SHOREZONE FUNCTIONALITY INDEX

REPORT GUIDELINE

Province of Trento

By
Maurizio Siligardi, Barbara Zennaro, Settore Informazione e Monitoraggio,
Agenzia Provinciale per la Protezione dell'ambiente

30 Dicembre 2010

Table of contents

Report introduction

The following report wants to give some guideline on how to write the "Shorezone Functionality Index Report". The goal is to reach a standardized report that would facilitate sharing and comparison between the different countries and lakes.
The SFI is currently applied in Europe (Italy, Austria, Germany, Hungary, Slovenia and Poland) in both the SILMAS and EULAKES European Project, and in South American (Chile). It is therefore important to have a standardized SFI report to facilitate communication between these different countries.

To better represent the idea of SFI report output, this guideline include an example of SFI report for Levico Lake, Trentino, Italy. These pages are highlighted with a yellow box on the text.

This first draft report is divided into 5 main chapters, with the goal to give to the reader, not necessarily familiar with the index or the lake, enough tools to understand the results.
The chapters are:

1. Introduction to the Shorezone Functionality index
2. Lake management actions and regulations relative to the country's lake
3. Lake's location, origin and history
4. Application of the Shorezone Functionality Index
5. Discussions e Conclusion

The **first chapter** introduces the Shorezone Functionality Index, explaining the index's goals and the methodology. This chapter is meant to give some background information to a more general public, may they be politicians, managers or students, to give them the tools to understand the meaning of the results. This chapter is standardized and will be copied at the start of each report, so that all the SFI report will have the same introductory chapter.

The **second chapter** briefly describes the general lake management actions that occur in the country where they studied lake is. This chapter is meant to facilitate understanding and communication between the different countries and project partners that are applying the SFI. Understanding the lake shorezone Functionality level in relation to the country's specific lake management could be an important point of discussion to learn from each other's experiences.

The last 3 chapters instead focus on the lake itself.

The **third chapter** includes a literal review concerning the lake itself, describing its location and origin, its history and any other possible developing issues related to the lake. This chapter will have maps at different scale of the lake, and will also host the SFI General Form (Form 1).

The **fourth chapter** focuses on the application of the Shorezone Functionality Index.

The sessions "Description of the homogeneous stretches" introduces one by one all the stretches identified in the field: a table will summarize the stretch basic info (field form number, length of the homogeneous stretch, stretch delineation, SFI results, Personal evaluation results, Special comments) while the text and the pictures will describe physically the stretch and cover the following topics:

- Description of environmental quality and vulnerability (Silmas 3.3.3)
- The shorezone related to surrounding habitat (Silmas 3.3.1)
- Ecotone function (Silmas 4.2)
- Detection of vegetation invasive/exotic species (Silmas 4.2.3, Eulakes 4.2.3)
- Shorezone functionality status (Eulakes 4.2.3)
- Vegetation community of the lake shore zone (Eulakes 4.2.3)

The **fifth chapter** present a statistical analysis of the results, describing the overall status of the lake shorezone, underlying its weakness, its strengths, and presenting scenario for adaptation strategies (*Eulakes*). Particular attention should be played when writing this chapter, as this is the one managers should focus on to understand the shorezone status of the lake.

Suggested style guide for the SFI report

Language: English spelling

Page format should have a "single line justification",

Suggested text's styles for the SFI report are described in the following table:

	Character	size	other
Chapter title	Bookman Old Style	12	Bold
General text	Bookman Old Style	12	
Figure	Bookman Old Style	10	
Table	Bookman Old Style	10-12 depending	

Reference: The reference list should be in alphabetical order and include the full title with the name of the journal given in full. When there are eight or more authors only the first three should be listed, following the et al. (example:

- Bossetti M., Baldo, S., Ricci, E. (2010). Notiziario comunale di Calavano. Anno XVIII, n°1, marzo 2010.

For reference in the text, just write the last name of the authors and the year of publication (example "Bosetti, Baldo and Ricci, 2010").

Table: Each table should be embedded in the text and accompanied by a title and explanatory caption at the top. Each table must be referred to in the text. Please do not embed Tables as pictures in the text.

Figures: all figures should be embedded in the text.

The front page

I leave it to your fantasy on how to impost the report front page, but elements that should always be present include:

- The title "Shorezone Functionality Index"
- The lake name
- The lake municipality, region and Country
- The operators and relators names and the agency the work on
- The date the report was written
- Possibly the logos of the agencies that permitted the SFI study on the lake (i.e. Your agency, the European Project you work on, the JTS)

SHOREZONE FUNCTIONALITY INDEX

LEVICO LAKE

Province of Trento, Levico town.

By
Barbara Zennaro, Settore Informazione e Monitoraggio, Agenzia Provinciale per la Protezione dell'ambiente

30 Dicembre 2010

The index

It would be useful to try to keep a similar index throughout all the SFI report. This will also aid the report sharing and comparison between the different countries and agencies.
An index sample is here represented:

Chapter one: the Shorezone Functionality Index

The following chapter is an example of how chapter 1 may look like. This chapter should be present in each report and could be simply be copies from report to report.

1. THE SHOREZONE FUNCTIONALITY INDEX

1.1 Introduction

The area around the shores is a transition zone (ecotone) between the surrounding territory and lake, and has important ecological functions such as: regulate nutrients inputs and protects from no-point source pollution, guarantees the execution of ecological processes, provides habitat, food and habitat for organisms, protects the shoreline from erosion. Its structure and the extension are influenced by the topography, the climate and the soil's geological composition, while its water fluxes, the nutrients and sediment inputs, and the diffusion of animal and plant species are influenced by the lake riparian vegetation.

The importance of understanding and evaluating the lake shore zone functions lead to the creation of a system of indicators, and therefore indices, that could evaluate the shorezone functionality: the Shorezone Functionality Index (SFI) was therefore developed in Italy in 2004 by the in National Environmental Protection Agency (APAT)'s working group, coordinated by APPA Trento, as the twin brother of the existing Fluvial Functionality Index.

While most of earlier indices were characterized by a particular analysis, for example to the water itself (chemical analyses) or the biotic environment (biotic indices), the Lake SFI looks at the overall status of the lacustrine environment, taking in consideration the whole environment.

Both biotic and abiotic factors are used to evaluate the buffering capacity of riparian vegetation, the complexity and artificiality of the shoreline, the anthropogenic use of the surrounding territory, and the way the inputs from the watershed enter the water body.

This semeiotic index is easily surveyed, evaluates the state of the environment, and assists in the identification of the causes of deterioration, zooming out from the waterbody itself to also include all the surrounding territory and watershed topography.

1.2 Methodology

The SFI application consists in the filling of two forms: the first form includes general information about the lake and its watershed (topography, morphology, climate…); the second form is filled during the field work for each the homogeneous shorezone stretch (a stretch a lake shore with similar characteristics). The parameters surveyed in this field form include ecological parameters (typology, width, continuity or interruption of the riparian vegetation),

socio-economic parameters (land use, presence of infrastructure…) and other abiotic parameters (steepness, concaveness, shore artificiality…).

The data collected in the field is entered in the Shorezone Functionality Software, which will evaluate a functionality value for each homogeneous stretch. There are 5 different categories of functionality, ranging from Excellent to Poor (table 1), as suggested by the WFD 2000/60/CE.

LEVEL	JUDGMENT	COLOR
I	excellent	BLUE
II	very good	GREEN
III	good	YELLOW
IV	fair	ORANGE
V	poor	RED

Tab. 1 Functioning Level and relative judgment and color for reference.

Of all the parameters collected in the field, only nine are actually ran in the software (Shore artificiality, Vegetation cover, Presence of interruption within the lake shorezone, Concavity of the shore profile, Presence of reeds, Presence of arboreal species, Presence of road infrastructure, Heterogeneity of arboreal vegetation, Presence of non-hygrophilous species). This happens because Artificial Neural Network Analysis (ANN) and, over all, the Classification Tree showed that these the numerical weight of these parameters influence the most the results. The parameters fall into a classification tree (Fig. 1) showing the level of functionality (described as a sum of percentages of each functionality level) for each homogeneous stretch.

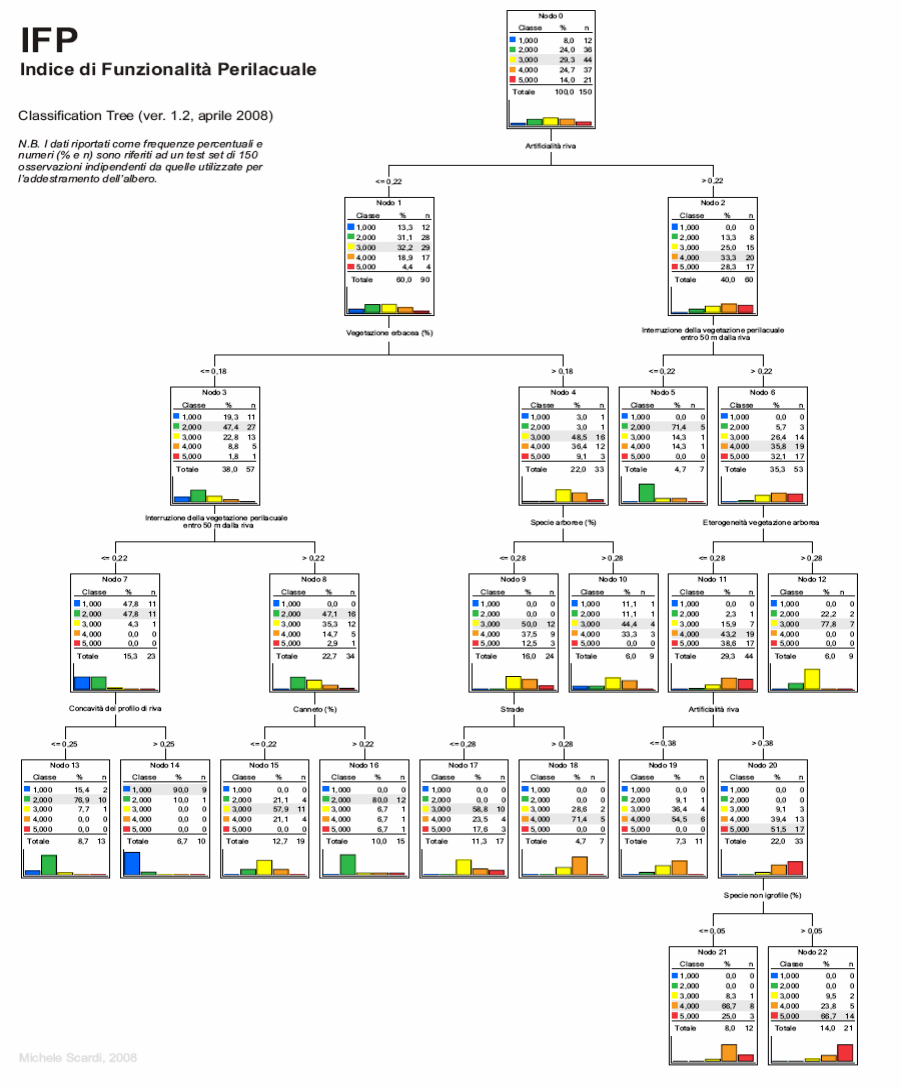


Fig. 1- SFI classification tree, each node is a surveyed parameter.

The software indicates (Fig. 2 , on the left side, the value given to each one of the 9 parameters of the stretch; on the lower right side it is indicated the path that was followed to reach to a certain results, while the graph on the top right indicates the possibility of each stretch to fall within one of the 5 identified functionality categories (in this case, the stretch is a 50% of 4th category, 32% of 5th and 18% of 3rd)..

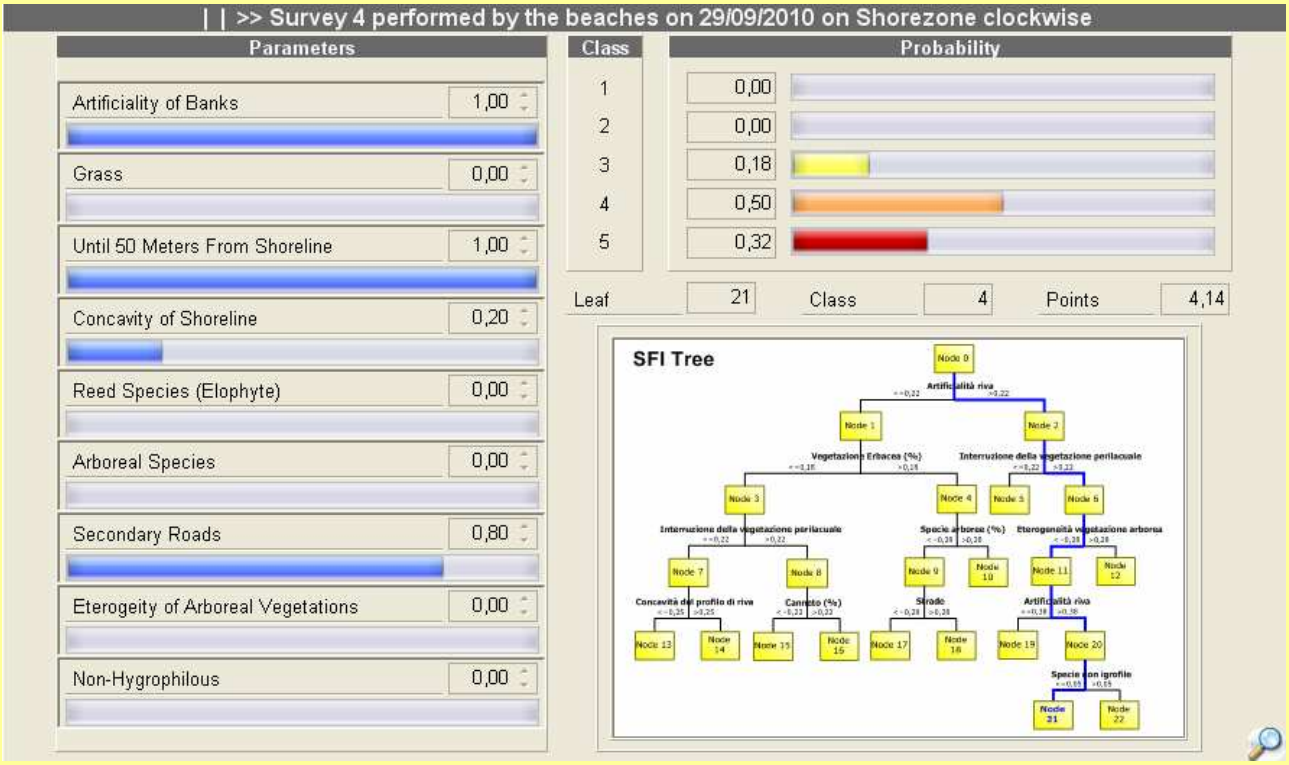


Fig. 2 - The results are then used to build the report and the map of functionality of the lake.

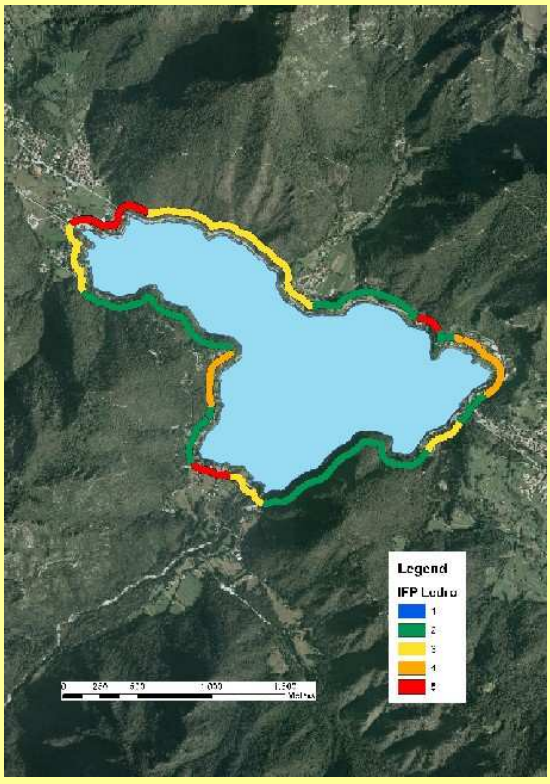


Fig. 3 - Example of a lakeshore zone functioning map (Ledro Lake, Trentino)

The obtained results are then projected on a map describing the shorezone functionality, where each level is associated to a different colour and a simbology. (Fig. 3)

1.3 Strengths

The potential of the SFI method lies in the ability of obtaining a synthetic value of lake shorezone functionality. The SFI method is an useful tool to aid the choices of future shore restoration actions and to suggest sustainable criteria for a ecosystem-based watershed management.

Moreover, SFI answers to the current needs, as requested by the 2000/60/CE Directive, to develop new indices able to assess the hydro-morphologic elements of lake's ecosystems, including the riparian zone.

The SFI proposed approach permits to complete the study of the internal lake's dynamics, often modified for production or recreational-tourists purposes. A lake shorezone management based on the concepts of its functionality allows to reconcile the environment protection with the human use of the lake, helping an eco-sustainable city planning and watershed management.

The reports give specific indications on what actions are needed to improve the functionality of the water body and can therefore be used to plan, monitor and evaluate restoration efforts.
Similarly, different scenarios can be modeled in a specific area to foresee the impacts that public or private work may have on the waterbody. The data can be entered into a GIS system, in order to carry out further spatial analysis and easily display the results in maps. For these reasons, these indices represent an important and powerful tool that can be used for sustainable planning and management.

1.4 Further contacts

It is possible to download for free both the Shorezone Functionality Index Manual (in Italian and English) and the SFI Software (in English) in the website of the Provincial Environmental Protection Agency of Trento:

http://www.appa.provincia.tn.it/appa/pubblicazioni/-Acqua/

For further information it is also possible to contact via email the following persons:
Maurizio Siligardi, Agenzia Provinciale per la Protezione dell'Ambiente, Settore Informazione e Monitoraggio: maurizio.siligardi@provincia.tn.it
Barbara Zennaro, Agenzia Provinciale per la Protezione dell'Ambiente, Settore Informazione e Monitoraggio: barbara.zennaro@provincia.tn.it

Charter two: Lake management in...

This chapter briefly describes the general lake management actions that occur in the country where they studied lake is. This chapter is meant to facilitate understanding and communication between the different countries and project partners that are applying the SFI. Understanding the lake shorezone Functionality level in relation to the country's specific lake management could be an important point of discussion to learn from each other's experiences.

Questions to be answered include:

- Who is responsible for the management of the lake shores?
- What are the monitoring and/or other researches carried out on in the lake?
- Is the shoreline private or of public access?

2. LAKE MANAGEMENT IN ITALY

The management of the lake shore in Italy is under the direct responsibility of the Region or the Province where the lake is located. For the province of Trento, the department of the "Servizio Bacini Montani" (Department for Alpine Watershed) looks after the vegetation that grows along the lake shore, looks after walking or bicycle paths and is responsible for managing the reeds.

The monitoring of the water quality is instead a responsibility of the Provincial Environmental Provincial Agency (APPA). Water samples are taken 6 times/years for Levico and Caldonazzo lake since 2006, twice a year from 2000 to 2006, while the macrophyte presence is controlled yearly.

The area going from the coastline inland for 10 meters is protected by the law (DgL152 - 3 April 2006) in order to assure the maintenance or the re-growth restoration of the spontaneous vegetation with function of buffer strip, stabilization of shore erosion and conservation of biodiversity. This are is considered public land and it is not legal to block any access to it, with the exception of safety cases. Any work done within this area, with the exception of works done for the public safety, need an authorization as stated in the law DgL 523 - 25 July 1904.

The shorezone (10 meters inland) can be given in concessions with the goal creating natural reserves, parks or other work of restoration or environmental re-evaluation. Privates owning the land adjacent the lake can not block the public access.

Charter three: Lake description

The last 3 chapters instead focus on the lake itself.

The third chapter in particular includes a literal review concerning the lake itself, describing its location and origin, its history and any other possible developing issues related to the lake.

The first session (3.1 –Location and Origin) it is meant to help readers to locate geographically and naturally the lake. Therefore it will include direction of the lake, maps at different scales, morphological origin of the lake and other important information, such as if there are main tributaries/estuaries.

The second session (3.2 –Lake general form) host the SFI General Form (Form 1) that describes the lake morphological, climatic and physical characteristics.

The third session (3.3 Lake developing issues) focuses more on the anthropogenic impact on the lake, describing its surrounding territory and causes of stress on the lake.

A special attention to SILMAS partners: this information is included in the form about "Lake General Data" sent to Edoardo Braccio for the WP6.

3. LAKE LEVICO

3.1 Location and Origin

Levico lake is located in Valsugana Valley, Province of Trentino, and it is easily reachable from Trento, about 21 km eastward. The tourist town of Levico (population = 7,300) is located on the southern-eastern side of the lake (Fig.4).

Fig 4. Location of Levico lake with respect to other main lakes and the city of Trento

Fig. 5 – Satellite view of Levico Lake

The lake was originated, similarly as the neighboring Caldonazzo lake located on the other side of Tenno's hills, by an alluvional damming created by Rio Maggiore (Fig.5).

The tributaries are the Visintainer and the Rio Maggiore streams. Its emissary joins the waters coming from Caldonazzo lake few hundreds meter downhill, representing the springs of the Brenta river.

Its waters are quite blue, but the transparency (Secchi Disk) average annual value of 5 meters, 7,6 m in winter.

Levico lake is the third natural lake for extension in Trentino, after the neighboring Caldonazzo lake and Garda lake. Its extension is big enough to mitigate the surrounding climate, and its hosts two beaches with a park and a camping.

The southern/eastern part of the lake is used for recreational purposes, which include swimming, recreational fishing. The lake waters are in part draw for irrigation of the adjacent land.

With the exception of the 2 developed areas (southern/eastern part of the lake) that present two beaches and a camping (Fig. 6), the shore is mainly characterized by coniferous forest running all the way to the water (Fig. 7), Reeds are present only on the southern end of the lake , and they form the protected biotope (instituted by the Province since 1988 and 1994).

Figs. 6 and 7: examples of the 2 lake's prevalent typologies.

3.2 Lake general form

The following SFI form 1 reassumes the lake morphological, climatic and physical characteristics.

Table …: SFI form 1

	origin[1]	Endorheic
	type[2]	Natural close
	location[3]	Planitial
	latitude	46°0'49.24" N
	longitude	11°16'41.55"E
	altitude of lake	400 m
	average altitude of catch basin	440 m
Morphological	area of catch basin (SB)	21,7 km2
	shore slope	0
	development of coast line	
	area of lake (SL)	1.164 km2
	volume	Km3
	maximum depth	38 m
	average depth	11 m
	average residence time	1,1000 years
	perimeters	6,6
	tributary/effluent capacity	
	SB/SL relationship	18,6

	level changes	
Climatic	precipitation	974,0 mm/year
	average maximum Jan. temp.	7,1 °C
	average max. July temp	29,3 °C
	main geological type of the substrate[4]	
Other	thermic cycle[5]	dimitic
	summer transparency (Secchi disk)	8 m
	trophic classification using indicator principles[6]	mesotrophic

3.3 Development issues

Most of the area around the lake is natural, and the surrounding territory shows these characteristics:

- 5 % urban area…
- 7 % agricultural area
- 82 % natural area (wood, meadow land,…)
- 5 % water
- 1 % wetland

About 5% al the lake area is protected, for a total of 0.39 km². The 3 protected sites include: Assizzi-Vignola, Biotopo of Pize' and the Biotopo Canneto di Levico.

The main anthropological pressure influence on the lake happens during the summer months when Levico town population increased remarkably due to tourism. On the southern/eastern side of the lake, there are public and private beaches, while the rest of the lake is natural.

There is not any special issues regard this lake.

Charter four: SFI application in Lake…..

The **fourth chapter** focuses on the application of the Shorezone Functionality Index.
At first, there is a short description of the field work methodology. This should include:

- Who did the survey and with which agency are they affiliated
- When was the survey carried out
- How was the survey carried out (by feet, by boat…)
- How many stretches were identified
- The map showing the results for the lake shorezone index.

The map should also always have certain characteristic, including:

- Title: "Shorezone Functionality Index" and "lake name"
- North arrow
- Legend
- Scale bar
- Stretches form number, as later described in the report
- The buffer for the shorezone goes 50 meters inland from the coast line.
- The Shorezone Functionality Index should always utilized the following colour code to describe different levels of functionality.

LEVEL	JUDGMENT	COLOR
I	excellent	**BLUE**
II	very good	**GREEN**
III	good	**YELLOW**
IV	fair	**ORANGE**
V	poor	**RED**

The sessions "4.1 Description of the homogeneous stretches" introduces one by one all the stretches identified in the field: a table will summarize the stretch basic info (field form number, length of the homogeneous stretch, stretch delineation, SFI results, Personal evaluation results, Special comments) while the text and the pictures will describe physically the stretch and cover the following topics:

- Description of environmental quality and vulnerability (Silmas 3.3.3)
- The shorezone related to sourrounding habitat (Silmas 3.3.1)
- Ecotone function (Silmas 4.2)
- Detection of vegetation invasive/exotic species (Silmas 4.2.3, Eulakes 4.2.3)
- Shorezone functionality status (Eulakes 4.2.3)
- Vegetation community of the lake shore zone (Eulakes 4.2.3)

SFI APPLICATION IN LEVICO LAKE

Field work in Levico lake was carried out by Maurizio Siligardi and Barbara Zennaro, from the Settore Informazione e Monitoraggio of the Environmental Protection Agency of the Province of Trento, in date 29 September 2010.
The survey of the lake on the whole eastern side and the southern side was carried out by foot, while part of the western side and the reeds biotope (form 7) was carried out from a rubber boat.
The whole shore was divided into 6 homogeneous stretches, that mainly differentiated by different levels of human pressure, presence of exotic and/or hygrophilous species.

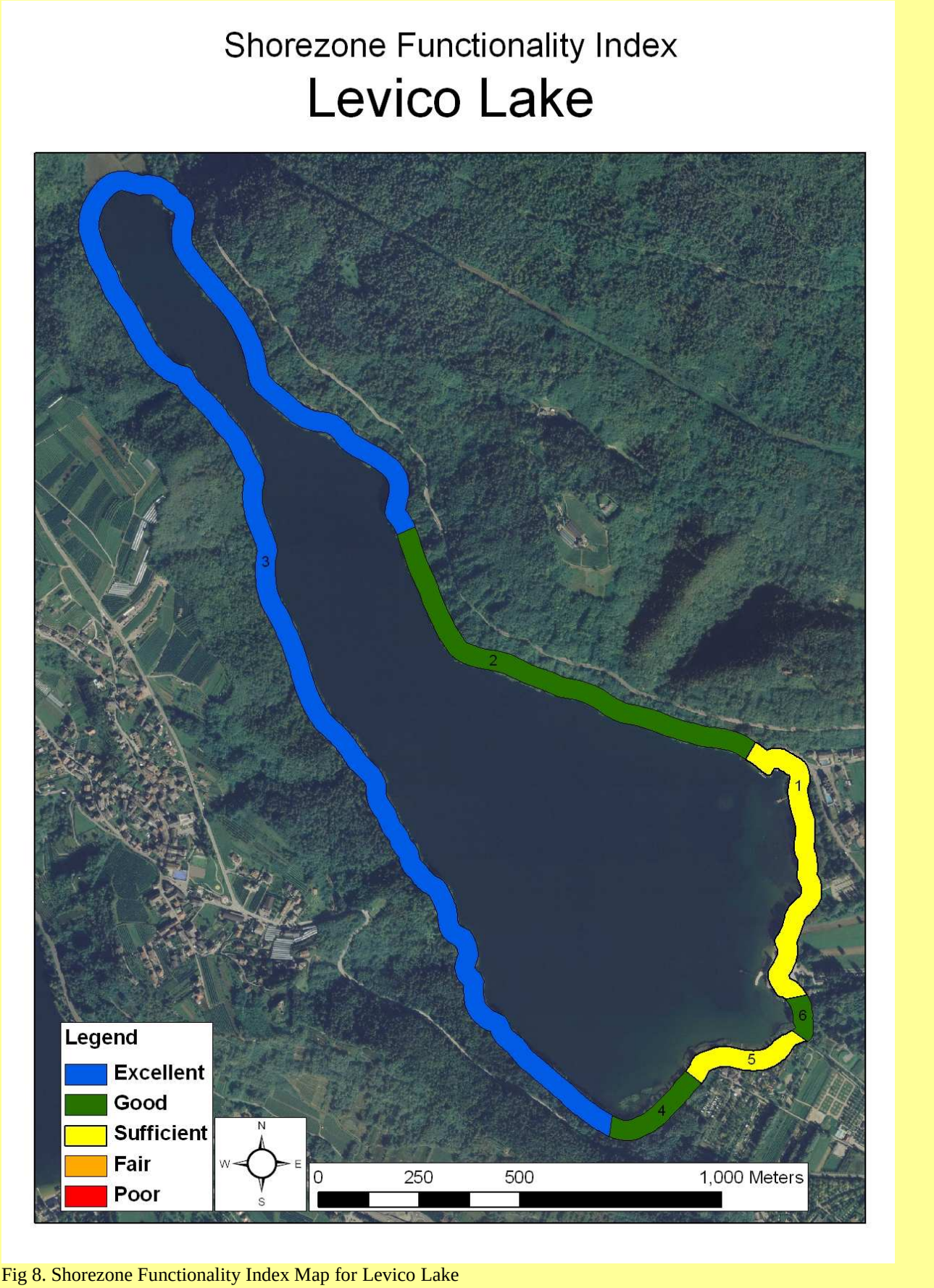


Fig 8. Shorezone Functionality Index Map for Levico Lake

4. 1 Homogeneous stretch 1

Field form number	4
Length of homogeneous stretch	750 m
Delineation	The beaches area, delineated to the east by the Brenta emissary, and to the west/north by the end of the beach and the start of the fisherman's trail.
SFI result	4
Personal evaluation	4
Notes	

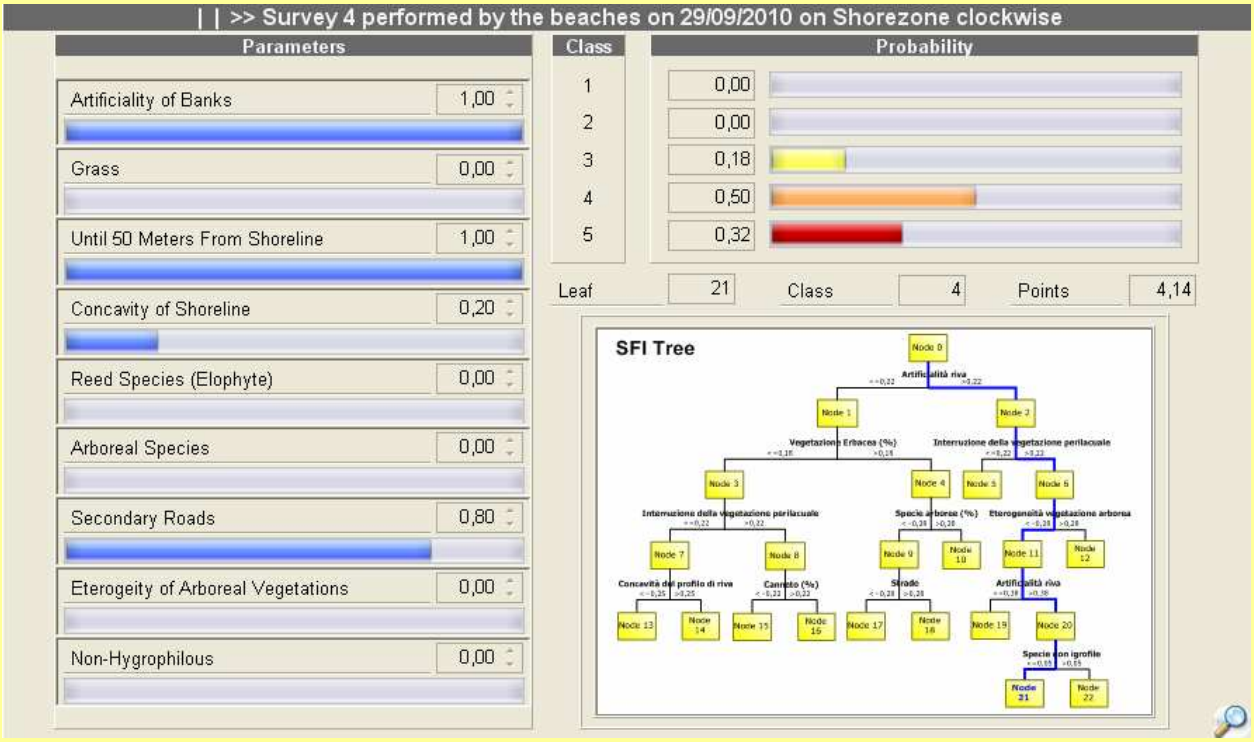
Fig. 9. View of the public beach

Fig. 10. View of the wall that divides the beaches

Fig. 11 Private beach

The stretch includes the beach area running along the southern side of the lake. This area is characterized by the lack of riparian vegetation, which the exception of small pools of wet reeds and few riparian trees (Fig. 9, 10, 11), which are anyway separated from the land by an impermeable sustaining wall. The beaches are artificial and are composed by shingles and cobbles.
Storm water collects into a small stream that enters the lake in this stretch.

The low result for the SFI is mainly due to the high artificiality of the shore and the lack of riparian vegetation: superficial waters and possible no-point source pollutant can flow directly into the lake in this area without encountering any particular barrier, therefore the aquatic environment is very vulnerable from inputs coming from the terrestrial one.
This stretch therefore does not have any ecotone function between the lacustrial and the terrestrial habitat.
The vegetation community is poor due to the presence of the english garden that occupies the majority of the shorezone. Although, the few trees present are riparian and autochnonous. They include the alder (*Alnus*), the poplar (*Populus*) and the willow (*Salix*).
Adaptation strategies to improve its ecotone function could be represented by the reconstruction of the present impermeable walls with permeable walls made of logs and rocks. The reeds that may grown behind it would work as a refuge for aquatic animals.



4.2 Homogeneous stretch 2

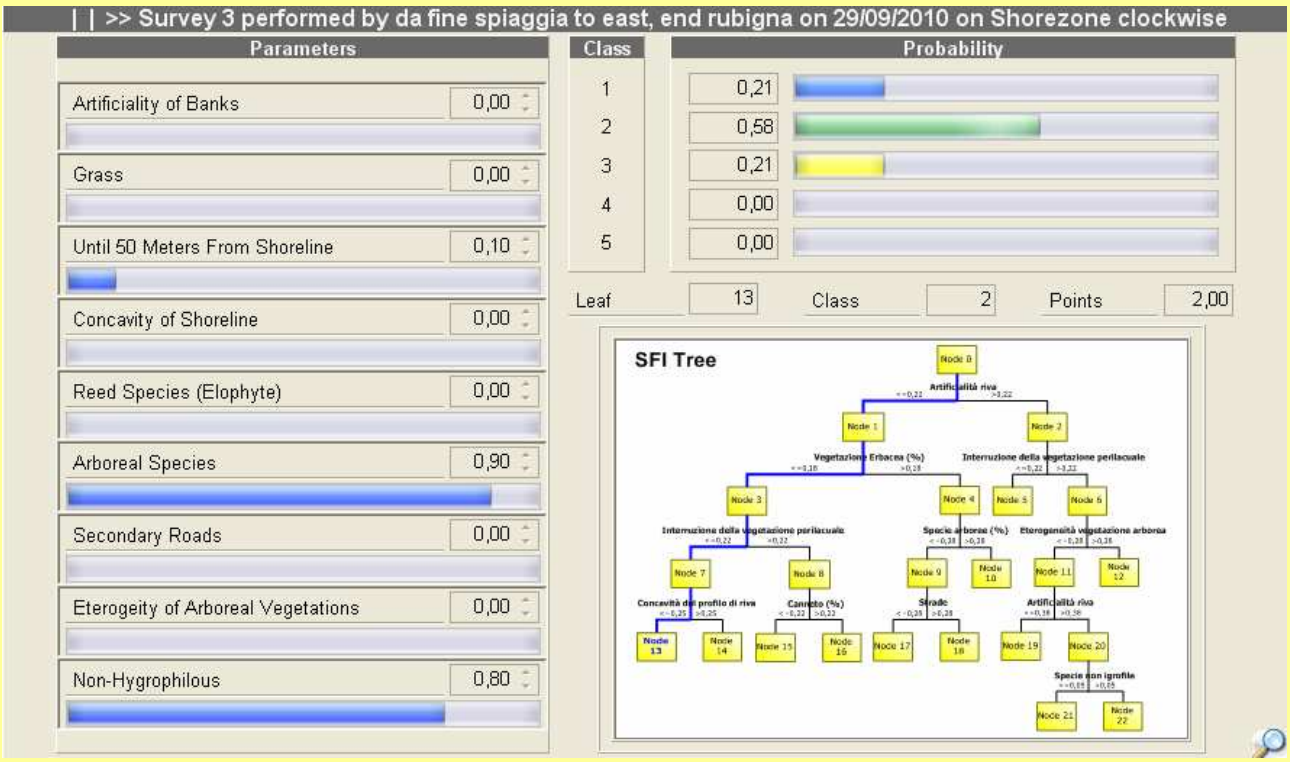
Field form number	3
Length of homogeneous stretch	1102 m
Delineation	Along the fisherman's path from the end of the beaches to halfway toward the eastern part of the lake, the area were the prevalence of *Black locust (Robinia pseudoacacia)* ends.
SFI result	2
Personal evaluation	2
Note	

This area is characterized by steep hills following into the lake in the eastern part of the lake. A small permeable path runs along the coast slightly interrupting the continuous of the vegetation (the canopy of the trees on the right and left side of the path in many instances touch each other). At the start of the path, for the first few hundreds meters, there is a small sustaining permeable wall (Fig. 12 and 13). Wet reed on this area are mainly absent (due to lack of shallow water).

Fig. 12 and 13. Different view of the fisherman path

The vegetation community is mainly composed by exotic species for a 40% of the total vegetation, including the Black locust (*Robinia pseudoacacia*) and the Ailanthus. Other trees present include the beech (*Fagus sylvatica*).

There are not interruptions of the vegetation area and agriculture fields are missing in the surrounding environment (0-200 meters from the coast). The shorezone should be able to filter no-point source of pollution (and storm water run-off), despite of the steepness of the area. The lower SFI with respect to form 3 is due to the presence of the vegetation exotic species, as above described.



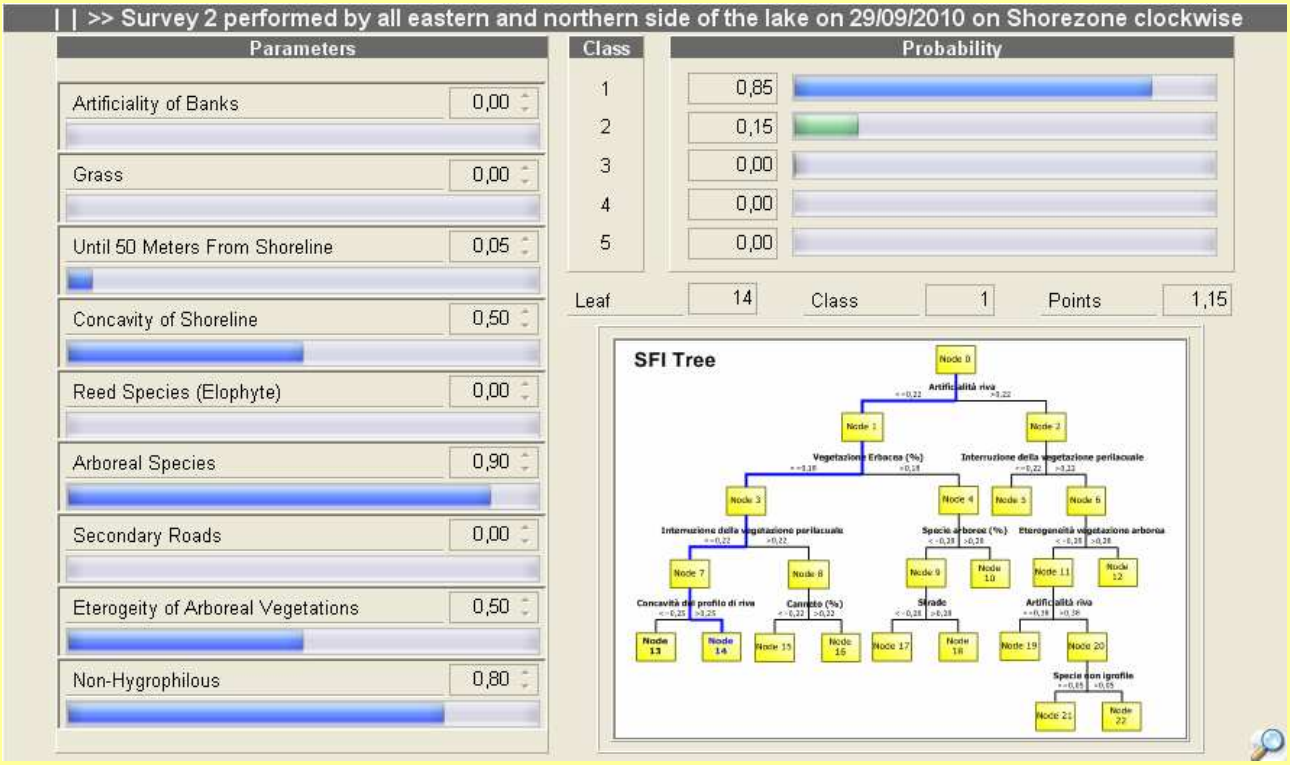
4.3 Homogeneous stretch 3

Field form number	2
Length of homogeneous stretch	4018 m
Delineation	On the western side of the lake, from the end of the Black locust, all the way to the western end then on the northern side of the lake.
SFI result	1
Personal evaluation	2
Note	

Fig. 14, 15, 16. Different view of stretch 2

This area runs from the end of the homogeneous stretch 3 all the way around the lake until the special protected area on the southern-western part of the lake. As for the stretch 3, this area is also characterized by steep hills following into the lake. The fisherman path runs until the western side of the lake, were this tributary emissary brings water into the lake and represent the sole minimal interruption of the lake shorezone. Paths or accesses to the shore are absent in the northern part of the lake. In this stretch, the presence of exotic species is limited, and mainly no-hygrophilous trees reach the lake until its shores (figures 14,15,16). Exotic species are here mainly not present, and the vegetation is characterized mainly by willows (*Salix*), alders (*Alnus*), furs (*Abies*) and larches (*Larix europaea*).

Wet reeds are also absent in this area. There aren't interruptions of the vegetation area and agriculture fields are missing in the surrounding environment (0-200 meters from the coast). The shorezone should be able to filter any cause of no-point-source of pollution (and storm water run-off), despite of the steepness of the area.



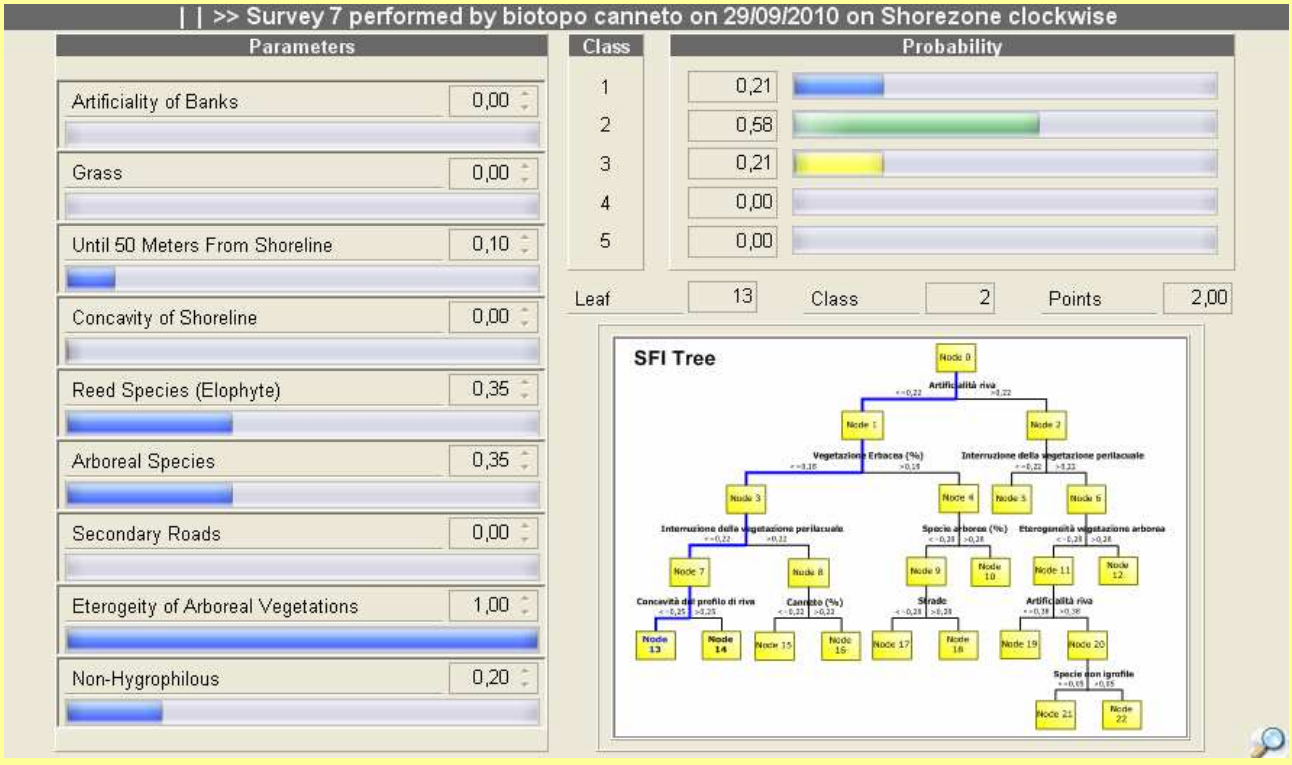
4.4 Homogeneous stretch 4

Field form number	7
Length of homogeneous stretch	262 m
Delineation	On the northerner –western side of the lake, where the protected reed biotope is.
SFI result	2
Personal evaluation	1
Note	The SFI results was penalized because of the lack of concavity

Fig. 17. View of the biotope

This stretch includes the special protected area of the wet reeds biotope. Here, reeds (*Tipha*) grow along the shore, followed by other aquatic plants (Fig. 17). The area behind this stretch is mainly flat and composed by shrubs and small trees and it is partly urbanized further out.

Given the flatness and the presence of hygrophilous species, this shorezone should have good filtering capabilities.



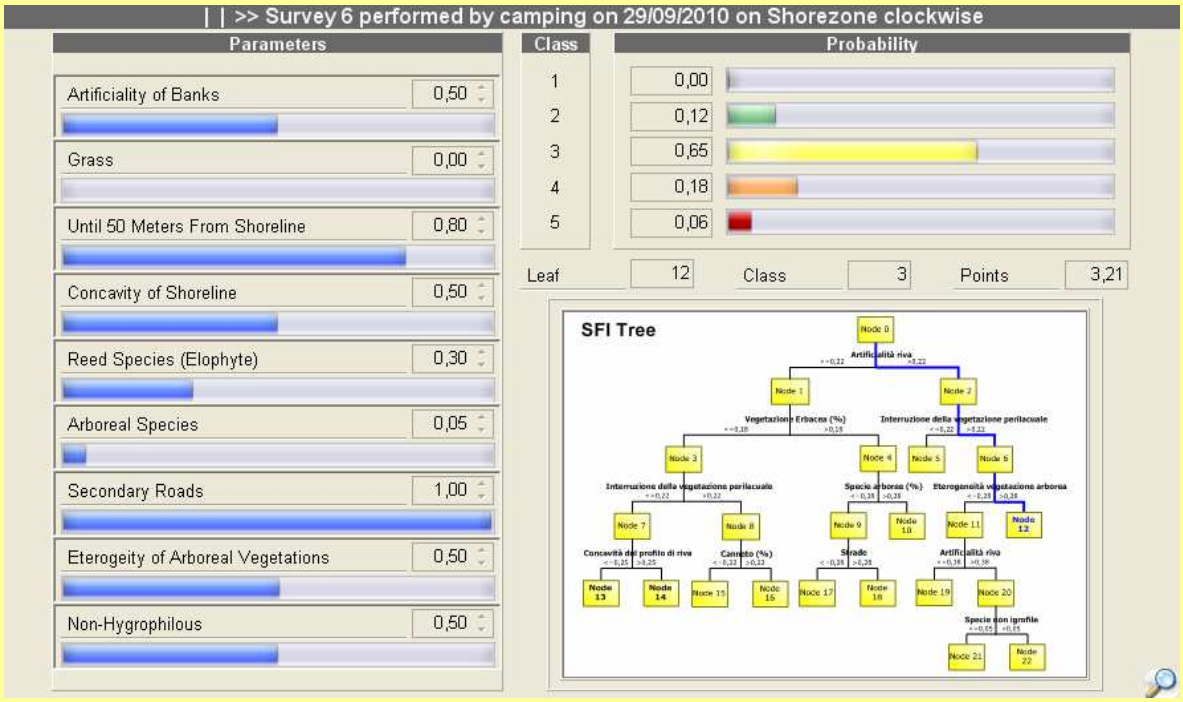
4.5 Homogeneous stretch 5

Field form number	6
Length of homogeneous stretch	313 m
Delineation	The camping starting from the end of the reeds to the Brenta emissary
SFI result	3
Personal evaluation	3
Note	

No Picture available

This stretch runs along the artificial beach created for the camping side. Reeds are present only in 2 small pools, and the area is mainly composed by bare soil slightly covered by small trees planted probably for shading, including alders (*Alnus*), poplars (*Populus*) and willows (*Salix*). Invasive species were not detected, but clearly the shorezone functionality is penalized by the strong human impact. The presence of the reeds pools could instead work as a sheltering area for moving aquatic animals, and it is reccomanded to leave them untouched.

The presence of bare soil, high population density during the tourism season, make this stretch were sensitive to pollution issues.

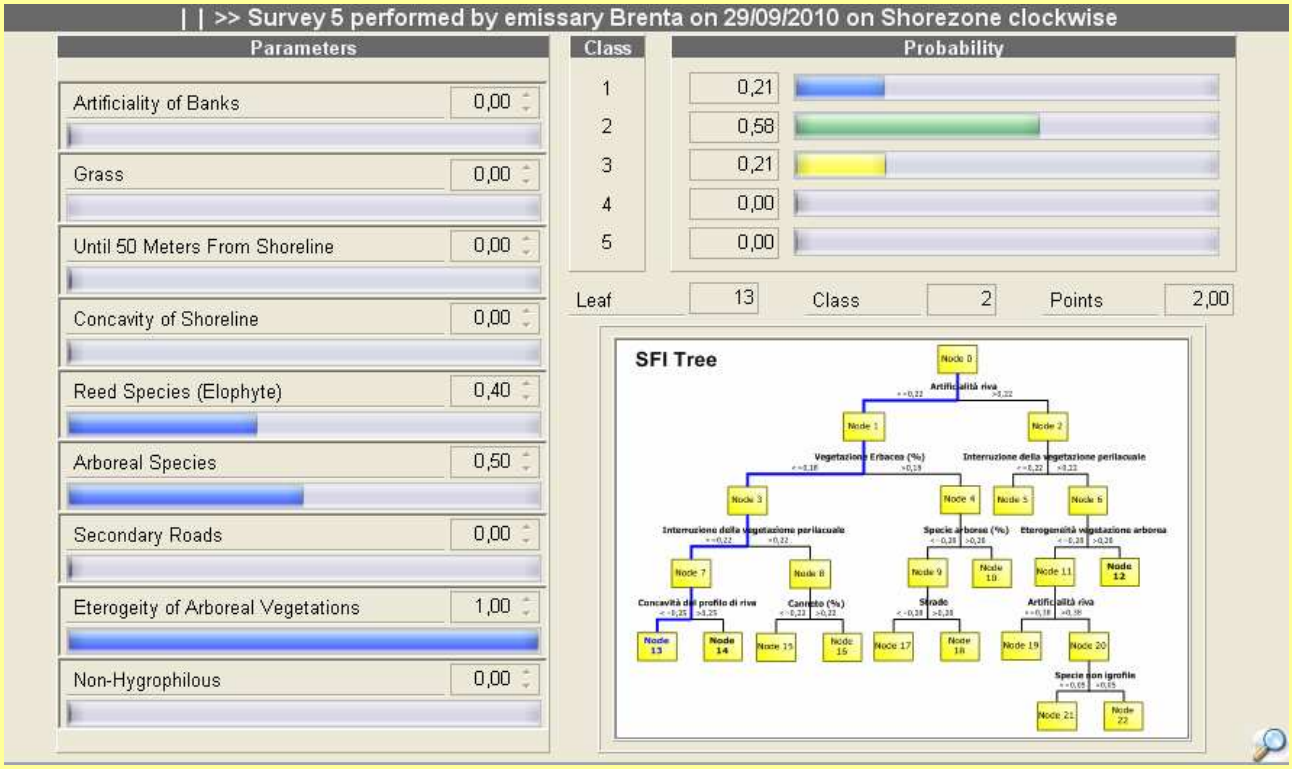


4.6 Homogeneous stretch 6

Field form number	5
Length of homogeneous stretch	106 m
Delineation	Brenta emissary
SFI result	2
Personal evaluation	2
Note	

Figure 18. View of the Brenta estuary

This small stretch englobe the area sourronding the Brenta emissary. This area is composed by an area of older trees such as alders and oaks on the left side of the emissary (Fig. 18), and a man-made area of the right side. Invasive species were not detected from the boat. The functionality of this area is relative as its extension is very limited.

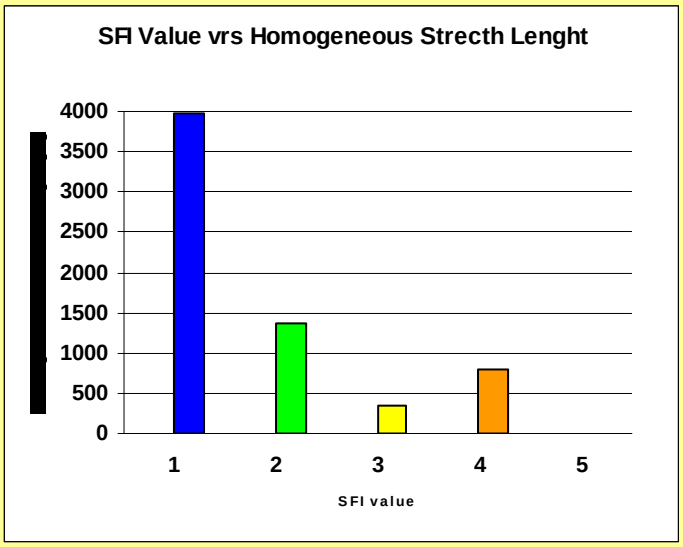


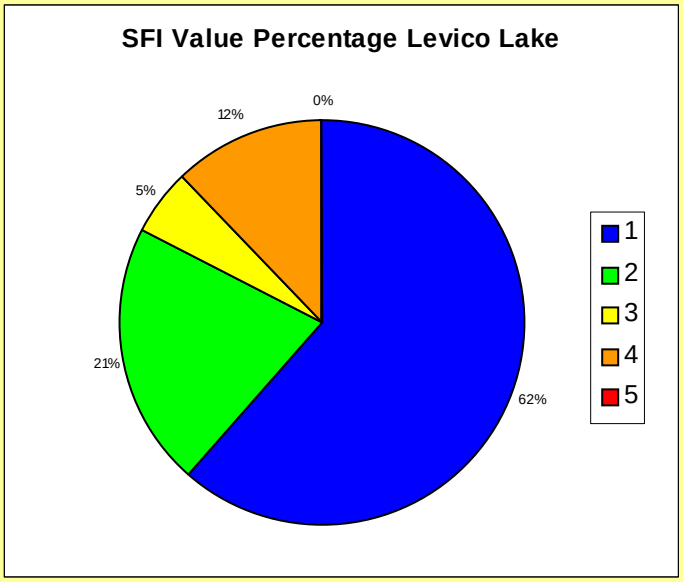
Chapter five: Discussion and conclusion

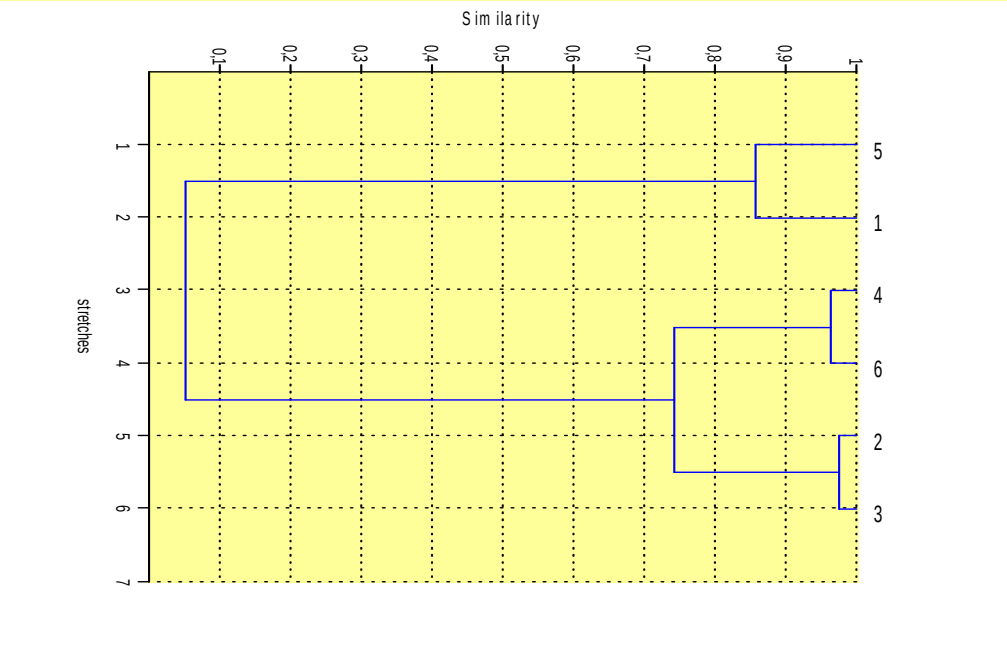
The fifth chapter present a statistical analysis of the results, describing the overall status of the lake shorezone, underlying its weakness, its strengths, and presenting scenario for adaptation strategies (*Eulakes*). Particular attention should be played when writing this chapter, as this is the one managers should focus on to understand the shorezone status of the lake.

5.1 Statistical analysis and overall status

On 6 individuated homogeneous stretches, more than half (62%) of the lake had an Excellent value. The stretches that felt on the second class (21%) were either penalized by the presence of exotic species or by the presence of human intervention, even if mild (such as the fisherman path or other roads) in the surrounding territory. The 2 beaches instead fall into the third and fourth class, the first one at the camping, being better thanks to the presence of the reeds and different arboreal riparian species.







The above cluster analysis graph groups the different homogeneous stretches based on the similarity in ALL the collected parameters in the field. It shows 2 distinct groups, one forms by shore 1 and 5 (the shore that are affected by a stronger degree of anthropogenic impact).

The potential of the SFI method lies in the ability of obtaining a synthetic value of lake shorezone functionality. The SFI method is an useful tool to aid the choices of future shore restoration actions and to suggest sustainable criteria for a ecosystem-based watershed management.

Moreover, SFI answers to the current needs, as requested by the 2000/60/CE directive, to develop new indices able to assess the hydro-morphologic elements of lake's ecosystems, including the riparian zone.

The SFI proposed approach permits to complete the study of the internal lake's dynamics, often modified for production or recreational-tourists purposes. A lake shorezone management based on the concepts of its functionality allows to reconcile the environment protection with the human use of the lake, helping an eco-sustainable city planning and watershed management.
In Levico lake, most of the shorezone shows present an excellent functionality, with homogeneous stretches able to carry out different ecological functions, such as nutrient removal from surface water running into the lake, shore erosion protection, provide habitat for aquatic and terrestrial species.
The rest of the shore looses values due to presence of exotic species and due to an increasing level on human disturbance.

5.2 Management Recommendations

Levico Lake does not present any particular issue regarding water quality and no particular management actions are suggested for the management of this lake. Although, to assure the good general health of the lake and a good water quality for the swimming beaches, we suggest to maintain the homogeneous stretch 3 to an excellent value. The homogeneous streacth 1 (swimming beach area) could be improved by replacing the broken impermeable wall with a permeable one, maybe constructed with woods and rocks, allowing the growth of the reeds in certain spots, also to ensure safe spots of migrations for small aquatic animals.