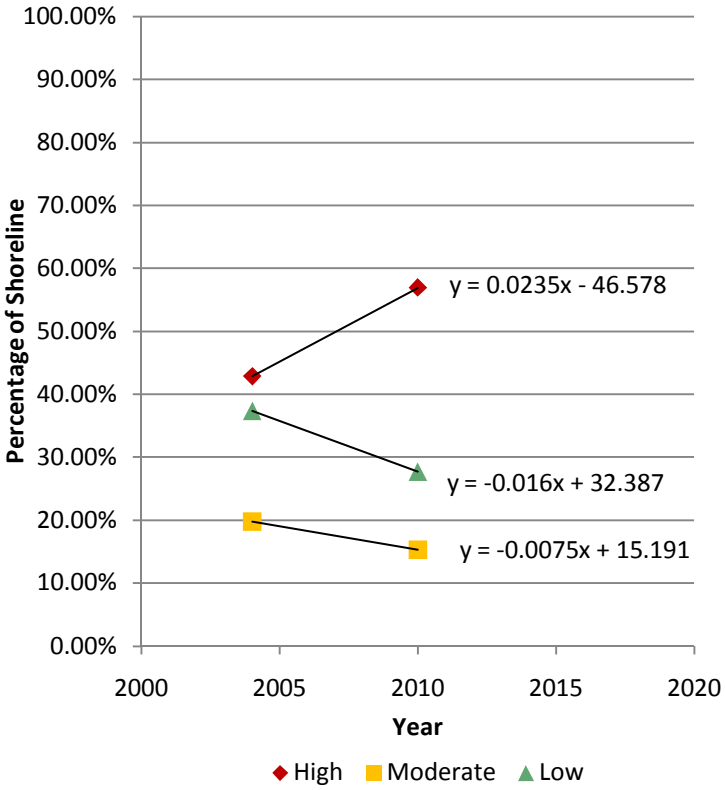


Figure 20 The percentage of shoreline that has a High, Moderate, or Low Level of Impact along central Okanagan Lake in 2004 and 2010.

An interesting result of the investigation into 2004 was the rate of change in areas classified as having a High, Moderate, or Low juvenile rearing value. To complete this analysis, it was assumed that the juvenile rearing value calculated based upon 2010 data would result in the same result using 2004 data. The analysis indicates that in areas of High rearing value, there is a loss of natural shoreline at a rate of approximately 1.3% percent. If the trend continues at this same rate, in 2020 there will only be 35% of the shoreline in natural condition in High value rearing areas. Again, this analysis is extremely simple and no specific inferences are made. It is just useful to identify where impacts are occurring and to potentially identify what species or life stages are being impacted.

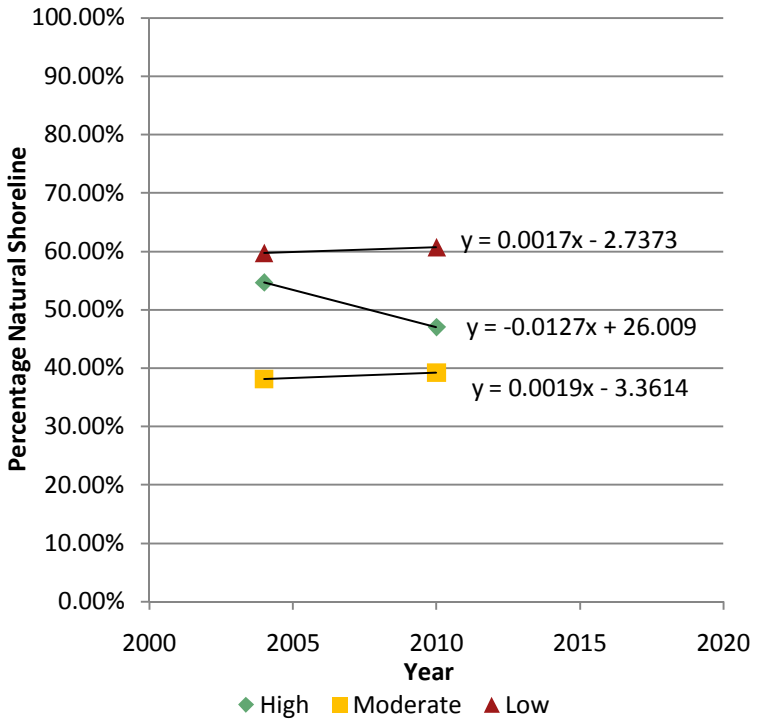


Figure 21 The percentage of natural shoreline in areas of High, Moderate, or Low Juvenile Rearing Value along central Okanagan Lake in 2004 and 2010.

Table 10: The shore length and percentage of shoreline areas classified as having High, Moderate, or Low Juvenile Rearing Value on Okanagan Lake in 2004 and 2010.

2004							2010							2020 Projects of % Natural Shoreline
Juvenile Rearing Category	# of Segments	Shore Length (m or %) Natural (m)	Natural (%)	Disturbed (m)	Disturbed (%)	Total	Juvenile Rearing Category	# of Segments	Shore Length (m or %) Natural (m)	Natural (%)	Disturbed (m)	Disturbed (%)	Total	
High	81	35016.7	54.68%	29018.33	45.32%	64035.6	High	81	30325.1	47.1%	34113.7	52.9%	64439.2	35.50%
Moderate	90	20921.0	38.09%	33999.55	61.91%	54920.9	Moderate	90	22166.9	39.2%	34361.6	60.8%	56528.9	47.66%
Low	13	5979.3	59.72%	4032.789	40.28%	10012.7	Low	13	4857.7	60.7%	3142.6	39.3%	8001.0	69.67%

Table 10: The lenght of natural and disturbed shorelines within the different Okanagan Large Lakes Protocol Kokanee Shore Spawning areas in 2004 and 2010.

2004								2010							
Black		Red		Yellow		No Colour		Black		Red		Yellow		No Colour	
Natural	Disturbed	Natural	Disturbed	Natural	Disturbed	Natural	Disturbed	Natural	Disturbed	Natural	Disturbed	Natural	Disturbed	Natural	Disturbed
80.51%	19.49%	62.36%	37.64%	32.87%	67.13%	28.37%	71.63%	77.3%	22.7%	60.5%	39.5%	29.9%	70.1%	23.6%	76.4%
22945.4	5555.54	17488.6	10554.3	6841.58	13972.6	14641.3	36968.2	22017	6484	16962	11081	6215	14599	12156	39454

The comparison to 2004 indicated there has been a reduction in the percentage of natural shorelines in all areas identified important to shore spawning kokanee (e.g., Black or Red Zones). The analysis indicates reduction in natural shorelines is occurring at less than 1% in all sites. The consistency in reduction across all identified zones indicates that even though the change is occurring, slowly, it is happening.

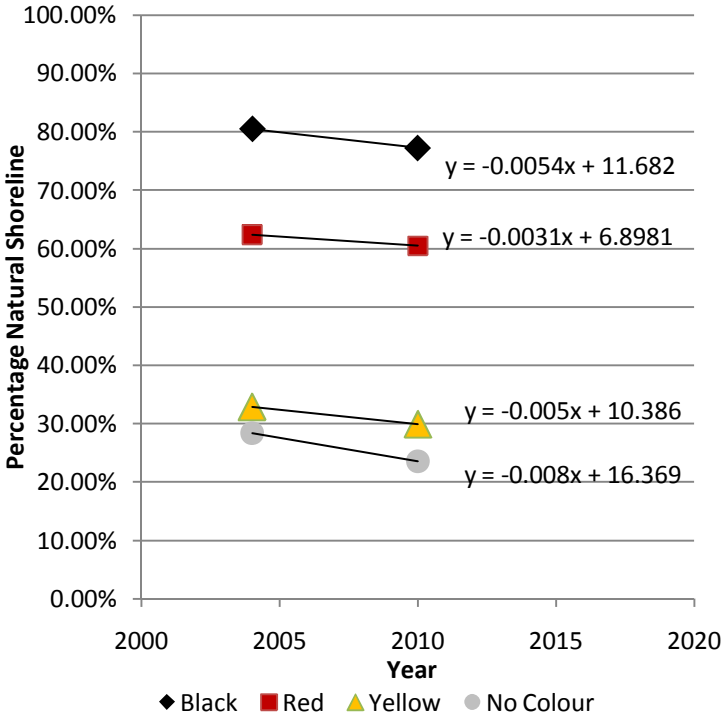


Figure 22 The percentage of natural shoreline in areas identified as being a Kokanee Black, Red, Yellow, or Non Colour spawning zone along central Okanagan Lake in 2004 and 2010.

The rates of loss of natural shoreline in areas classified as Very High, High, Moderate, and Low also show a decreasing trend. The assumption was made the habitat values in 2004 were identical to those resulting from the 2010 habitat index, similar to kokanee black zones and juvenile rearing analyses. The rate of decrease in areas classified as Very High was less than the rate in areas classified as High, Moderate or Low. The most dramatic decrease was a loss of approximately 1% per year and occurred in areas classified as High habitat value.

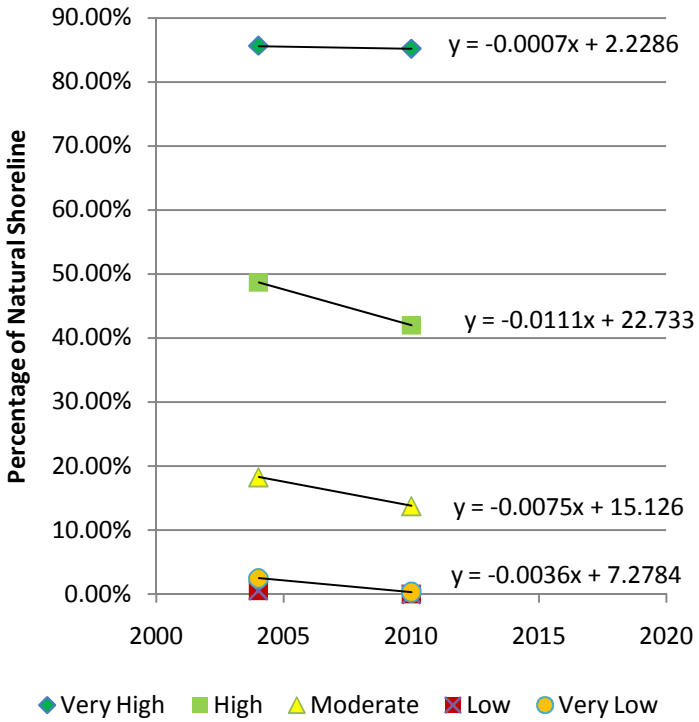


Figure 23 The percentage of natural shoreline in areas identified ranked as Very High, High, Moderate, Low, and Very Low along central Okanagan Lake in 2004 and 2010.

Table 12: The shoreline that is natural and disturbed (m and %) within each of the different AHI rankings in 2004 and 2010.

2004					2010				
AHI Rank	Natural		Disturbed		AHI Rank	Natural		Disturbed	
	m	%	m	%		m	%	m	%
Very High	35656.37	85.60%	5998.978	14.40%	Very High	35485.19	85.2%	6170.164	14.8%
High	19692.28	48.67%	20767.11	51.33%	High	16997.44	42.0%	23461.916	58.0%
Moderate	6427.599	18.28%	28730.59	81.72%	Moderate	4854.649	13.8%	30303.45	86.2%
Low	44.59968	0.57%	7798.99	99.43%	Low	0	0.0%	7843.59	100.0%
Very Low	96.09355	2.50%	3755.179	97.50%	Very Low	12.45616	0.3%	3838.816	99.7%