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Perspectives on Sustainable Fisheries Management — Case Examples from Sweden and Finland

Edited by Niilo Valkonen

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Intellectually Driven Management of Natural Resources of the Green Belt of Fennoscandia

Karelian ENPI CBC

This project is co-funded by the European Union, the Russian Federation and the Republic of Finland.

Perspectives on Sustainable Fisheries Management — Case Examples from Sweden and Finland

Contents

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Forewords

By Niilo Valkonen, Future Missions Oy

Sustainability is an increasingly common subject in the field of fisheries management. Simplistically speaking, fishing can be considered ecologically sustainable when fish populations do not decline over time due to fishing practices. Although the concept does not seem complicated, practice has proven otherwise, especially when the economic and social aspects of sustainability are considered.

Hilborn (2008) recognizes three elements typical for biologically, economically and socially successful fisheries around the world. These are [1] restricted access, [2] maintenance of biological productivity and [3] cooperation of stakeholders. Based on my personal experience, achieving long-term success in the first two elements usually requires the third element to be present. This makes cooperation of stakeholders the key element in successful fisheries management. Although stakeholders, here in Finland for example, are often busy promoting their own interests and incapable of compromising for the common good, we have several examples where cooperation of stakeholders has led to outstanding results.

This publication was conducted by Future Missions Oy as part of Karelian ENPI CBC funded project IntellGreenBelt. The project aims at promoting sustainable use of fish resources and fisheries development in the Green Belt of Fennoscandia, among other things. The present publication consists of five articles introducing successful fisheries management examples in Finland and Sweden. The articles are meant for provoking thoughts among fishermen and policy makers also beyond the project's operating area. Each of the five articles has a different approach to the subject; however, all represent sustainable fisheries management.

The first two articles focus on northern pike which is a popular game fish and common catch for recreational fishermen. The first article is based on a study on effects of size-selective fishing of pike conducted by the University of Helsinki. The second article, on the contrary, relies heavily on practical experience and discusses the guiding principles of sustainable fishing tourism development in Sweden. Although the two articles approach pike fishing from different perspectives, they come to the same conclusion – in order to maintain opportunities for good pike fishing and healthy ecosystem under heavy fishing pressure, the big ones need to be protected.

The third article is a story of ordinary people who did something extraordinary for their local brook. As the article points out, significant results can be achieved through ambition, cooperation and hard work. Indeed, the case is an epitome of the phrase "where there is a will there is a way". The fourth article has a more societal approach and it combines experiences from various communication projects that have been carried out in the eastern Finland during past few years. The article discusses how to influence decision-making among different stakeholders. The results indicate that achieving a significant change in fisheries management requires continuous involvement and communication through different channels, such as face-to-face meetings and media coverage.

The last article focuses on fisheries co-management in Lake Vättern, Sweden, where fisheries co-management group was established in 2004. As it is pointed out in the article, experiences are promising and suggest that participatory approach can lead to more transparent policy system, stronger legitimacy of policy and enhanced level of stakeholder commitment.

It is useful to remember, however, that each fisheries management case is individual. Something that has proven to be successful under certain circumstances might not bring the same results elsewhere. As a consequence, examples introduced in the present publication should not be adopted without considering the local circumstances. Nevertheless, we believe that this publication provides a valuable insight for anyone working in the field of fisheries management and contributes towards improved environmental governance in the Green Belt of Fennoscandia.

[Reference: Hillborn, R. 2008. Knowledge on how to achieve sustainable fisheries. Fisheries for global welfare and environment, 5th World fisheries congress 2008, 44-56]

The Effects of Size-Selective Fishing on Pike Populations

By J. Tiainen, M. Olin & H. Lehtonen / University of Helsinki, Department of Biological and Environmental Sciences

1

Pike fishing and sustainability

Recreational fishing is hugely popular in Finland as 1.5 million people practise it at least once in a year (FGFRI 2014). Recreational fishing may have negative effects on fish stocks including decline of populations and changes in the species, fish size and trophic composition (Post et al. 2002, Lewin et al. 2006) This applies also in Finland due to high popularity and widespread use of destructive fishing gear such as gillnets in recreational fishing. Pike is one of the most important fish species in recreational fishing with ca. 7,000 tons per annual catch; however, no length or bag limits are set for pike fishing in Finland despite of decreasing trend in the annual pike catches (FGFRI 2014). The effectiveness of recreational fishing is likely not decreasing as there has been a rapid development in fishing techniques and fishing gear. Also modern fast and well-equipped boats with advanced electronic equipment encourage enthusiastic fishermen to practise their hobby effectively year-round (Radonski 2002, Cooke & Cowx 2006).

Pike is widespread and abundant predatory fish in the Northern hemisphere (Craig 1996), and an important catch in recreational fisheries in all Europe and North America (Pierce 2012). As a top predator, pike is a keystone species in boreal lakes. It has a profound role in the ecosystem since it can regulate the amount of its prey species (Craig 1996). Although pike is not considered an endangered species, local overfishing, environment deterioration related to shoreline construction projects, water level regulation and increased turbidity caused by climate warming have raised concern for pike stocks also in Finland (Lehtonen et al. 2009). To ensure sustainable use of pike stocks in the long-term, it is important to increase our understanding on the ecological effects of pike fishing and manage pike fishing in the way which ensures fishermen's opportunity to catch large pike also in future and maintain productive pike populations and healthy ecosystems.

Recreational fishing is size-selective and often targets large trophy fish (Lewin et al. 2006), which may cause serious harm to fish populations. Smaller mean and maturation size and slower growth have been reported in many marine and freshwater fish species due to size-selective fishing (Conover et al. 2009). Intensive fishing has also been shown to inflict behavioural changes in the fish as actively swimming and fearless individuals are more likely to become caught (Härkönen et. al. 2014). In the long term, this induces risks of permanent changes in the fish population via genetic selection towards slower growth and smaller maturation size (Post et. al. 2003, Cooke & Cowx 2004). Size-selective fishing may also be sex-selective. Female fish are vulnerable to size-selective fishing because they reach maturity later than males and grow faster, thus becoming easier catches (Horppila et. al. 2011). Catching of large and fast-growing female fish may lead to a decreasing reproduction success as large females are known to have better reproduction success than smaller females due to higher fecundity and better egg and offspring quality (Murry et. al. 2008, Kotakorpi et. al. 2013).

The detrimental effects of size-selective fishing can be mitigated by regulating the allowed fishing equipment, e.g. gillnet mesh size. Also legislation plays a major role in size-selectiveness as fisheries are often regulated by setting different length limits. Most common regulation has been lower length limit, but also upper length limits and combination of these two regulation methods, i.e. harvestable slot length limit, may be used (Arlinghaus et al. 2010). To ensure effective length-based regulation, it is often combined to other regulatory measures such as banning or restricting certain gear types or setting bag limits for anglers. This kind of fishing regulation demands certain skill level from anglers as appropriate fish handling techniques need to be applied to keep post-release mortality at the lowest possible level.

KESKALA study – Background, aims and methodology

In an 8-year field study conducted by the University of Helsinki, effects of two different size-selective fishing strategies on pike population density, biomass and population structure were compared. The research focused especially on the role and importance of large pike. The purpose of the study was to find out possibilities for maintaining productive pike stocks in terms of population size, biomass and offspring quality by utilizing different size-selective fishing strategies.

The study was conducted in four small oligo-mesotrophic and humic Southern Finnish forest lakes in Evo region, Hämeenlinna, during years 2006–2013 (Olin et al. 2010). Size of the lakes is between 2.1 and 13.8 hectares; the lakes are nearly pristine and reserved only for research purposes. Pike populations in the test lakes were subject to size-selective pike removal which started in 2008. Pike removal was conducted by removing 50% of the biomass of the targeted sub-population by using two different methods. In two lakes, a minimum length limit (MLL) of 40 cm was applied. In the other two lakes, a harvestable slot-length limit (HSL) of 40–65 cm was applied. Pike population densities were determined based on a mark-recapture programme.

Pike were caught by fyke nets and wire traps during spawning period in the spring and by angling in the autumn. Also other fish assemblage as well as benthic invertebrate and zooplankton communities and water physical and chemical properties were monitored during the study.

Results – Large individuals vanished rapidly if they were not released

In the HSL lakes, pike population densities and biomasses remained relatively stable despite of intensive fishing of 40–65 cm pike (Figure 1). Large, i.e. >65 cm pike, that were released comprised a substantial part of the total biomass during the study, indicating low mortality of catch and release. However, in the other HSL lake, Haarajärvi, biomass of large pike diminished little, probably due to decreased recruitment of large size classes. The other MLL lake, Lake Majajärvi, experienced a clear population density and biomass decrease during the study period. In the other MLL lake, Lake Hokajärvi, pike biomass remained high regardless of intensive fishing. However, in both MLL lakes the biomass of large pike collapsed completely after four years of pike removal.

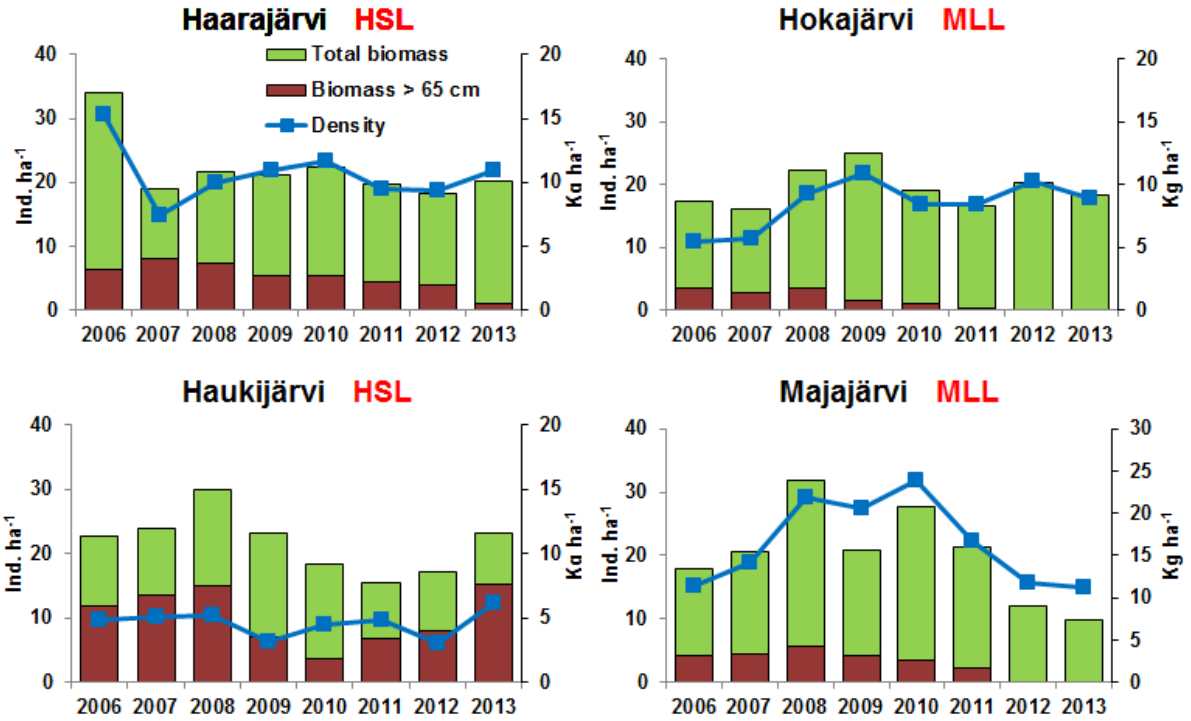

Figure 1. Pike population estimates (blue line), total biomasses (green columns) and large ≥65 cm pike biomasses (red columns) in research lakes in years 2006–2013. HSL=Harvestable slot-length limit, MLL=Minimum length limit. Pike removal started in year 2008.

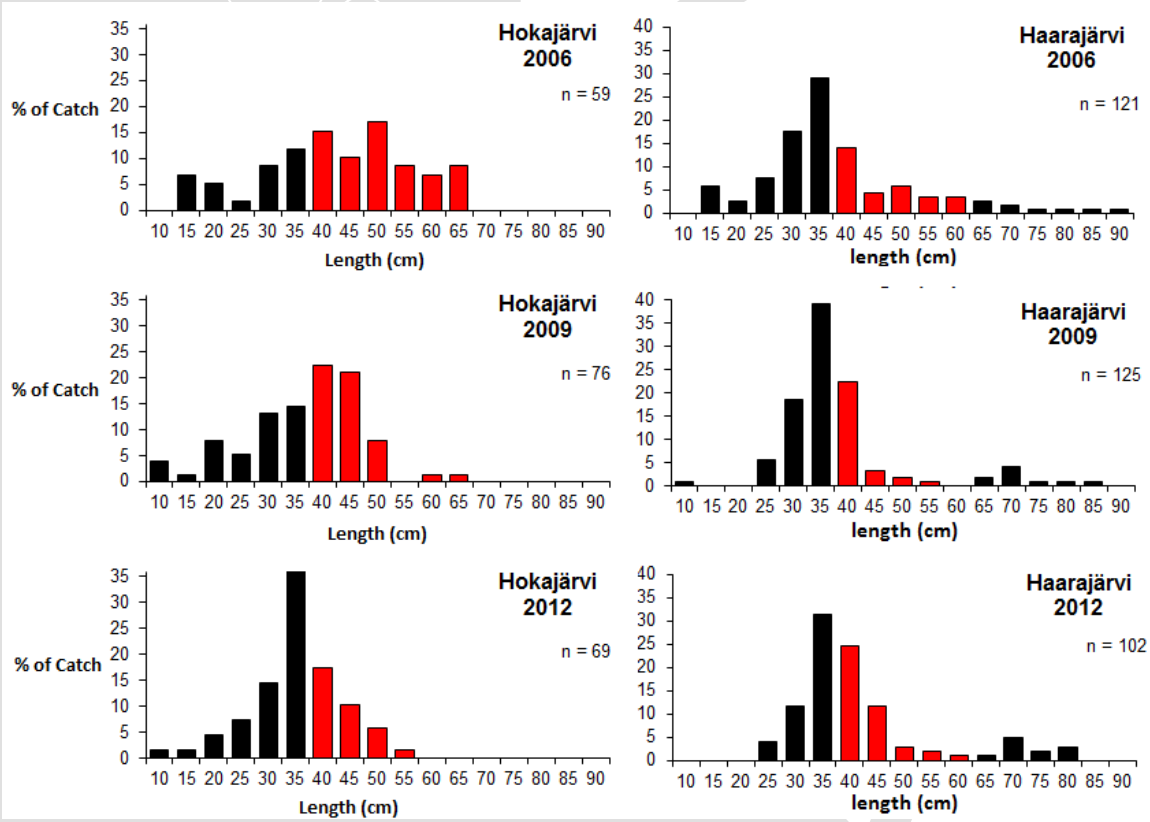

Figure 2. Pike length distribution at 5 cm size classes in lakes Hokajärvi and Haarajärvi in years 2006, 2009 and 2012. The size-classes shown in red were subject to fishing.

There was a clear difference in the development of population size structures between the MLL and HSL lakes. In MLL lake Hokajärvi, a significant change in pike population structure occurred. In the beginning of the study in 2006, all size-classes of pike (30–65 cm) occurred relatively equally; however, removal of >40 cm pike gradually led to the dominance of 35–40 cm pike in the population until the study was concluded. On the contrary, in HSL lake Haarajärvi, the pike population structure remained nearly unchanged during the experiment (Figure 2).

Conclusions and recommendations

According to the above-presented study, harvestable slot-length limit treatment retained large pike in the lake, which is considered an essential feature in sustainable fishing. The research confirms other current studies (Birkeland & Dayton 2005, Arlinghaus et. al. 2010) according to which protection of large pike is recommended by setting upper length limits rather than setting only lower length limits. Especially large individuals are vulnerable to the effects of fishing as they cannot be replaced easily. On the contrary, small pike in the test lakes were resilient to fishing as only 1 of 4 lakes showed signs of population density decrease by pike removal. Thus, even intensive fishing of small pike can largely be compensated by increased survival and growth. However, adequate survival of harvestable-size pike has to be ensured in order to maintain large pike in the lake in the long term. Therefore, fishing pressure has to be proportioned to growth rate to ensure adequate recruitment of specimens exceeding the upper length limit (Arlinghaus et. al. 2010).

Maintaining large pike in the lake ecosystem has several advantageous effects. Firstly, large females have high fecundity and better offspring quality than smaller individuals. In the earlier study of the KESKALA project (Kotakorpi et. al. 2013), it was found that the offspring of large female are larger and have more energy in their yolk sack reserves, which makes them less vulnerable to predation, more capable to use various prey items and more resilient to starvation in their early life. Secondly, being predators at the peak of the food chain, large pike are vital for the functioning of the ecosystem (Craig 2006). Abundant pike population can control

roach and bream stocks, working against eutrophication process. Especially large pike have an important role as they are the only piscivores that are able to eat large-sized cyprinids (Hart & Hamrin 1988). Large cyprinids are usually females and thus the most fecund spawners; they are also a significant cause of bioturbation retaining eutrophic conditions. Consequently, consumption of large cyprinids by pike is important. Thirdly, large pike are important trophy fish for anglers (Lewin et al. 2006). Thus maintaining large pike in a lake makes it an attractive target for anglers, increasing the lake's recreational value. According to the above-presented study and others (Koski, 2009, Stålhammar et. al. 2014), pike is relatively resistant to catch and release fishing with less than 10% mortality, which makes it possible to control pike fishing by slot-length limit regulation.

It can be concluded that if fishery stakeholders and authorities want to develop high-quality pike fishing and ensure vital pike population and natural ecosystem in their water bodies, regulation of pike fishing as well as promoting the importance of pike for the ecosystem is recommended. A transfer from "kill'em'all-fishing" to selective fishing by setting length limits is particularly important if there is considerable fishing pressure for pike in the area. Determining appropriate length limits for pike is another important task. The lakes used in the research are small and have low production and slow pike growth. Therefore, upper length limit of 65 cm which was applied in the study is not likely to be valid everywhere. In their modelling study, Arlinghaus et al. (2010) suggest that ideal slot length limit for maintaining large pike is achieved by setting minimum length limit of 45 cm and maximum length limit of 75-80 cm. In Sweden's Baltic Sea region, a 40-75 cm slot length limit is set for pike with daily bag limit of three pike, as an answer to the declining pike stock. Based on the above-presented study and examples from elsewhere, we recommend setting harvestable slot length limit with lower length of 40-45 cm and upper length of 70-75 cm for pike fishing.

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How to Build a Successful Tourism Business Based on Sustainable Fishing?

By J. Zafaradl / Karlstad, Sweden

2

Sport-fishing tourism

Sport fishing tourism is nowadays highly spoken for and considered a great opportunity to create income and new business activities in the rural areas of Sweden, for example. While this is true, lack of knowledge and appropriate regulations combined with shortsightedness in pursuit of results might in some cases produce a risk for the resource as well as the product. In developing sport fishing tourism business, sustainability of the fish stocks and the tourism products need to be maintained.

This article discusses sustainable sport fishing tourism and its development. Furthermore, the article introduces some sport fishing tourism destinations, some of which are successful and some not. Finally, the article summarizes some ideas and key points on how to develop and maintain a successful sport fishing destination.

Background

My experience and background in sustainable fishing tourism development is based on Skaraborg area, Sweden. The area has different types of water bodies with various conditions. I base my theories and ideas on the experiences gained in my work and combine them with an input from colleagues from different parts of Sweden. Although a development project normally lasts only two to three years, we share a mutual sense of responsibility regarding the resources and try to avoid any kind of shortsightedness.

In my work I try to combine traditional regulations to preserve well-balanced fish populations with a "tuned" approach from scientific studies on how to develop tourism in sensitive environments such as national parks. I have taken the liberty to use and, one might say, change the meaning of the concept *recreational capacity* to involve ecological,

environmental and economic parameters, and apply it to sustainable sport fishing tourism, enforcing ideas into this term based on personal experiences and beliefs.

I would also like to add that my examples are not suitable to all sites; size, seasons, target groups, target fish, current regulations, possible private ownership and various other factors must be considered in developing sport fishing tourism.

Basic strategy

When I first started to plan sport fishing tourism development in my local area, I listed the water bodies according to size, access, potential entrepreneurs, regulations, current entrepreneurs, potential accommodation possibilities and a number of other parameters. I contacted two mobile fishing guides who started to provide fishing tourism education to local accommodation providers.

Cooperation between accommodation companies and fishing guides proved a win-win situation to all parties. It became obvious that a strong network between accommodations providers, guides and other local entrepreneurs is a way to increase diversity and to meet the demands of the operators and the customers. Informing local tourism agencies on the process and delivering concrete materials like packages and destinations is also essential. It is beneficial for the fishing guides to yearly invite tourism agents on free guided fishing tours, as this creates free vendors in the tourist offices. The effects of networking and cooperating create involvement in the area's development and make the synergy effects more visible.

In developing new tourism business it is important to keep different stakeholders informed on the ongoing efforts. The landowners of our operating area were invited to the meetings in which they were explained what was being done and why was it profitable for the whole area. Landowners were encouraged to apply new fishing regulations such as maximum size limits. However, this was not always received in a positive way due of old prejudices.

Large pike are often considered a threat to other popular species such as pike-perch and trout. In order to change this conception, it is important to understand that large pike result from well-balanced fish populations, and harming this could affect trout and pike-perch populations in a negative way. Pointing out economical and marketing values of large pike is also essential especially when targeting international sport fishing guests. Trophy fish in all species are crucial; although some waters do not deliver many of them, guests should always have a sense that "there is a chance to catch the fish of my dreams".

"Recreational capacity" and sport fishing tourism

Recreational capacity can be considered as a factor in developing sustainable sport fishing tourism in natural waters without interfering the preservation of ecological, social and economic status of the water and fish stocks. Recreational capacity is a common term when discussing national parks as a resource for outdoor-activities, for example hiking. The concept can be applied to fishing tourism as well.

Different parameters can be used to ensure recreational capacity of the water area. Most common means are rules and regulations protecting the fish stock, especially trophy fish. These include guidelines and policies for the management of the destination and its customers. Other instruments are based on price and access to fishing sites. This means more income per guest without increasing the fishing pressure – volume is not necessary. Fewer guests at the destination help to maintain the sense of originality and exclusivity, enabling higher price for the product.

SWOT analysis

When launching a project to develop sport fishing tourism, it is essential to identify threats and possibilities before actual planning. One way to do this is to assemble a group of stakeholders together with persons who have expertise in sport fishing tourism and carry out a SWOT analysis. List threats and possibilities in an objective way and discuss and evaluate them to see what type of work is necessary to eliminate some of the threats and enable as many the possibilities as possible.

Strong fish populations are the main resource in sport fishing tourism and it is essential to identify factors that might threaten them. If possible threats are ignored, it may risk the ecological status of the water but also the economic value of the product.

Case study: The effects of shortsightedness

Lake B has potential to attract sport fishing tourists from upper price segment. Owner of the lake is interested in building cabins to the lakeshore for fishing guests. No long-term planning or SWOT analysis are made. Fishing regulations are nearly inexistent, and there are no intentions to change them. To launch the business, the lake owner starts cooperation with a foreign agency. Majority of the clients from the target country do not practice selective fishing and terms such as catch & release, bag limits or maximum size regulations are unfamiliar to them. Accommodation prices are kept down to attract a volume of guests through the operator. In one or two seasons all the cabins are fully booked. The fishing has very high quality producing numerous trophy fish of pike between 8-15 kilograms. However, few of the trophy fish are released.

After 4-5 seasons of operation, returning guests are noticing a stagnation in the amount of trophy pike although the lake is relatively large (15 km²). Bookings do not continue at the same level as before; to compensate this, the landowner contacts another sport fishing tourism operator from another market area. The process is started from the beginning. This time, however, there are no trophy fish and marketing becomes difficult. The lack of trophy fish eliminates the possibility to attract new clients who are willing to pay for a product based on high quality fishing.

What could have been a top notch sport fishing product in the high price segment is today an ordinary holiday destination. Prices are on an average level: the former added value of the product from great pike fishing is lost. Ironically, many target groups from central Europe consider strict fishing regulations as receipt for great fishing. It is important to remember that regulations are not only a way to preserve the resource and the product but can also be considered as free marketing.

Nothing catches the eyes of potential clients better than photos of trophy fish that were released.

Income and occupancy rate

My experience in working in tourism, especially in sport fishing tourism, is that many national and regional tourism agencies which might launch development projects focus on occupancy rate to measure profitability of sport fishing tourism. This is a simple and very logical way; however, it can be misleading if the added value is not considered. It is not the occupancy rate which defines the progress in sport fishing tourism but the amount of money generated by each guest that is interesting. Combining parameters such as *number of entrepreneurs involved in the product* and what *direct synergy effects* are created reveal the real "income spectra". Do not exclude "the ripples on the water" in this genre of tourism.

This said, there are several examples where a high occupancy rate is crucial to a sport fishing destination. This kind of products are often placed in the lower price segments. Entrepreneurs have found a way to receive a high number of guests but do not risk sustainability and reproduction of the water area. Control of the resource is essential. In the following case, I present a product based on stocking fish – a Put & Take area.

Case Study: Hökensås Sportfiske AB – Volume in Sport Fishing Tourism

Sweden's largest company engaged in sport fishing tourism, Hökensås Sportfiske AB, has been operative since the 1950s. The company has an area including 23 lakes and four kilometers of stream with brown trout, char and rainbow trout. Hökensås Sportfiske AB has a fish farm producing high quality stock fish especially for sport fishing. The company is self-sufficient on fish delivering stock fish also to a number of other Put & Take lakes in Sweden.

Hökensås Sportfiske AB's annual turnover is over 10 million SEK and it has 10 full-time employees. The company cooperates with a camping area and accommodation service provider which is situated strategically in the area. The company owns a tackle shop and sells approximately 30,000 fishing licenses per year.

The company can adapt and modify fishing regulations in its destinations. If too many guests visit the area at the same time, the feeling of "wilderness" might be lost and pressure on the fish stock become excessive. This could harm the business in the long term. In the situations that may risk the area's recreational capacity, the company can adjust their fishing license prices. By increasing the fishing license price, the effects are curbed to a balanced level. The company can thus control the fish stocks as well as the recreational capacity.

Although Hökensås Sportfiske AB's operation is based on license volumes, the company offers products also in higher price segments. It provides one or two designated areas where only fly fishing is allowed. It also offers products of added value, such as courses, rental waters and guiding services. Hökensås Sportfiske AB base their products on dynamic regulation and full control of the resources and the price on the product.

Regulations

Well-thought fishing regulation is important in maintaining sustainability of the fish stocks in popular sport fishing destinations. Fishing methods should be adapted to local circumstances and different seasons so that impacts on the fish population and the environment would be as small as possible.

Bag limits and minimum and maximum length limits are examples of common regulations which help to maintain sustainability of the fish populations and protect trophy fish. Furthermore, regulations based on spawning seasons and spawning grounds for pike and pike-perch can be considered: for example, different spawning areas can be protected in different years. If the fishing tourism destination management wishes to implement stricter regulations at the site than they are authorized, a contract between guests and the destination can be made to enforce the regulations.

Fishing guests should be advised to use appropriate release equipment, such as weigh sling, unhooking pad, knotless rubber landing nets and pliers for cutting hooks. Boga Grips and gaffs should be forbidden. Fish should be handled with care and should not be kept unnecessarily out of the water. Only artificial lures and barbless hooks should be recommended or allowed. All rental equipment and equipment used by fishing guides should be suitable for selective fishing.

Fishermen should be advised to use appropriate release equipment. Weigh sling and unhooking pad are often combined in one product.

It is essential to inform the guests on the rules and restrictions applying to the sites. Up-to-date information on the regulations should be available at all times in appropriate places. If there are personal contacts between guests and the site management, short briefings concerning rules and regulations are preferred.

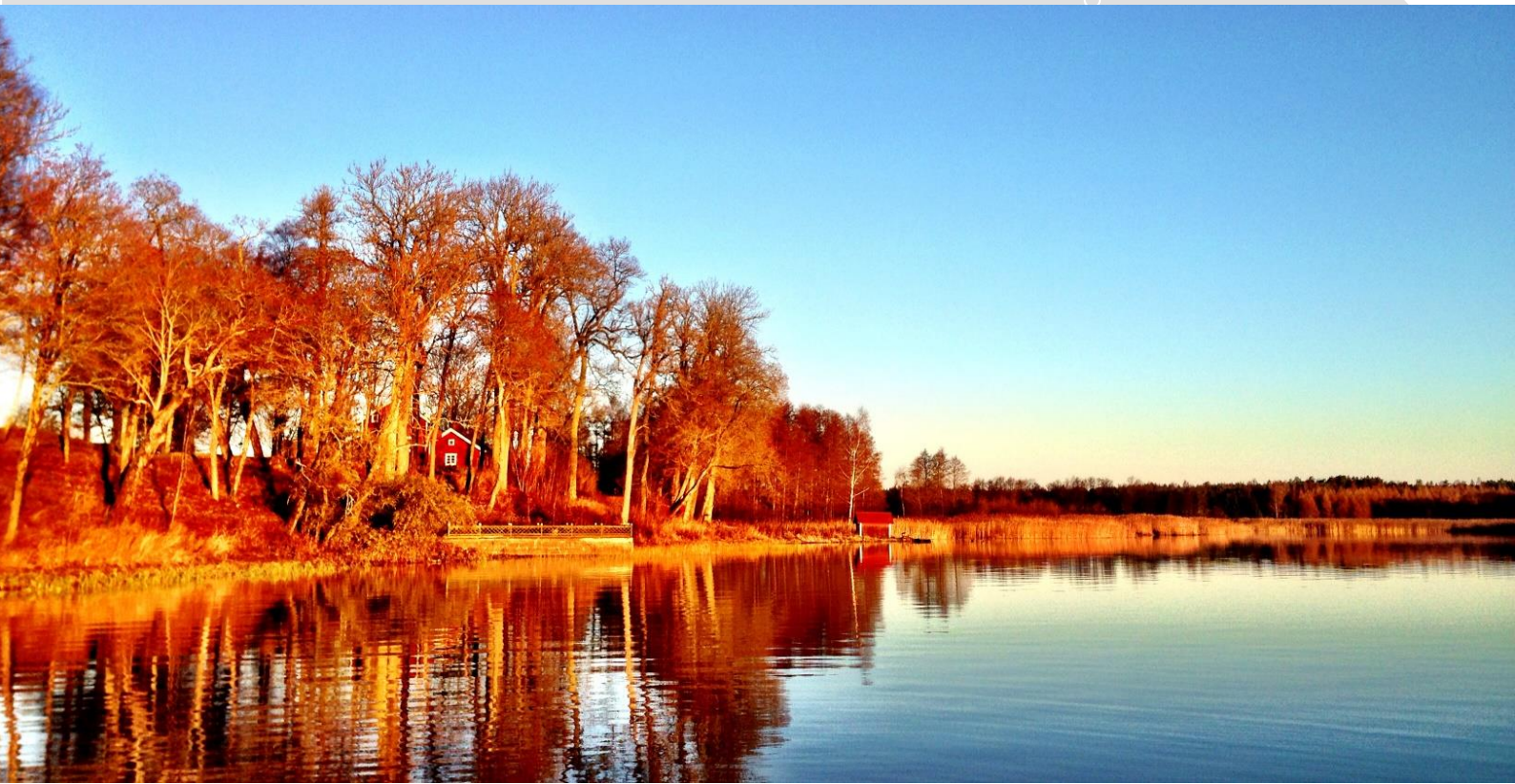
"Dynamic regulation" is one way to control fishing pressure and preserve the sustainability of the fishery. It means that the fishery management can without further notice adapt the fishing regulations to preserve and protect the fish stock. Dynamic regulation requires the fishery management to keep continuous track of sold licenses and catches made by the customers.

Case Study: Lake Sibbo – Big Fish Sweden (pike, pike-perch and perch)

Lake Sibbofjärden is a freshwater lake connected to the Baltic Sea and located 1.5 hours south of Stockholm. The lake is privately owned and leased by the company Big Fish Sweden / Skärgårdsguiderna. Lake Sibbo is a natural water without any fish stocking. Target fish include pike, pike-perch and perch. Big Fish Sweden AB has a turnover of 1-2 million SEK per year. The company claims to reinvest a large percentage of its profit in the development and refining of the business, for example new boats.

Lake Sibbo is a well-organized destination with advanced regulations. Products can be categorized in upper and middle price segments and the site offers trophy specimens in all predatory species. The owners of the destination focus on additional sales to generate more income per guest: guiding services, rental equipment, rental boats and exclusive packages in cooperation with local entrepreneurs, for example dinner at local restaurants after fishing. The destination receives guests mainly from Italy due to close cooperation with an Italian operator. Consequently, it is not dependant on the national market which is often more price-sensitive, and does not have to rely on weekend or one-day bookings.

Although there is a no-kill principle in Lake Sibbo and all guests are well-informed on the appropriate fish-handling techniques, the company aims to further develop their product to avoid ecological and economic impacts caused by fishing pressure. To ensure the recreational capacity, new measures are planned to maintain the sustainability and durability of the fish stock. The management aims to increase income per overnight stay with all-inclusive accommodation packages. This will reduce the numbers of guests but generate more income and stimulate weekly bookings. The destination also plans to attract fly fishers interested in catching predatory fish. Fly fishers are not as interested in the quantity of the caught fish as spin and jerk bait fishers.



Summary of key points:

Planning for a destination/product:

- Review the available water areas and think which fishing methods can be practised there.
- Review the available entrepreneurs and potential new entrepreneurs.
- SWOT analysis. List threats and possibilities.
- Market analysis. Define target groups – national or international (and target countries).
- Market-driven product development – define which target groups are available in your product framework.
- Evaluate the resource – status, strength and appropriate regulations.
- Educate and inform stakeholders or private land/water owners in the potential of sport fishing tourism and try to adapt/reform the regulations to *protect and attract.*

Product:

- Aim to maximize price of the product – find a balance.
- Add value to the product to legitimize an increased price level.
- Create a strong network. Cooperation creates synergy effects and involvement.
- Inform all parties on rules and regulations.
- Inform regional and local tourism agencies on the finished products, packages and guides.
- Try to connect to or locate added value to the fishing product: city breaks, sightseeing, hiking etc.
- Create channels to international target groups.
- Make sure there is a competent receiving "apparatus" especially when the media or international travel agencies are engaged.

Recreational Capacity:

- If possible, enforce a dynamic regulation.
- Focus on sustainability in three areas: social, environmental and economic durability.
- Preserve fish population and protect trophy fish.
- Keep number of people small to protect environment and its attractiveness (sustained value in the product).

John Zafaradl, the author of this article, holding a pike that resulted from proper fishery management.

Longinoja Stream Restoration

By J. Salonen / Helsinki, Finland

3

Hundreds of rivers in Finland have been dammed and cleared for different reasons. These have included building of power plants, clearing of river beds for timber floating, straightening of rivers to speed up water flow and so on. As environmental awareness has increased, concern for fish species such as trout has become more vocal. In many localities, natural trout populations have been lost as rivers have been modified. Since that, there have been various restoration efforts to improve the situation.

Restoration of the rapids has become more common since the 2000's as its benefits have become more known. Recently acquired results implicate that restoration is useful even at small sites. Appropriately realised restoration works benefit not only salmonids but the whole ecosystem in the area including people. An encouraging example is provided by Longinoja stream in Helsinki.

Background of Longinoja stream projects

Longinoja stream is located approximately 10 kilometres from Helsinki city centre. The stream begins behind Malmi airport where small ditches are led to a main channel. Here the stream flows through a green strip between residential houses finally running into Vantaanjoki river. From sea to inland, Longinoja is the first tributary for Vantaanjoki river. Trout that have completed sea migration reach this site easily.

Longinoja stream is seven kilometres long and its catchment area covers approximately 12.3km2. Majority of the catchment area consist of coated or constructed surfaces and the stream water level may rise significantly after rains. Usually the rise is from 10 to 50cm; after continuous rains, however, the water level may rise above one metre. Run-off water carries objects which do not belong in the stream, such as rubbish people have discarded. Chemicals used in the area along with other substances are dissolved in the stream with run-off water.

Longinoja stream has served as a ditch delivering rainwater away from a residential area. This is why the river bed has been cleared more than once. The latest clearing was completed at the end of the 1990's. In the beginning of 2000, the stream was completely straightened and cleared of rocks.

From an urban ditch into a trout stream

For critically endangered trout ascending the Vantaanjoki river, reproduction in a straightened and cleared stream was practically impossible. In the autumn 2001, however, large trout were observed in Longioja stream seeking spawning grounds. After the surprising discovery, a volunteer-based restoration project was quickly organised. Immediately the trout started to arrive to the newly gravelled spawning grounds.

Restoration of Longinoja stream into its natural state has continued actively since that. Restoration efforts have succeeded in creating natural reproduction conditions for trout. Volunteer-based works continue every year with stoning and gravelling of the areas where current is stronger, usually 20–50 metres at a time (picture 1). Dozens of gravelled spawning grounds for trout have been created in the stream. River bed roughness and water flow have also been diversified by creating bends and pits in the stream.

Heavy flooding strains stream banks, at places collapsing even large banks into the channel. Consequently, the restoration works have aimed at slowing down erosion that gradually covers gravelled sites in the stream with suspended matter causing deeper areas with a slower current to fill up and become shoaled. On the other hand, erosion slowly reshapes the straightened channel more stream-like.

Picture 1. Volunteer-based restoration efforts of Longinoja stream have continued since 2001.

Volunteers clear gravelled spawning sites every year before the spawning season of trout. This is done by breaking the gravel surface and stirring away suspended matter which has accumulated on the gravel. The stream is also cleared of rubbish and when required, trees fallen on the river bed. The main idea, however, is to let the stream return to its natural state, which is advanced by trees and other organic matter in the river bed.

Licences required for restoration works were obtained via Helsinki city engineer's office. Completed restoration measures should not have a damming effect on the stream. Majority of the works have been completed as volunteer-based projects. City of Helsinki has provided assistance by transporting rock and wood used in the restoration to the stream bank. Machines have only been used in few bigger restoration projects realised by City of Helsinki and Helsinki Environment Centre.

At present, the stream is at places approximately 5 metres wide. Depth of deepest wintering spots is few metres. Mean depth is above one metre in cultivated areas; the best reproduction and fry areas have water depth of approximately 20–50cm.

Creative restoration

The first restoration project of Longinoja stream included a restoration plan. Presently no actual plans are compiled; the area will take shape according to the restorers. These volunteers include "old hands" who have participated dozens or even hundreds of restoration projects during the past years and have learned to build gravelled spawning grounds in the stream suitable for trout.

Restored areas are decided on a yearly basis. Before the project, the volunteers find out what can be done in which part of the stream. Chosen area is monitored for finding out different water level alterations.

Restoration methods are various. Some volunteers build stone steps and others place rocks sparsely in the stream. Some use wood as chute. Some create small gravel spots in the stream, others prefer larger gravelled areas.

Restored area takes shape by feeling, knowledge, skill and good luck. Newly built spawning grounds can attract trout in the following autumn but may also remain untouched for several years until suddenly becoming popular. Pictures 2 and 3 show an example of restored area before and after a restoration project.

Pictures 2 and 3. One of the restored sites in Longinoja stream. Pictures were taken at the same place before and after restoration works.

Cooperation matters

Cooperation has been in a central role in Longinoja stream restoration measures. Volunteer-based restoration projects have been lead by Finnish Fishing Tourism Association since 2001. City of Helsinki and Virtavesien hoitoyhdistys ry (association for improving river and stream conditions) have participated in the restoration efforts. Also The Finnish Environment Institute has completed project-based restoration works in Longinoja stream. Helsinki Environment Centre has measured water quality, temperature and suspended matter drift in the stream. The Finnish Game and Fisheries Research Institute uses electrofishing for yearly collecting data on trout fry numbers and densities; this data is then entered in a test fishing register. Green areas department of City of Helsinki maintains piping in the stream by removing blockages.

When the restoration measures were begun in Longinoja stream, hundreds of euros were received every year as donations for restoration works. Donations enabled completion of small-scale restoration projects every year. When City of Helsinki started a programme on improving the conditions of rivers and streams in 2007, possibilities of volunteer-based projects were more widely recognised. Since that, City of Helsinki has provided rock and wood material for restorers in various projects and sites. Participation of City of Helsinki has enabled restoration of larger areas. Large stones are delivered along the stream with bucket loaders. Sponsor of Longinoja restoration works has for several years been a local company whose managing director contacted the volunteers, expressing their wish to support the restoration of the stream.

Results

Electrofishing results of the Finnish Game and Fisheries Research Institute indicate high trout density in Longinoja stream. Approximately 200 specimens of different age trout occur in the stream per 100 metres. Trout occur in the stream around the year. In the summer, different age trout can be observed by walking along the stream. Fry hatched during the spring can be seen in gravelled areas and older fry and brood fish in the sites with lighter current. Some 3 or 4-year-old trout leave for sea migration and return year of two later for spawning in their native stream. Diagram 1 shows electrofishing results in Longinoja stream since 1997.

Best sites for reproduction of trout in Longinoja stream are found in the area behind Ring Road I which is the busiest highway in Finland. Most drop height in the stream is in this area which creates suitable spawning places with stronger current.

In the autumn, trout arrive to gravelled spawning grounds to reproduce after sea migration. Hundreds of local trout also spawn in the stream. At places the fish are so numerous that new gravelled sites would be required. Largest trout detected in the stream are 70–80 cm long. Most trout ascending the stream are 40–60 cm long and have spent one year in the sea before spawning. Size of local brood fish in the stream is 25–60 cm.

Longinoja stream flows mainly on a green strip between residential houses. Its basin is the scenic centre of northeastern Helsinki and Longinoja trout have become important to people living in the area. Fish photographing and spawning observing attract dozens of watchers at best evenings (picture 4). Fishing is prohibited in Longinoja stream.

Secret of Longinoja success

Restoration is not rocket science. What is required is will to improve fish stocks. Doing is learning and each rock placed in the stream is almost without exception beneficial for the fish. When restoration success is assessed, the fish are the best judges.

Reason behind the Longinoja restoration success is in spawning and nursery areas which have been variedly created at different sites in the stream. Diversity ensures that fish can find a suitable spawning ground although water level in the stream alters. Diversified realisation of the sites can be observed during the spawning season. Some trout spawn at deeper, more sheltered spots, and others prefer lighter and shallower current. Persistence, yearly organisation of unpaid restoration projects and talking about the stream in public are also very important.

Informing on Longinoja stream projects has been open since the beginning. Hikers in the area as well as newspaper and internet articles are gladly informed of a local stream bustling with endangered trout. Information signs posted along the stream as well as a Facebook group are part of the information campaign. This has created a Longinoja stream community which at the same time protects the trout from fishing.

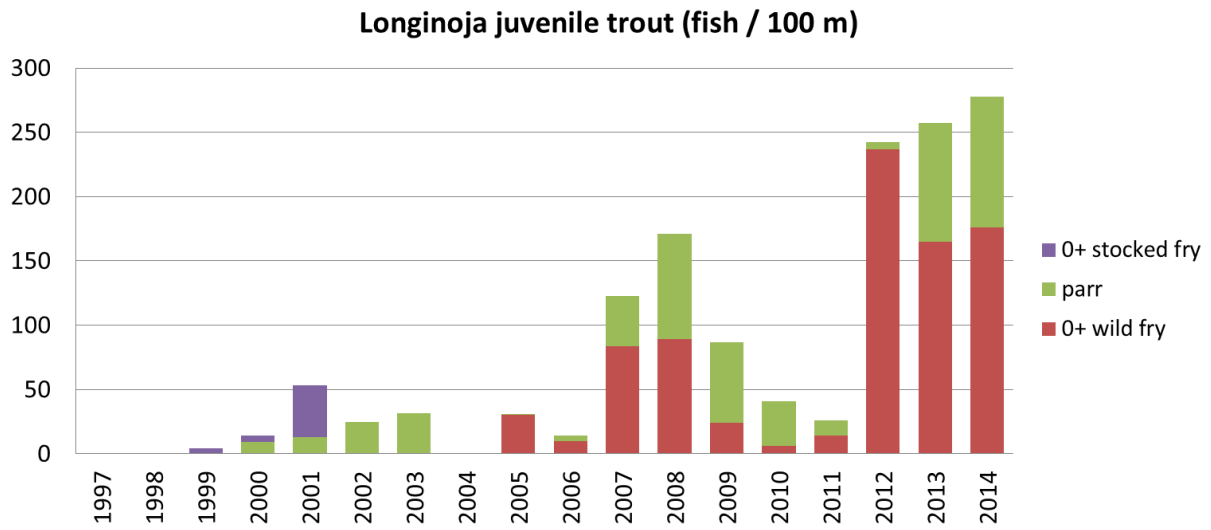


Diagram 1. Electrofishing results in Longinoja stream (Finnish Game and Fisheries Research Institute)

The following advice on stream restoration are by Juha Salonen, Longinoja restoration active:

- Find out whether the stream has an existing trout population which can be strengthened by restoration of the stream.
- Water quality is essential for trout. For example, too acid water is not suitable for reproduction of trout. Clarify the questions concerning water quality.
- Be open and network. Contact different quarters and discuss their views on stream restoration.
- Obtain necessary licences for restoration.
- Find out what type of gravel is needed in the stream. Suitable gravel for spawning ground consists of different size small rocks up to 5cm diameter.
- Examine whether there are enough sheltered spots for fish fry. Suitable fish refuges can be built from different size rock and trees fallen on the stream.
- Gravel varied sites in the stream. Create gravelled areas in the beginning of rapids, bends and sites with strong current. In other words, don't lay all the eggs in the same basket. Restored spawning sites should not get dry even when water level is low.
- Talk about goals and accomplished results of your project.
- Be passionate and share enthusiasm with other people participating the project.
- Involve people which move about in the area and let their spread information.
- Don't give up after the first setback; keep progressing towards your goal with determination.
- Perceive and witness how a ditch is slowly transformed into a stream which attracts not only fish but also other animals.

Picture 4. Longinoja attracts fish photographers. (Picture: Henrik Kettunen)

Promoting Sustainable Salmon Fishing Practices on Lake Saimaa and Lake Pielinen

4

By M. Laakkonen / Joensuu, Finland

Lake Saimaa and Lake Pielinen are the biggest lakes in the Eastern Finland and important habitats for different salmon species. Valuable salmon species populations living in the lakes include landlocked salmon *(critically endangered)*, freshwater brown trout *(endangered)*, arctic char *(critically endangered)*, and grayling *(near threatened)*. These species require special attention and maintenance.

The concern is related to maintaining the genetic diversity of the valuable salmon populations and improving their vitality. Reviving salmon populations involves many complex stages which must succeed, for example spawning ground renovations, free migration both in lake and river areas, improving the water quality, etc. An essential prerequisite are sustainable fishing practices. Sustainable fishing refers to managing fish populations in a way which ensures their vitality and regenerative capacity.

Within the past few years, general awareness on sustainable fishing of salmonids in the Eastern Finland has significantly increased. This article discusses some of the procedures which have been successful in improving the situation.

Measures to promote sustainable fishing and decision-making

From the beginning of the 2000's there has been a growing interest in progressing sustainable fishing in the Eastern Finland. Several projects, publications and other measures have been carried out to find solutions for weak salmon stocks and to promote sustainable fishing. These include for example the following:

Projects:

- Landlocked salmon and trout project on Lake Pielinen 2008-2010 (Pielinen Karelia Development Center Ltd)
- Sustainable fisheries and eco-tourism development project 2011-2014 (Centre for Economic Development, Transport and the Environment for South Savo, [ELY-centre])
- Project to promote sustainable fishing practices on Lake Saimaa 2011-2014 (Centre for Economic Development, Transport and the Environment for North Karelia, [ELY Centre])

Publications:

- *Strategy for Landlocked Salmon,* 2003 (Ministry of Agriculture and Forestry) and its update
- *Management Plan for Landlocked Salmon,* 2011 (Centre for Economic Development, Transport and the Environment for North Karelia [ELY Centre])
- *Perspectives on Sustainable Fishing of Landlocked Salmon,* 2011 (Future Missions Oy)

The "Project to promote sustainable salmon fishing practices on Lake Saimaa" was a European Union funded (LIFE+) communication and negotiation process which continued approximately three years. The total budget of the project was 361,670 EUR and it was implemented by the Centre for Economic Development, Transport and the Environment for North Karelia (North Karelia ELY Centre). Another significant project "Sustainable fisheries and eco-tourism development project" was funded by the European Regional Development Fund with a total budget of approximately 600,000 EUR. The project was implemented by the South Savo ELY Centre.

The above-listed projects and publications had in general similar objectives and target groups, which enabled close cooperation in their implementation. Objectives of these projects can be summarized as follows:

1. Communicating up-to-date information to the target audiences on the status of endangered fish species and the required measures for their improvement;

2. Coordinating recovery of the threatened fish populations by promoting sustainable fishing practices and eco-tourism opportunities;

3. Preparing regional and local population-specific management plans in cooperation with stakeholders and target audiences (fishery districts and water area owners).

Go where the decisions are made!

Making a change in the fishing culture is a long process. The most important stakeholders must be identified in order to ensure that the process is effective. The system how fisheries are regulated varies by country, of course, and decision-making bodies are different. In Finland, for example, some of the most important decisions are made at the grassroot level.

Several bodies are responsible for fishing regulation in Finland: the Ministry of Agriculture and Forestry, regional ELY Centres, the National Board of Forestry (Metsähallitus) and fishery districts and water area owners. Due to the latter, the local decision-making is in an influential role and cooperation with different parties is essential.

Fishery districts are decision-making committees with a statutory right to make decisions regarding organisation and supervision of fishing in their area. A fishery district committee has 1–2 meetings per year. Fishery districts are obligated to follow sustainable fishing principles. However, accomplishing this is challenging: fishery district members are often laymen and do not necessarily possess the required expertise to perceive which actions are needed in promoting sustainable fishing in all situations.

Water area owners own a certain water area. They decide on the organisation of fishing and fish stocks management in those cases which do not belong to fishery districts or fisheries authority. The perspective for the fish stock management may be narrow because of small size of the owned areas which can sometimes cover only few hundred hectares or less.

Action proposals for fishery districts and their implementation

The most important measure under the "Project to promote sustainable salmon fishing practices on Lake Saimaa" was the preparation of action proposals for the target audiences (60 proposals in total). The action proposals were reviewed in cooperation with fishery districts and water area owners. It was agreed that fishery districts and owners process the action proposals and, if necessary, decide on further measures and scheduling.

During the project, the project manager visited 1–2 meetings of each fishery district and water area owners, attending over 100 meetings in total. Several important decisions were made as a result of the meetings.

The most significant progress was achieved in the following areas:

- ✓ Establishing protected fish zones in lakes and river basins (grayling, brown trout, landlocked salmon and arctic char)
- ✓ Establishing ascent routes in narrows

Good results were also achieved in:

- ✓ Minimum catching sizes for salmonids
- ✓ Minimum mesh sizes for surface and midwater gillnets
- ✓ Prohibiting fishing of salmon by long line

The following proposals were mainly accepted as recommendations:

- ✓ Restricting number of hooks per lure
- ✓ Releasing landlocked salmon and brown trout with intact adipose fins
- ✓ Fishing quotas.

The "Project to promote sustainable salmon fishing practices on Lake Saimaa" was implemented at an opportune moment. Preparation of the action plans and the series of meetings with local stakeholders to promote sustainable fishing regulations can be considered a successful procedure. However, fisheries' management is an ongoing process and cooperation with local decision-makers and authorities should be continuous to support the work in the Vuoksi river basin in the Eastern Finland.

When fishing regulation is renewed, the role of local people should be stressed. Local and regional features should always be considered and the voice of local people and fishermen heard. Uniform regulation is needed to a certain extent; however, in some cases exceptions are essential in order to make the regulation effective. Cooperation with local decision-makers and fishermen ensures that the new rules will be adopted.

Communications

Communication and education have important roles in promoting sustainable fishing. Within the last few years, sustainable fishing of salmon and trout has gained media exposure and publicity in the Eastern Finland through several projects.

For example the publication *Perspectives on Sustainable Fishing of Land-locked Salmon (*2011*)* emphasizes the role of individual fishermen in reviving endangered fish stocks. The publication encourages fishermen not only to comply with the fishing restrictions but also to proactively improve their fish handling practices. The following list provides practical instructions and hints for sustainable fishing:

- Law obligates fishermen to release protected and undersized fish. Any landlocked salmon and freshwater brown trout that have an adipose fin and are caught in Lake Saimaa or Lake Pielinen should also be released regardless of the fish size.
- Choose lures and bait holders with fewer hooks. This will facilitate release of undersized specimens.
- Use fishing pliers and a knot-free, rubber-coated landing net as well as a water container. This helps releasing the fish and they will survive the release better.
- Do not use more than 2–4 gillnets.
- Avoid using gillnets with dense mesh sizes. They catch unwanted undersized fish.
- Catch different fish species and prefer naturally reproducing species.

Any landlocked salmon and freshwater brown trout that have an adipose fin and are caught in Lake Saimaa or Lake Pielinen should be realeased.

The "Project to promote sustainable salmon fishing practices on Lake Saimaa" included also a wide communication campaign targeted at recreational and professional fishermen. The campaign provided information on the status of endangered fish populations and the influencing factors in the Eastern Finland. The campaign gained a broad media exposure and the project staff met thousands of people in various events. Two large discussion events as well as opening and closing seminars were also organised within the project.

During the project, species-specific strategies and management plans were adapted to a more easy-to-understand form both visually and in terms of their content. To promote sustainable fishing, a lure design competition was organised to develop lures that cause less damage to fish and encourage manufacturers to produce such lures.

The fewer hooks there are on the lure, the easier it is to release the fish.

The website www.jarvilohi.fi maintained by the North Karelia ELY Centre was also improved. The website provides information on endangered salmonid species and accomplished measures and results; also communications material is provided. English and Russian language versions were also produced for the site. The North Karelia ELY Centre will continue to maintain the website.

Another successful action to promote sustainable fishing of salmon and trout was carried out in a Karelia ENPI CBC funded project "IntellGreenBelt". In cooperation with Lake Pielinen fishery district and three surrounding municipalities, the project designed information signs that were installed to twenty most important boat ramps around the lake. Information signs were extremely positively welcomed by recreational fishermen showing that this type of simple procedures continue to be efficient and very much needed today.

As a result of communicational and educational efforts carried out to promote sustainable fishing, the tone among fishermen has changed significantly in the internet discussion forums. Presently there are day-to-day discussions on sustainable fishing in the social media and fishermen are becoming more and more aware of endangered salmonid populations, expressing their concerns. The discussion is not always positive; however, knowledge and interest towards sustainable fishing is clearly increasing.

To assess the awareness on endangered status of salmonids in the Eastern Finland, two surveys were carried out in 2012 and 2014. The questionnaires were distributed to fishery districts, professional fishermen and fishing clubs to examine the target groups' attitudes and knowledge related to endangered salmonid stocks in Lake Saimaa. Based on the survey results, the awareness on endangered status of salmonids has increased in the two year period. However, the survey also indicates a clear need for continued communications. Below is an example of the survey question:

Endangeredness of the salmonids in Vuoksi river basin. Percentage of correct answers (%) in 2012 and 2014.

Species	Endangeredness (according of classification 2010)	Correct answers 2012	Correct answers 2014
Land-locked salmon	Critically endangered	10.4	20.7
Arctic char	Critically endangered	28.1	35.4
Grayling	Near threatened	12.5	16.7
Brown trout	Endangered	10.2	19.5

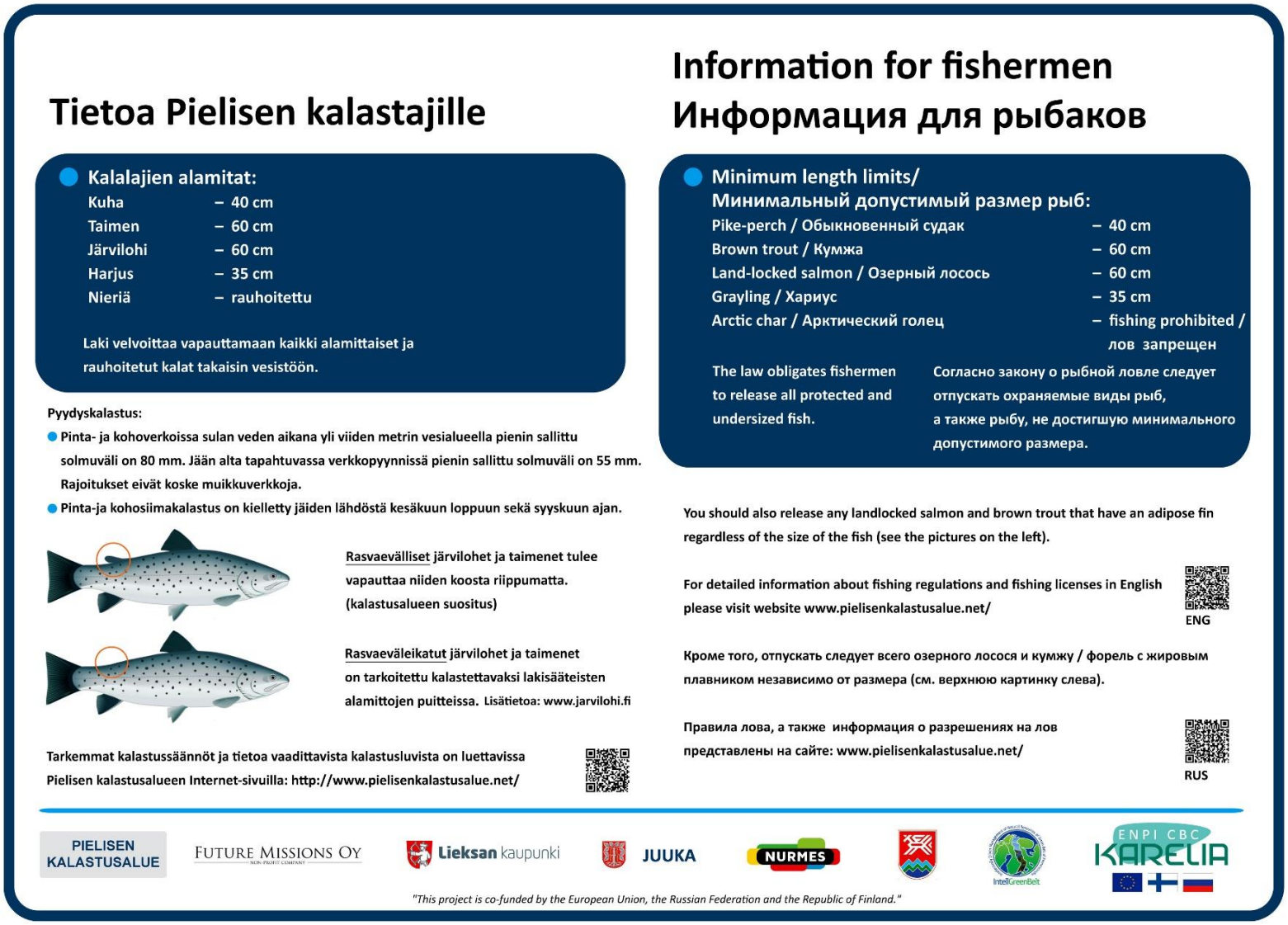
Conclusions

All in all, it can be stated that awareness on endangered fish species in the Vuoksi river basin has increased significantly during the last few years among fishermen and those responsible for the decisions on fishing and fisheries management. Nevertheless, it should be noted that reviving endangered fish stocks takes time and no significant changes in fish stocks can be expected in too short time periods.

Effects will also be delayed because the implementation speed of the decisions differs according to the decision-makers and fishermen must adopt the new restrictions. Due to the life cycle of salmonids, the project results will not be immediately evident in the fish stocks upon the conclusion of the project. However, it can be assumed that the impacts of the above presented actions will reflect in the salmonid stocks during the next five years.

Key points in achieving results in promoting sustainable fishing:

- Cooperate with local people.
- Make things understandable.
- Meet people face to face.
- Remember the importance of media visibility.
- Repeat information again and again.
- Encourage fishermen to use new methods instead of accusing them for not doing so.
- Use different media channels (TV, radio, newspapers, social media, information signs etc.).
- Be patient; the process is slow.
- Practise what you preach, i.e. lead by example.



Tietoa Pielisen kalastajille

Kalalajien alamitat:

Kuha	– 40 cm
Taimen	– 60 cm
Järvilohi	– 60 cm
Harjus	– 35 cm
Nieriä	– rauhoitettu

Laki velvoittaa vapauttamaan kaikki alamittaiset ja rauhoitetut kalat takaisin vesistöön.

Pyydyskalastus:

- Pinta- ja kohoverkoissa sulan veden aikana yli viiden metrin vesialueella pienin sallittu solmuväli on 80 mm. Jään alta tapahtuvassa verkkopyynnissä pienin sallittu solmuväli on 55 mm. Rajoitukset eivät koske muikkuverkkoja.
- Pinta-ja kohosiimakalastus on kielletty jäiden lähdöstä kesäkuun loppuun sekä syyskuun ajan.

Rasvaevälliset järvilohet ja taimenet tulee vapauttaa niiden koosta riippumatta. (kalastusalueen suositus)

Rasvaeväleikatut järvilohet ja taimenet on tarkoitettu kalastettavaksi lakisääteisten alamittojen puitteissa. Lisätietoa: www.jarvilohi.fi

Tarkemmat kalastussäännöt ja tietoa vaadittavista kalastusluvista on luettavissa Pielisen kalastusalueen Internet-sivuilla: http://www.pielisenkalastusalue.net/

Information for fishermen
Информация для рыбаков

Minimum length limits/
Минимальный допустимый размер рыб:

Pike-perch / Обыкновенный судак	– 40 cm
Brown trout / Кумжа	– 60 cm
Land-locked salmon / Озерный лосось	– 60 cm
Grayling / Хариус	– 35 cm
Arctic char / Арктический голец	– fishing prohibited / лов запрещен

The law obligates fishermen to release all protected and undersized fish.

Согласно закону о рыбной ловле следует отпускать охраняемые виды рыб, а также рыбу, не достигшую минимального допустимого размера.

You should also release any landlocked salmon and brown trout that have an adipose fin regardless of the size of the fish (see the pictures on the left).

For detailed information about fishing regulations and fishing licenses in English please visit website www.pielisenkalastusalue.net/

ENG

Кроме того, отпускать следует всего озерного лосося и кумжу / форель с жировым плавником независимо от размера (см. верхнюю картинку слева).

Правила лова, а также информация о разрешениях на лов представлены на сайте: www.pielisenkalastusalue.net/

RUS

PIELISEN KALASTUSALUE · FUTURE MISSIONS OY · Lieksan kaupunki · JUUKA · NURMES · IntellGreenBelt · ENPI CBC KARELIA

"This project is co-funded by the European Union, the Russian Federation and the Republic of Finland."

The project "IntellGreenBelt" designed and installed information signs to lake Pielinen. The signs were positively welcomed by recreational fishermen showing that this type of simple procedures continue to be efficient and very much needed today.

Lake Vättern Co-Management Group

By J.Norrgård [1] and A. Sandström [2]

5

[1] Lake Vättern Society of Water Conservation

[2] Swedish University of Agricultural Sciences (SLU), Department of Aquatic resources, Institute of freshwater research

Abstract

Governance regimes that involve various forms of co-management approaches are becoming increasingly important in the management of natural resources. As part of a national initiative to facilitate new fishery management regimes in Sweden, a fisheries co-management group was founded in Lake Vättern, Sweden in 2004, with Lake Vättern Water Conservation Society as its lead partner. The main participants include various fishery organizations, local, regional and national authorities, water conservation groups, researchers and non-governmental organisations.

The co-management group has emerged as an arena for management advice, conflict resolution, general discussion and information exchange between different groups. The group has no formal mandate for regulating fisheries, only an advisory function. However, its advice is still in many cases implemented by the national authority. The experiences from Lake Vättern are promising and suggest that co-management may have several advantages compared to traditional government-centred governance regimes.

Introduction

Fisheries governance is described by FAO (2001) as "the manner in which power and influence are exercised in management". Gray (2005) distinguishes between three types of governance: hierarchical, market and participatory governance. In the present article, the experiences from the development of the governance of fisheries during the last decade in the fifth largest lake in Europe, Lake Vättern in Sweden, are reported and reviewed from a hierarchical to a more participatory governance regime.

About Lake Vättern

Lake Vättern (1,893 $km^{2)}$ lies within four county administration borders and eight municipalities in the south of Sweden. It is highly oligotrophic lake, 4-6 µg P L^{-1}, and a Secchi disc depth ranging from 10 to 18 m. The drainage area is relatively small (6,360 km^2) compared to the lake surface. Mean depth is 40 m and maximum depth 128 m (Fig. 1). Approximately 250,000 people are dependent on water from Lake Vättern for their daily water consumption (Lindell, 2008).

Since the 1990s there has been a sharp decline of Arctic char (Salvenius umbla) population while American crayfish (Pacifastacus leniusculus) has increased. The latter has generated significant income for professional fishers but is also important for sport and subsistence fishing. Recreational fishing sector targets mainly Arctic char, trout (Salmo trutta), stocked salmon (Salmo salar), perch (Perca fluviatilis) and Northern pike (Esox lucius).

Similar to fisheries in many other large lakes in Europe, Lake Vättern fisheries are small-scale and used to be governed exclusively by regional and national authorities. Initially the fisheries were mainly regulated by the national authority, Swedish board of Fisheries. This authority was replaced in 2011 by the Swedish Agency for Marine and Water Management (SwAM). The national authority controls most aspects of fishing, the 'who, what, how, where and when'.

Fishing is divided into three legislative categories: two main categories are professional and recreational (including sport fishing and fishing for subsistence) and the third is fishing in private waters. Professional fishing requires a licence provided by the county administration councils (by mandate from the national authority). Currently there are 20 fishers in Lake Vättern.

Landowners administrate fishing rights at near-shore waters (generally 0–300 meter from the shoreline), and non-licensed recreational fishing is allowed in the whole lake (excluding the most northern archipelago area). Commercial and other fishermen are allowed to fish all kinds of fish, however, time (i.e. seasonal closures), place (public or private waters), extent (meters of gillnets etc.) and minimum legal size and gear type are regulated by law. For example, crayfish fishing is allowed as leisure activity during some weekends at the end of the summer. Gear and mesh sizes are also regulated by law.

Specific to Lake Vättern is that the recreational fisheries have a larger relative importance and they take a markedly larger part of the catch in many species compared to the commercial fisheries (Alenius & Halldén, 2012). The main species in which recreational fishermen have a high proportion of the catch include trout (*Salmo trutta)*, stocked Atlantic salmon (*Salmo salar)*, perch (*Perca fluviatilis)*, Northern pike (*Esox lucius)* and Arctic char *(Salvelinus salvelinus)*.

Fishing in Lake Vättern has altered its character substantially during the last decade. The traditional gillnet fishing, focusing mainly on salmonid species such as whitefish (*Coregonus lavaretus)* and Arctic char, has been replaced by fishing of an introduced species, signal crayfish (*Pacifastacus leniusculus)*, which has rapidly become the most economically important species for the fisheries in the lake. It currently constitutes 95 percent of the fishing industry income. Due to change to the new species (signal crayfish) combined with deteriorated stocks of traditional focal species, particularly Arctic char, commercial fish catches have declined since the mid-1970s until the recent years.

Fish communities in Lake Vättern are monitored by hydroacoustic surveys combined with mid-water trawling (Sandström et al., 2014), and a monitoring programme on benthic fish species using multi-mesh gillnets started in the summer 2005. In addition, a monitoring programme on whitefish (Coregonus lavaretus) has been carried out during the recent years in cooperation with commercial fishermen and researchers.

Lake Vättern Society of Water Conservation

During years 1950–1960 Lake Vättern was subject to large effluents of untreated nutrient rich water mainly from sewage treatment plants. This lead to the lake being threatened by eutrophication. As a consequence, Committee of Lake Vättern Water Resource Management was formed in 1957 with an objective to protect the lake's unique value and to coordinate measures, monitor programmes and carry out research on the lake. The first water management plan was accepted in 1970 and measures to limit the eutrophication of the lake were initiated. In 1989, the organisation was re-organised and Lake Vättern Society of Water Conservation was formed. It continues to run monitoring programmes and to coordinate different interests in the lake itself and the surrounding drainage area. The society's work is financed by its members, including for example local and regional authorities, regional councils and private companies around Lake Vättern.

The objective of the society is to promote sustainable and healthy lake ecosystem by:
- Influencing structural planning in the society to acknowledge the lake
- Coordinating and evaluating investigations
- Initiating concrete measures, e.g. by managing projects
- Providing information on Lake Vättern, i.e. reports, conferences etc.

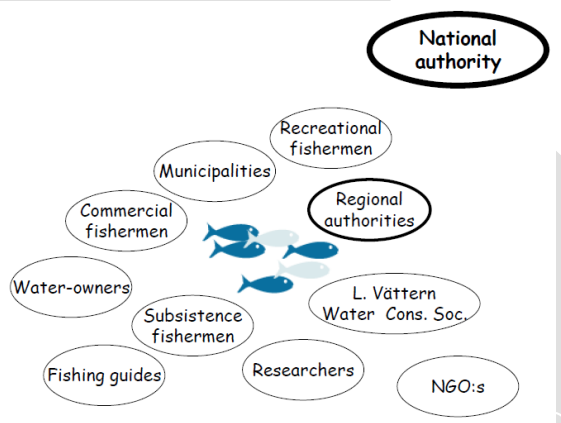
The work is based on the following goals:
- Conserving the lake as nutrient-poor clear water lake
- Protecting professional and recreational fishing as well as other outdoor activities
- Guarantee the drinking water quality of the lake.

Fisheries co-management group

There are numerous stakeholders depending on the resources provided by the lake. These include the community's need for fresh water, the fishermen's need for water and fish along with other people using the lake for leisure activities, and the military's need to have a shooting test area.

A historical tradition of scientists collaborating with local fishermen existed in Lake Vättern (Tiselius, 1723; Widegren, 1863; Smitt, 1886; Ekman 1916; Svärdson 1957 and 1979). In the past, meetings were held between commercial and recreational fishers; however, the meetings ended in the 1990s due to a national reorganisation. After that the regional council's fishery adviser has organised regular meetings with different groups separately. A tension and mistrust developed within the fishing community particularly between professional and recreational fishers but also between fishermen and the national fisheries agency. This has influenced the relationship of the council administration boards and the fishermen as well.

Parallel to the rapid change of the fishery and crisis for many fish stocks, a new form of governance was implemented in the early 2000s in Lake Vättern. As part of a national initiative to facilitate new fisheries management regimes, a fisheries co-management group was founded in 2004 with Lake Vättern Water Conservation Society as its lead partner. Representatives of recreational fishing, professional fishermen, Swedish Fishing Tourism Association, Fishing Waters Owners Society, Swedish Board of Fisheries, the councils and most municipalities around the lake participated in the project. In 2007, Lake Vättern Water Conservation Society decided to give the Fisheries Co-management group the status of a working committee answering directly to the board.



Composition of participants in the Lake Vättern fisheries co-management group. The level of participation of a certain group is indicated by the distance to the centre of the image. Authorities responsible for fisheries regulation are shown in bolder line. Drawing by Laura Piriz (2004).

Today, the Fisheries Co-management group serves as a forum for dialogue relating to issues of fishing and fisheries administration in Lake Vättern. Stakeholders with different interests can address issues concerning for example how fish conservation in the lake should be conducted, what

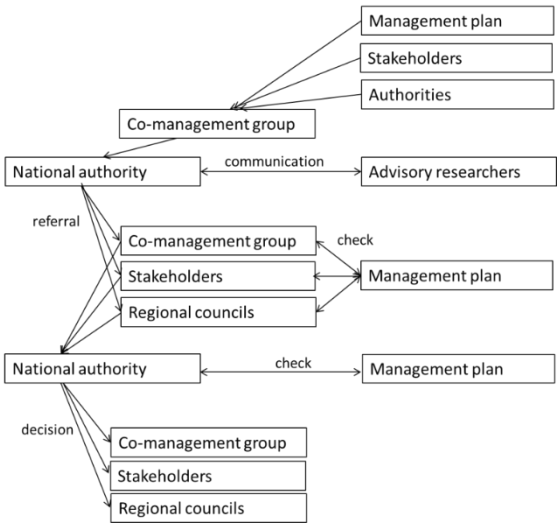
can be done to improve the situation regarding declining fish stocks, how limited fish resources should be allocated among different fishing categories and issues concerning regulations and fisheries control. However, the group has no formal mandate for regulating fisheries, only an advisory function.

The vice chairman of Lake Vättern Water Conservation Society also acts as chairman for the Fisheries Co-management group, and operative and secretarial work is led by a coordinator from the Lake Vättern Water Conservation Society. The Executive Committee consists of the following organizations: Freshwater Fishermen organization, Lake Vättern Angling and Fish Conservation Society, Fishing Waters Owners Society, Swedish Anglers organization, Swedish Fishing Tourism Association, Lake Vättern Crayfish Economical Organization, the municipalities around the lake (8), The Swedish Agriculture University, the regional councils around the lake (4) and the Lake Vättern Water Conservation Society.

Day-to-day work of Fisheries Co-management is conducted in six working groups: Rules and Regulations, Fishing Controls, Investigation & Monitoring, Information & Communications, Fishing Management in Vättern's tributaries, and the Crayfish Group. Guideline materials and proposed resolutions are developed by each group so that decisions can be made jointly in the working committee. Across-the-board issues and ongoing secretariat functions are managed by a coordinator.

The Fisheries and Habitat Management plan

From the very first meeting of the co-management group, all participants expressed a great concern about the decreasing population of Arctic char. The work was immediately begun and resulted in an official document – the Fisheries and Habitat Management plan (Norrgård 2009) – which has been seen as a road map for managing all fisheries in Lake Vättern. The document points out general guidelines and policies as well as multi-level aims and goals to reach a sustainable fishery in Lake Vättern. In addition, the document consists of specific measures and actions with detailed information on responsibility, costs, timeframes and evaluation. This information has been frequently used in the co-management group proposals. During 2014, the document was reviewed and renewed, as the majority of the suggested measures and actions had been conducted and fulfilled. The idea is that the document is renewed every six years, following the cycles of the European Union Water-Framework Directive.

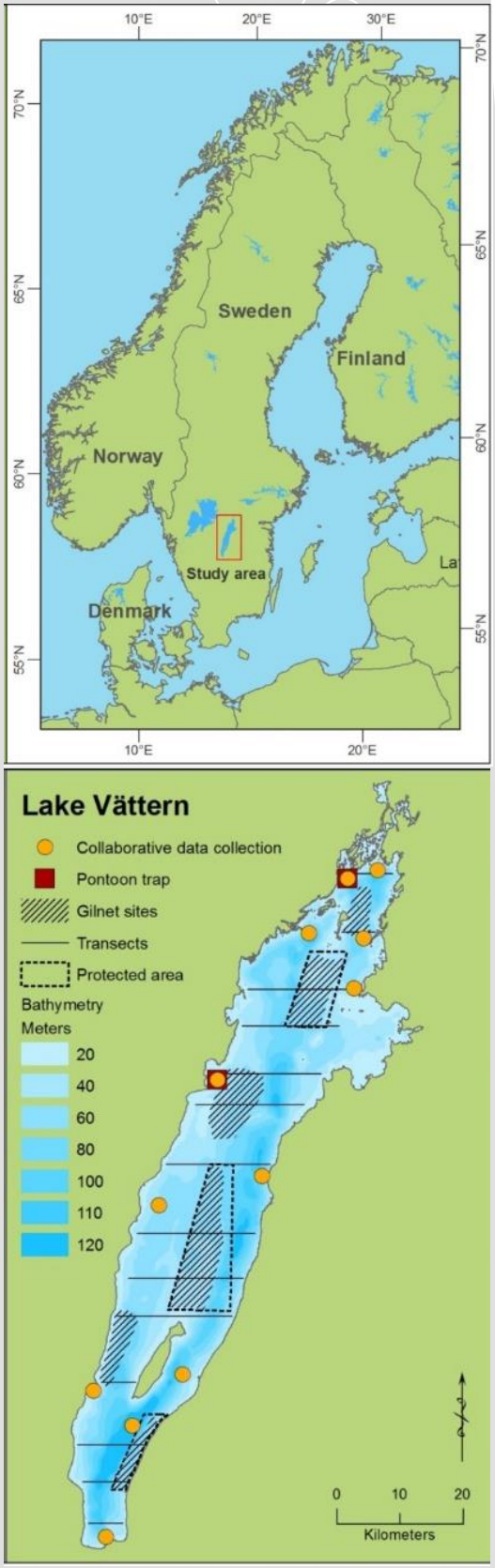


Flow chart showing how a fisheries regulation proposal in the management plan, or from stakeholders or the authorities, is processed.

Recent changes in the fishing restrictions

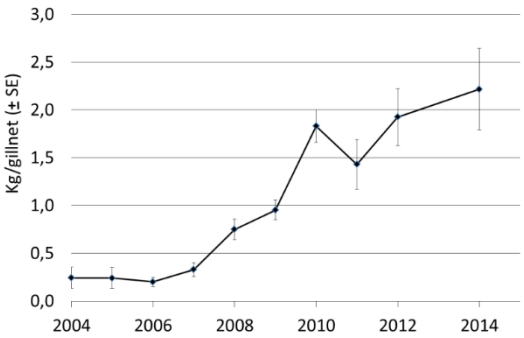
A package of fishing restrictions were implemented in Lake Vättern in 2005–2007. The decisions were taken by national authorities but involved in most cases preceding discussions with the stakeholders. During the implementation phase, information and influencing possibilities were channelled through the co-management group.

All fishing was forbidden in three large areas comprising 15 percent of the lake surface, which created the largest test conducted in Europe (or to our best knowledge, in the entire northern hemisphere) involving closed areas on a large lake. Other restrictions included bag-limit (for salmonids) and bait limitations (maximum of ten baits per boat) for sport fishermen, single hook baits, increased minimum legal size limit for Arctic char and a substantial increase in the minimum



Map of Lake Vättern and the sampling areas in the monitoring programmes using gillnets and hydroacoustics combined with midwater trawling, and the collaborative sampling conducted in the whitefish project (see text under heading "GAP - Connecting Science, Stakeholders and Policy").

legal size limit for Arctic char and a substantial increase in the minimum legal mesh size of gillnets, and additional protection of Arctic char and trout spawning areas and also spawning migration areas. These management efforts have helped to turn the trend for most fish species in the lake (Sandström et al., unpublished).



The CPUE of Arctic char in the gillnet monitoring programme shows a positive trend since the protected areas were established in late 2005.

GAP - Connecting Science, Stakeholders and Policy

In order to bridge the gap between stakeholders and scientists, several initiatives have been taken in the recent years to enhance fishermen's participation in research and management. Lake Vättern Water Conservation Society and the Swedish University of Agricultural Sciences take part in international participatory research project which brings fishers, scientists and policymakers together to work towards sustainable fisheries for the benefit of the society (Mackinson et al 2011, Jacobsen et al 2011, also visit http://gap2.eu/).

In Lake Vättern, fishermen and scientists carry out a cooperation project aiming to increase knowledge on the ecology and exploitation patterns of two focal fish species, whitefish and Arctic char. The aim is to jointly develop selective fishing for whitefish, minimizing by-catch of Arctic char and juvenile trout. The work is organised through the fisheries co-management group. Issues of interest to stakeholders span from applied measures such as selectivity of gear and implementation of fishing regulations to ecological aspects such as fish resource polymorphism and spawning activity. Involving fishermen and stakeholders in the research and data collection activities has resulted in a broader basis of knowledge; thus far the experiences are promising

and suggest that adopting participatory approaches may enable a stronger legitimacy for policies, an enhanced stakeholder commitment and potentially a more resource-efficient data collection programme. A strong local commitment and increased accountability of all stakeholders in the fisheries sector will increase the possibility of achieving long-term sustainable fishing in Lake Vättern.

Contribution to the governance

In the time period 2005–2012, a total of 96 decisions were taken and documented by the co-management group (Linke et al., unpublished). The national agency did not participate in the decision-making concerning fisheries regulation. The main aim was to reach consensus in all issues but in five cases it was not possible. In these cases, not all fishery stakeholders supported the actual group decision, which was specifically noted and underlined in the basis for the decision. All of the above mentioned decisions concerned fishing rules, fisheries control and/or management issues.

Of 96 decisions, 66 led to the desired results (changes in the fishing rules or organisation of fishing etc.), 22 are pending and eight decisions failed to reach the desired result. Half of the failures were advices regarding fisheries regulations that were not adopted by the national agency. Nine proposals have so far been submitted to the National agency concerning changes in the current Swedish law on inland water fisheries (FIFS: 2004:37). Among these, four have resulted in the revision of regulations, three are pending and two have been rejected. Thus, although the group has no formal mandate for regulating fisheries, their advice is in most cases implemented by the national authority (van Mastrigt, 2013).

Evaluation of the co-management process

The co-management process in Lake Vättern has been studied by two separate research centres (Jacobsen et al 2011, Stöhr et al, 2014), and the results show that the participating actors have been successful in developing trust and cooperation among different stakeholders and enhance learning. Careful design of the learning platform and skilled facilitation and mediation are considered key elements in achieving these results. Nevertheless, lack of direct mandate to regulate fisheries has been identified as one of the major disappointments for the co-management group. This is highlighted in Stöhr et al. (2014) in their analysis of determining the success of co-management groups. In addition to the feeling of disappointment for not achieving a mandate for the fishing regulations, there is also a feeling that the process for reaching the desired results has been too slow. Nevertheless, as described in van Mastrigt (2013) and Linke et al. (unpublished), the co-management group has a relatively high success rate of the proposed measures, as almost 70 percent of their advice has been adopted by the national authority.

Stöhr et al (2014) highlight key factors that have been important in bringing about the positive outcomes in the Lake Vättern case. These include e.g. compensation of travel costs and income losses for fishermen and stakeholders when attending meetings, detailed protocols where minority opinions also are noted and a strong moderator creating a respectful attitude and making sure that all participants are allowed to speak.

Furthermore, participants have addressed the fact that 'ecological uncertainty' remains a crucial aspect in discussions and decisions; although increased knowledge has been gained through investigation conducted within the co-management initiative leading to the resolution of some conflict issues, there is remaining uncertainty due to the complexity of the ecosystem itself and its various influencing factors. This demonstrates the fact that understanding complex ecosystems among scientists and authorities as well as among fishermen should be developed through multiple sources (previous generations, neighbours, scientific reports) and experience (learning-by-doing in the context of fisheries). The results also supports earlier research on the importance of stakeholder dialogue between various groups to ensure a better understanding of the ecosystem and thus provides a stronger basis for decision-making and compliance, and it concludes on the importance of shared understanding in the context of resource management (Lundholm & Stöhr, 2014).

Co-management - What does it take?

- Funding resources
- Organized fishermen and good internal communication
- Skilled leadership
- Time!

Keystones for participatory research

- Keep the process open and transparent
- Assure that research is of interest to the participants
- Involve all participants as early as possible
- Identify a suitable level of participation.

Getting stakeholders to the table and staying

- The importance of neutral leadership of chair
- Coordinator: credibility, passion
- Adapting the process to the stakeholders
- Ensuring that key objectives and possible influence on policies are understood by the participants
- Evaluation of the participation process.

In the authors' opinion, participatory research projects are very useful for establishing good contacts with stakeholders and could be a first step when aiming towards co-management governance models (including stakeholders). Here fishermen could also be useful allies in the development of management policies. Fishermen spend many days over the years on the lake which gives them a deep intuitive knowledge of the ecosystem and the environment. This knowledge is not always supported by scientific work but must be used and evaluated according to scientific data. With appropriate planning and study design, fishermen will provide a wide coverage both in time and space which is difficult to reach in another way. Their knowledge and participation is an important role in a fruitful co-management process.

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