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In fisheries, sea and water management

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Front cover: Angling at the Swedish west coast. Photo: Håkan Carlstrand.
Back cover: Sweden’s most handsome trout. Photo: Martin Karlsson.
Fish illustrations by Wilhelm von Wright

Summary

Knowledge and valuation of ecosystem services are important components for reaching the governmental goals for improving the natural environments. Recreational fishing has more than one million practitioners nationwide. Knowledge about the fishers and their catches increases the ability to assess whether the ecosystem services are retained. In addition, it gives means for evaluating the actions for the conservation, restoration and sustainable use of oceans, lakes and rivers. Knowledge of recreational fishing is also needed in order to follow up the details in its environmental objectives relating to outdoor recreation, tourism industry and the governmental goals in the open-air policy.

The EU's common fisheries policy, the Swedish environmental policy and Swedish fisheries policy all emphasize that ecosystem-based management should be implemented. Thus, there are needs for knowledge of the ecosystems which are exploited by humans. Fish populations are important components of aquatic ecosystems, and are affected by the surrounding environment, while they themselves affect the structures of the aquatic food-webs. Fishes often have regulatory functions in the ecosystems, and thereby contribute to valuable ecosystem services in addition to the more obvious services as providing food and recreation for humans.

Mostly issues regarding the impacts of fishing-related activities on fish populations have been focused on commercial fishing. A widespread and intensive commercial fishing may lead to the depletion of stocks or, at worst, a collapse of the fish populations; the fish population reaching such low levels that recovery may be difficult. In recent years the knowledge of the impact of recreational fishing on aquatic systems has increased, but still the effects of recreational fishing on ecosystem are relatively poorly studied, compared to commercial fisheries. For many, it may be difficult to accept that recreational fishing may affect fish populations; each fisher/angler favour just their own fisheries without bearing in mind that although the small influence from each individual fisherman may be small, it will be significant when many fishermen harvest from the same stock. Recreational fishing and its effects on the aquatic ecosystems are often neglected in fisheries science, mainly due to the lack of data to estimate recreational fishing harvest with a sufficient resolution to calculate the effort and landings of recreational fisheries.

In this report, we try to give an overall picture of the fish species needing increased knowledge in order to get an estimate of harvest in recreational

fisheries and thereby the effect on fish populations. Furthermore, we also try to give a picture of international studies and finally to give examples of methods concerning how and to what extent one may conduct studies in Sweden. Our proposal is largely based on combining different surveys in specific areas that we believe can be used to scale-up the results. We suggest data collation of recreational fishing is concentrated to areas with public waters, because in other water bodies the land owner has sovereignty under the law. The focus areas we point out are those already having some data collection, both in terms of recreational fishing and environmental monitoring / stock assessment and where there are non-fishing protective areas nearby. Collection of data should not be made in all areas at every year; three areas are suggested to become intensive areas (data collection every year) and the remaining areas data collection will take place every three years - on a rolling schedule. The sampling methods we recommend are national survey (i.e. mail and telephone surveys), recording of catches in fishing tourism, voluntary catch registration of individual anglers, collection of data from fishing competitions, on-site inventory of fishing effort (e.g. count fetter and trailers), inventory of catch per effort (e.g. by creel-surveys) and fish tagging studies.

For the west coast we propose one focus area, Älgöfjorden. At the coasts of Bohuslän County and the northern part of Halland County the fishing pressure is high for lobster and crab and therefore a focus area should be established in this area. We suggest that data are collected by on-site visits for inventorying fishing effort (counting numbers of pots / buoys / fishing people), combined with catch registration can return an estimates on catch per effort, and this can then be applied to a larger area.

Another potential focus area is the area around Torhamn (Blekinge) which, for example, is popular area recreational fishing for pike. Torhamn is one of three national reference areas for coastal fish monitoring on the East Coast and has been monitored since 2002. It is also desirable to study aspects of fishing mortality in recreational fisheries. To our knowledge, there are no national studies that have explored the effects of catch-and-release in natural environments over long periods of time.

The Bråviken Bay is a relatively limited and well-defined area having considered high recreational fishing pressure, but large time series from fish monitoring programmes are lacking. This site will give good opportunities for studying pike, pikeperch and to some extent also sea trout, data collection is suggested to take place every third year. An adjacent area is Kvädöfjärden having fish monitoring time series from 1989. Closely situated to Kvädöfjärden is Licknevarpefjärden where fishing has been prohibited since

1970. Additional areas that are of interest to follow up with some regularity are Asköfjärden, Gålö and / or Lagnö in the Stockholm archipelago. In the future it might be fruitful to shift data collection intensity between Torhamn in Blekinge and an area in Stockholm archipelago. Such decision should be based on factors like where the most practical solutions / contact network can be found.

In the Gulf of Bothnia angling with nets, traps and similar gears are relatively widespread. We suggest that Långvind Bay in Gävleborg County, is an area for the study of recreational fishing in a relatively sparsely populated county and is most likely typical for large parts of the Gulf of Bothnia. Data collection is suggested to take place every year.

As for the Gulf of Bothnia the recreational fishery in the Bothnian Bay are mainly targeting the whitefish, sea trout and, to some extent also perch. By monitoring the recreational fisheries in Kinnbäcksfjärden near Piteå, we hope to be able to describe the local recreational fishing patterns and then apply these values for catch per effort for most of the coastal strip of the Bothnian Bays.

Recreational fishing is widespread in all of the five largest lakes in Sweden, and there is a need for data collection in all five. In Lake Vänern, Lake Vättern and Lake Mälaren there are fish monitoring data of good quality and regularity. However, in the two smallest lakes, Lake Hjälmaren and Lake Storsjön in Jämtland County, few test fishing areas and few studies regarding recreational fishing have been made. For Lake Vättern we suggest that data collection is done every year; especially the archipelago in the northern part of the lake will be an excellent area for the study of recreational fishing for pike. In the other four lakes we propose that data collection is made every third year.

By studying recreational fishing - its practitioners, scope, gear-use, and harvest, it will be possible to achieve a more detailed view of how recreational fishing is done and how it varies along the Swedish coast and in the five largest lakes. Such knowledge is important for the managers of common fisheries resources and the monitoring of environmental status and evaluating the recreational goals established by the Swedish governments.

Svensk sammanfattning

Kunskap om och värdering av ekosystemtjänster är en av miljömålssystemets bärande delar. Fritidsfiske har mer än en miljon utövare och nyttjar både ekosystemens kulturella och producerande tjänster. God kunskap om omfattningen och utövarna samt fritidsfiskets fångster ökar möjligheten att bedöma om ekosystemtjänsterna är bibehållna samt om åtgärder för bevarande, restaurering och hållbart nyttjande av hav, sjöar och vattendrag har önskad effekt. Kunskap om fritidsfisket behövs också för att följa upp preciseringar i miljömålen som berör friluftsliv, turismnäring och målen inom friluftspolitiken.

Både inom den gemensamma fiskeripolitiken och den nationella miljö- och fiskeripolitiken betonas att en ekosystembaserad förvaltning ska genomföras. För en sådan behövs såväl kunskap om ekosystemen som allt mänskligt nyttjande av dessa. Fiskbestånden utgör viktiga komponenter i de akvatiska ekosystemen och både påverkas av den omgivande miljön, samtidigt som de själva påverkar födovävarnas struktur. Fisken står ofta för reglerande funktioner i ekosystemet och bidrar därmed med viktiga ekosystemtjänster utöver de mer självklara tjänsterna i form av att de ger mat och rekreation.

Störst fokus gällande påverkan från fiskerelaterade aktiviteter har inriktats på yrkesfiske. Ett utbrett och intensivt yrkesfiske kan leda till att utarmning av bestånd eller i värsta fall en utfiskning till en nivå när populationer svårligen kan återhämta sig från. Trots att kunskapen om fritidsfiskets påverkan på akvatiska system har ökat under senare år så är fritidsfiskets ekosystemeffekter relativt svagt studerade jämfört med yrkesfiskets. För många kan det vara svårt att acceptera att fritidsfisket kan påverka bestånden, eftersom man ofta ser till sitt eget fiske utan att tänka på att en liten påverkan från en enskild fiskare totalt sett kan bli mycket omfattande när många fiskare påverkar samma bestånd. Att man försummat fritidsfiskets påverkan på systemet inom fiskeriforskningen beror främst på att det saknas data för att skatta fritidsfiskets uttag med en tillräcklig upplösning för att kunna beräkna fritidsfiskets effekter.

I följande rapport försöker vi ge en samlad bild för vilka arter som är i behov av ett utökat kunskapsunderlag med avseende på fritidsfiskets uttag och påverkan. Vidare försöker vi ge en bild av hur man internationellt arbetar med liknande frågor och ger slutligen exempel på metoder på hur och i vilket utsträckning man kan arbeta på ett nationellt plan. Vårt förslag grundar sig i stort på att man kombinerar olika undersökningar i särskilda fokusområden som vi bedömer kan användas för att skala upp resultaten från. Vi föreslår att man koncentrerar insamlingen av fritidsfiskedata till områden med allmänt

vatten, eftersom i enskilda vatten har fiskevattenägaren överhöghet enligt lagstiftningen. De fokusområden vi pekar ut är sådan där det redan bedrivs viss datainsamling, både vad gäller fritidsfiske och miljöövervakning/beståndsuppskattning och där det finns fiskefria områden i närheten. Insamling av data ska inte ske i alla områden varje år, tre områden förslå bli intensivområden och i övriga ska insamling ske vart tredje år efter ett rullande schema. De insamlingsmetoder som vi förespråkar är nationell enkät, fångstregristrering inom fisketurismen, frivillig fångstregistrering av enskilda fritidsfiskare, insamling av data från fisketävlingar, inventering av fiskeansträngning (t.ex. räkna boja och trailers) på plats, inventering av fångst per ansträngning (t.ex. genom provfisken) och märkningsstudier.

På västkusten förslås ett intensivområde, Älgöfjorden. Eftersom merparten av Bohuskusten och norra delen av Hallands län har ett högt fisketryck på fokusarterna hummer och krabbtaska kan man definiera ett fokusområde utifrån praktiska aspekter. Genom att göra on-site-besök där man inventerar ansträngning (antal tinor/bojar/fiskande personer), kombinerat med fångstregistreringsblanketter kan man få en skattning av hur stora fångsterna per ansträngning är, detta kan sedan skalas upp på större skala.

Ett annat potentiellt intensivområde är området kring Torhamn där det bland annat finns ett utbrett fiske efter gädda. Torhamn är ett av tre nationella referensområden för kustfisk på ostkusten och har övervakats sedan 2002. Önskvärt är också att studera dödlighetsaspekter i fritidsfisket. Oss veterligen finns det inga nationella studier som studerat effekter av t.ex. catch-and-release i naturliga miljöer över lång tid.

För att studera främst fokusarterna gös och gädda och i viss mån öring föreslår vi studier vart tredje år i Östergötlands län. Bråviken har ett erkänt högt fritidsfisketryck och är också ett relativt avgränsat och väldefinierat område. Tidsserier från provfisken saknas dock. Ett angränsade område är Kvädöfjärden med tidsseriedata från 1989. I anslutning till Kvädöfjärden ligger Licknevarpefjärden där det rått fiskeförbud sedan 1970. Ytterligare områden som är av intresse att följa upp med en viss regelbundenhet är områdena Asköfjärden, Gålö och/eller Lagnö i Stockholms skärgård. Det kan också bli fråga om att skifta karaktär i intensitet/fokus mellan Torhamn i Blekinge och ett område i Stockholm. Det är mest praktiska lösningar/kontaktnät som avgör vilket av områdena som blir fokusområde med intensivstudier och vilket som blir övervakat med lägre intensitet.

I Bottenhavet är fritidsfisket med mängdfångande redskap relativt utbrett. Långvindsfjärden i Gävleborgs län tror vi lämpar sig som fokusområde för att studera fritidsfiskets omfattning i ett relativt glesbefolkat län representativt för stora delar av Bottenhavet.

Liksom för Bottenhavet är fritidsfisket i Bottenviken centrerat kring fokusarterna sik, öring och i viss mån abborre. Genom att följa upp fritidsfiskets omfattning och utveckling i Kinnbäcksfjärden, nära Piteå, hoppas vi kunna beskriva det lokala fritidsfiskets mönster och sedan räkna upp fångst per ansträngning till större delen av Bottniska vikens kustband.

Fritidsfisket är omfattande i samtliga av de fem stora sjöarna, och vi ser ett behov av datainsamling i alla. I Vänern, Vättern och Mälaren finns relativt gott om bakgrundsdata. I de två minsta sjöarna, Hjälmaren och Storsjön i Jämtland, är provfiskena få och få riktade undersökningar angående fritidsfisket har gjorts. Det tredje intensivområdet är Vättern. Speciellt skulle Norra Vätterns skärgård vara ett ypperligt område för studier av fritidsfiske efter gädda. I de övriga fyra sjöarna föreslår vi riktade studier vart tredje år.

Genom att studera fritidsfiskets utövare, omfattning, redskapsanvändning, och uttag av fisk kan man få en mer detaljerad bild kring hur fritidsfiskets karaktär och omfattning varierar längs Sveriges kust och i de Stora Sjöarna. Detta är i förlängningen betydelsefullt för förvaltningen av de gemensamma fiskeresurserna samt uppföljning av miljömålen och friluftslivsmålen.

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Photo: Henrik Ragnarsson Stabo

1 Project objective

This report is the result of a project and partnership between the Department of Aquatic Resources at the Swedish University of Agricultural Sciences (SLU Aqua) and the Swedish Agency for Marine and Water Management. The objective of this project was to devise proposals for a national plan and enhanced methodology for recreational fishing data collection. That is, registration and analysis of recreational fishing practitioners, scope, and the use of gears and catches in lakes, rivers and along the coast, integrating in-depth studies of recreational fishing with national studies. The project should result in data for decisions on a national plan and budget for long-term provision of national fisheries management and follow-up of the environmental targets and recreation targets of the knowledge base.

In 2014, the project aims to:

1. Assess what knowledge is essential for fisheries management in respect of the scope and harvest of recreational fishing for coastal areas and the five great lakes. This assessment will be based on existing information on the scope of recreational fishing and commercial fishing, as well as the stock situation. To identify focus species for management on the basis of recreational fishing surveys and target species for commercial fishing.

2. Define the need for stock data and recreational fishing data necessary in order to provide advice on appropriate management of recreational fishing for marine and freshwater species coastal and lake species. To attempt to answer questions such as "Where does recreational fishing take place? Is it possible to correlate fish monitoring with recreational fishing pressure?" This work will be facilitated if focus species are identified and problem species are highlighted.

3. Analyse and suggest analysis methods for recreational fishing data (existing data from national surveys, existing projects within the Department of Aquatic Resources and international studies) for the extent and effects of recreational fishing.

4. Assess the need for case studies/in-depth studies and work in cooperation with the Swedish Agency for Marine and Water Management as part of a national strategy to submit proposals for how such studies may be formulated for specific areas as an integrated extension and calibration of national surveys carried out by Statistics Sweden.

5. Work in cooperation with the Swedish Agency for Marine and Water Management to examine other available data which may indirectly provide an index on recreational fishing practitioners and fishing effort, such as national surveys for following up environmental targets and recreation targets, population density, the incidence of recreational boats and AIS on recreational boats. The option of using

recreational fishing pressure indicators, for example, to define the transferability of harvests and any influence on other geographical areas.

6. Propose a long-term plan for data collection, data storage, data hosting and analyses of recreational fishing within fisheries management. This plan must include an assessment of the costs and a proposal for distribution of responsibilities.

Photo: Henrik Ragnarsson Stabo.

2 Definitions

Recreational fishing: All fishing carried out using rods, nets, cages and other tackle which is not commercial fishing, pursuant to fishing licences for fishing in the sea or personal fishing licences in lakes Vänern, Vättern, Mälaren, Hjälmaren and Storsjön in Jämtland. The purpose of recreational fishing is usually a combination of fishing for recreation, tourism, competition and for catching fish for anglers' own use, but a certain amount of fishing for profit may also take place in the freshwater area. Since 2011, legislation on fishing has prohibited the sale of recreational fishing catches from the sea. There is no such provision for the freshwater area. We normally differentiate between recreational fishing using handheld tackle and recreational fishing using passive gears. Handheld tackle normally includes various kinds of fishing rods, hand lines or angling devices. Passive gears normally include various kinds of nets and fish traps.

Commercial fishing: The Fisheries Act (Fiskelagen 1993:787) refers to fishing for profit pursuant to sea fishing licences and personal fishing licences for fishing in the great lakes of Vänern, Vättern, Mälaren, Hjälmaren and Storsjön in Jämtland.

Free fishing with handheld tackle: This is regulated in accordance with the annex to Section 9 of the Fisheries Act (1993: 787). This Act permits free fishing in private waters using handheld tackle along the east coast, from the municipality of Östhammar in the county of Uppsala down to the promontory of Torhamn in Blekinge, around Gotland and in the five biggest lakes in Sweden (Vättern, Vänern, Mälaren, Hjälmaren and Storsjön in Jämtland). All types of fishing are permitted, except for fishing for crayfish in the inland lakes.

3 Introduction and background

Recreational fishing is a popular past-time in Sweden, but it has not been studied sufficiently. Few surveys have been done on the recreational landings of fish and the few surveys that do exist are not particularly detailed. Knowledge of catch size and the effects of recreational fishing on stocks is usually sparse or uncertain, even where more or less systematic catch data is collected. Smaller geographical or administrative areas such as small, locally managed lakes or waterway sections may be an exception.

However, the scope of recreational fishing in Sweden over the last few years has been highlighted by means of surveys of various types which indicate that recreational fishing represents the majority of the harvest for a number of the species fished in inland waters and the coastal zone. However, these surveys do not provide a clear picture of the composition of catches and the size of the actual harvest of fish and crustaceans from various stocks.

Sweden is different to other countries in Europe in that it does not carry out regular registration or reporting of recreational fishing catches[1]. The number of anglers in the country has been estimated to be just over 1 million, which makes recreational fishing one of the most common recreational pursuits. By way of comparison, around 2.4 million people take part in sports in Sweden[2] , around 2.2 million people pick berries at pick-your-own farms[3] and 1.8 million people take part in various study circles at study associations[4]. Some people may think that things are fine as they are; recreational fishing is an activity in which the authorities should not get involved, anglers and owners of fishing rights can deal with this without the involvement of the authorities. However, a number of aspects deserve highlighting:

- Knowledge of and evaluation of ecosystem services is one of the structural elements of the environmental target system. Recreational fishing utilises the ecosystems' cultural and producing services. Having a good knowledge of scope and people who fish, and also of catches from recreational fishing increases the chances of assessing whether the ecosystem services are being maintained, as well as the effect of measures for the preservation and restoration of seas, lakes and waterways. Knowledge is also required in order to follow up specifications of the environmental targets in respect of recreation, the tourism industry and the objectives of recreation policy.

- Both collective fisheries policy and national environmental and fisheries policy emphasise the fact that ecosystem-based administration must take place. To do this, knowledge of the ecosystems and all human utilisation of it, is required.

- For some species, the harvesting of fish by anglers in public waters may be as great as or greater than the commercial landings. If researchers are to be able to carry out reliable analyses and recommendations for fisheries management, all significant fish harvesting must be included.

- Knowledge of the focus and scope of recreational fishing is important if it is to be possible to provide advice to individual owners of fishing waters on how they could manage their stocks. Some fish

[1] Svenskt fritidsfiske och fisketurism 2020. The Swedish Board of Agriculture and the Swedish Agency for Marine and WaterManagement. http://www.jordbruksverket.se/amnesomraden/landsbygdsutveckling/branscherochforetagande/fisketurism/fritidsfiske2020.4.449e88113dc95b78dc8000134.html

[2] Statistics Sweden 2012. Idrotten i siffror. http://www.rf.se/Undermeny/Statistik/

[3] http://www.mynewsdesk.com/se/svensktsigill/pressreleases/en-av-fyra-svenskar-plockar-baer-paa-sjaelvplock-780921

[4] http://www.folkbildning.se/Studieforbund/Statistik-om-studieforbunden/Statistik-studieforbund-2012/

species are very sensitive to even apparently low fishing pressure, and the need for information on recreational fishing harvests and influence is every bit as important as knowledge of fish ecology.

- The 2012 strategy document for the Swedish Board of Agriculture and the Swedish Agency for Marine and Water Management emphasises the importance of promoting the development of fishing tourism and creating conditions to allow the industry to grow. Only collated knowledge of the current scope of recreational fishing and the ecology of fish species can provide the frameworks for such an expansion. Fish and crustaceans are not an inexhaustible resource, and there are often complex links between the environment and various human influence factors.
- The scope of recreational fishing both regionally and nationally should be made clear to authorities and decision-makers; partly because they need an overall view, and partly because they must be able to make good decisions on physical and mental accessibility for hindered groups, infrastructure, etc. which may benefit fishing tourism and recreational fishing, for example. This may relate to signage, information on fishing rules, tarmacking roads to boat ramps, etc.

The Department of Aquatic Resources at SLU carries out fish monitoring on behalf of the Swedish Agency for Marine and Water Management. Most of this fish monitoring is for purposes other than assessing the effect of recreational fishing. It may relate to national or regional environmental monitoring, stock assessments for assessing possible fishing quotas for commercial fishing, mapping of species distribution, monitoring of liming operations, recipient monitoring in areas affected by industries, monitoring of physical measures, etc. If recreational fishing takes place in or near these areas, we have good knowledge on fish stock numbers, but if recreational fishing takes place in other areas there may be a need for new fish monitoring or reprioritisation of the locations for fish monitoring. Commercial fishing quotas are often based on knowledge of fish stocks in large, connected offshore areas such as the Baltic Sea or North Sea, while recreational fishing often focuses on coastal stocks where knowledge on a smaller geographical scale is required for the management of these. It is also very important to be able to relate some form of fishing pressure parameter to the fishing-independent data we analyse each year. The reason for this is not only to reinforce national environmental monitoring of fish, but also to increase understanding and knowledge of how recreational fishing affects fish stocks. High fishing pressure may be the single biggest influence factor on fish communities, and therefore have a greater effect than other environmental pressure to the environment.

One fundamental factor for achieving ecosystem-based management or management on the basis of the ecosystem approach is a good knowledge of the ecosystems and how people utilise and influence the ecosystems. Management of our natural resources needs to be based on the boundaries and complexity of the ecosystem, be adaptable and involve many local stakeholders and users. Knowledge of fishing in seas, lakes and waterways is needed to support such management. As recreational fishing is a major utiliser of ecosystem services, a supply of knowledge on recreational fishing is needed; both for economic valuation of recreational fishing and for understanding how catches affect fish stocks and what measures are required to achieve sustainable utilisation of nature and fish stocks.

The surveys carried out in Sweden into the scope of recreational fishing have been either general (national Statistics Sweden surveys, see below) or occasional initiatives in reality, often focusing on a specific species and/or area. The methodology has changed when repeated surveys have been carried out, and the data collected often varies from study to study in terms of scope and quality. This makes it difficult or, at times, impossible to compare or merge various surveys in order to draw more general conclusions or calculate the scope and significance of recreational fishing between years. A consistent national plan is required for collection of recreational fishing data. The most general method when wishing to know how much of the population devotes itself to a certain type of leisure pursuit or other activity is to transfer the details provided to quantitative data which can be used in research. Social services often refer to triangulation in order to indicate that two (or more) methods are used to confirm a result[5]. The term "triangulation" is borrowed from navigation, where it refers to a way of determining the distance to a point if you have two points with a known distance between them. The idea is that it is possible to attain a more reliable result if you can arrive at the same results by using different methods, or if you can give a more precise estimate by combining different methods. It is not possible to rely on a single method when estimating the volume of fish taken during recreational fishing, or the value of this catch. Combining different observation and calculation methods can reduce the errors inherent in the individual methods. For recreational fishing, this may mean combining the results of surveys with field observations, voluntary logbooks kept by fishing guides, for example, and interviews with anglers.

In this report, we have stayed with the definition of recreational fishing which is used for data collection in the national surveys carried out by Statistics Sweden on behalf of the National Board of Fisheries initially, and later on behalf of the Swedish Agency for Marine and Water Management. This means that all fishing is included in the statistics, except for the commercial fishing that takes place pursuant to sea fishing licences or personal fishing licences in the freshwater area. The sale of recreational fishing catches from the sea has been prohibited since 2011, and in this context these are defined as all fishing which does not take place pursuant to fishing licences. When fishing in the freshwater area, there is nothing in the fishing legislation to prevent fishing taking place for profit. This is why it is difficult, when collecting data, to differentiate between the fishing which takes place for recreation, tourism and competition and for catching fish for anglers' own use and other fishing, unless this fishing is commercial fishing pursuant to a personal fishing licence.

[5] Rothbauer, Paulette (2008) "Triangulation." In Given, L. (Ed.), "The SAGE Encyclopedia of Qualitative Research Methods." Sage Publications. pp. 892-894.

4 Environmental targets and recreation policy targets

The overall Swedish objectives in respect of the environment have been summarised by Riksdagen (Swedish Parliament) to form an environmental target system. These objectives include many of the environmental requirements which Sweden with which has to comply in accordance with the international conventions and the EU directives for the environment.

The Swedish system also includes recreation, the cultural environment and health aspects. The overriding objectives in the Swedish system are reproduced in the form of a generational target which means that we must hand over to the next generation a society where the major environmental problems have been resolved, without causing greater environmental and health problems outside Sweden's borders. Riksdagen has established the generational target and 16 targets for quality and the environment, and the government has decided on stages on the way towards these targets. Knowledge of and evaluation of ecosystem services is one of the structural elements of the environmental target system. Recreational fishing utilises the ecosystems' cultural services (such as recreation and natural experiences) and producing services (catches for own use). Having a good knowledge of scope and people who fish, and also of catches from recreational fishing increases the chances of assessing whether the ecosystem services are being maintained, as well as the effect of measures for the preservation and restoration of seas, lakes and waterways.

The Swedish Agency for Marine and Water Management holds coordinating responsibility for the implementation of – among other things – the environmental targets relating to seas, lakes and waterways.

The generational targets for these environmental targets are specified as follows.

Living lakes and waterways

"Lakes and waterways must be ecologically sustainable and their variety of habitats must be preserved. Natural production capacity, biodiversity, cultural environmental values and the ecological and water-conserving function of the landscape must be preserved, while also safeguarding the criteria for recreation."

Seas in equilibrium and a living coastline and archipelago

"The North Sea and Baltic Sea must have a production capacity which is sustainable in the long term, and their biodiversity must be preserved and cultural heritage taken into account. Coast and archipelago areas must have a high degree of biodiversity, recreational value and natural and cultural value. Industry, recreation and other utilisation of sea, coast and archipelago areas must take place in a manner which promotes sustainable development. Particularly valuable areas must be protected from intervention and other disruptions."

As recreational fishing, alongside swimming and boating, are the most important recreational activities in, beside and on water, a supply of knowledge on recreational fishing is important in order to follow up on the environmental targets and plan which measures need to be implemented in order to preserve and restore ecosystem services.

In its bill En svensk strategi för biologisk mångfald och ekosystemtjänster [A Swedish strategy for biodiversity and ecosystem services] (prop. 2013/14:141), the government emphasises the fact that the value of ecosystem services needs to be clarified. The values of biodiversity and ecosystem services, which indicates that ecosystems services must be integrated in decisions on society – where relevant – by 2018.

One of the reasons for the collective new fisheries policy is an attempt to achieve ecosystem-based management. Within the national scope for action, the target of the Swedish Agency for Marine and Water Management is that management should be based on the ecosystem approach[6]. One fundamental factor for achieving ecosystem-based management or management on the basis of the ecosystem approach is a good knowledge of the ecosystems and how people utilise and influence the ecosystems by means of recreational fishing, for example.

Riksdagen has made a decision on recreation policy targets on the basis of government bill 2009/10:238. An abundant supply of nature, the interest of individuals and the involvement of non-profit organisations form the basis for people's opportunities for recreation. This forms the starting point for the ten recreation policy targets decided upon by Riksdagen. The recreation targets provide support for recreation stakeholders. The forests, mountains, lakes and archipelagos of Sweden are just some of the unique environments which provide major opportunities for active recreation.

The overall target for recreation policy is to use the Right to Roam – for instance – as a basis and support people's opportunities for spending time in the countryside and pursuing outdoor activities. As recreational fishing is a significant part of all recreation taking place in, beside and on water, a good knowledge of recreational fishing is of major significance if the Riksdag's recreation policy targets are to be met.

The ten recreation targets are defined as follows:

1. Nature accessible to everyone

Nature must be accessible to all. This means ensuring that there are plenty of opportunities to spend time in and enjoy nature and the countryside and that people's varying needs are met. Areas offering good accessibility are identified, familiar and appreciated and are managed from a long-term standpoint. Accessibility has high priority in respect of planning, information and management of nature and the countryside, as well as other areas of significance for recreation.

2. Strong involvement and interaction

Strong involvement and interaction, centred on personal and non-profit involvement. Organisations should work together more than they do at present. Greater interaction may help more people to devote themselves to recreation more frequently. Established structures should also exist for discussion and coordination of recreation locally, regionally and nationally.

3. The Right of public access

The Right of public access forms the basis for recreation. This involves safeguarding the Right of public access and ensuring that the general public, landowners, associations and companies have a good knowledge of the Right of public access.

[6] http://www.naturvardsverket.se/Stod-i-miljoarbetet/Vagledningar/Ovriga-vagledningar/Ekosystemansatsen/

4. Access to nature for recreation purposes

There is access to nature for recreation purposes. This involves urban planning and land use taking into account the need for access to attractive nature and countryside for the purposes of recreation.

5. Attractive nature near to urban areas

There is attractive nature near to urban areas for recreation purposes. This means that the population have access to green areas and countryside near to urban areas with high recreational, natural and cultural environment values.

6. Sustainable regional growth and rural development

Assisting with sustainable rural development and regional growth in all parts of the country. This should involve recreation and natural and cultural tourism helping to reinforce local and regional attractiveness and assisting with strong, sustainable development and regional growth. Natural and cultural tourism should be highlighted and prioritised as strategic initiatives in the hospitality industry. Experiences should be characterised by sustainability, quality, addition of value, accessibility and safety.

7. Protected areas as a resource for recreation

That protected areas provide a resource for recreation. This involves protected areas of value to recreation creating good conditions for spending time outdoors by means of management and maintenance promoting recreation and outdoor pursuits.

8. Rich recreation in schools

Rich recreation in schools. This involves preschools, preschool classes, primary and secondary schools and corresponding school forms and youth recreation centres running recreation activities and teaching students about conditions for a good environment and sustainable development in accordance with the steering documents for the activities. Children and students should be given plenty of opportunity to spend time outdoors.

9. Recreation for a healthy population

Creating the conditions to allow people to be physically active in nature and the countryside on a regular basis. This involves compiling evidence-based knowledge of initiatives promoting health and creating conditions for recreation, and passing these on to municipalities, county councils, non-profit organisations and other relevant stakeholders.

10. Good knowledge of recreation

There is good knowledge of recreation. This means that there is established research into recreation and that statistics have been compiled on the subject on the basis of the scope of the subject area and its multidisciplinary nature, that this adopts a long-term approach and is based on the needs of recreation stakeholders. Authorities, organisations, municipalities, landowners and companies should have extensive knowledge and expertise on issues relating to recreation, the configuration of the countryside, sustainable utilisation and natural and cultural tourism.

Photo: Martin Karlsson

5 Fishing rules/national regulations

5.1 Legislation relating to commercial fishing

Swedish commercial fishing is mostly regulated by the common fisheries policy adopted within the EU. There are also a number of national regulations regulating fishing in the sea along the coast and in the five great lakes of Vänern, Vättern, Hjälmaren, Mälaren and Storsjön in Jämtland.

The Swedish Agency for Marine and Water Management holds overall national responsibility, and the authority provides support for the government's EU work. Pursuant to authorisations, the Swedish Agency for Marine and Water Management makes decisions on regulations concerning fishing and fish conservation measures. National Board of Fisheries regulations (2004:25; 2004:36; 2004:37), the EU Common Fisheries Policy Act (1994:1709) together with the Fisheries Act (1993:787) regulate commercial fishing and include provisions on matters such as commercial fishing licences and boat permits, special boat permits pursuant to individual fishing rights, reporting obligations (fishing logbook, electronic logbook, trans-shipment declaration and landing declaration), catch limits, provisions for trade operations (registration of first recipient and sales notes) and weighing of catches. The Swedish Agency for Marine and Water Management also bears overall responsibility for Swedish fisheries inspection and is responsible for implementation of landing inspections.

5.2 Legislation relating to recreational fishing

Recreational fishing is regulated in the Fisheries Act (1993:787), the Regulation on fishing, aquaculture and fisheries (1994:1716) and in regulations in the Swedish Agency for Marine and Water Management's Code of Statutes (HVMFS). The latter relate primarily to the sea and the five great lakes, along with waterways opening out into these water areas up to the first migration barrier. However, certain provisions relating to species protection and prohibited fishing methods are applicable throughout the country. There is also special regulation of fishing above the conservation limit (reindeer grazing land).

The Fisheries Act includes the basic provisions concerning the right to fish. As regards where people are permitted to fish, we differentiate between public water, individual water and what is known as individual free water. Public water is water which is not included as part of a property and can be found along the coasts and in the great lakes of Vänern, Vättern, Hjälmaren and Storsjön in Jämtland. Mälaren occupies a special position in that the state has paid owners of fishing rights there for the intrusion involved in allowing the general public to fish there using sport-fishing tackle. According to the Public Water Areas (Boundaries) Act (1950:595), public water is essentially all coastal water and water in the great lakes situated at least 300 metres from the mainland or an island of a length of at least 100 metres. In the Fisheries Regulation, the government has limited the use of tackle for recreational fishing to certain listed items and quantities of tackle. However, this restriction does not apply to anyone fishing pursuant to individual rights.

HVMFS includes regulations arising for reasons of fish conservation. Regulations are flexible and are amended at times on account of the prevailing stock situation. Such provisions relate to factors such as protected areas, recovery periods, minimum and maximum dimensions and catch and tackle restrictions.

In inland waters, most of the restrictions required for fish conservation are determined by the owners of fishing rights themselves. Management often takes place via a fish conservation area association according to the Fishery Conservation Areas Act (1981:533).

The provisions which largely regulate fish conservation with regard to leisure fishing along the coasts and in the great lakes can be found in two statutes, National Board of Fisheries regulations on fishing in the Skagerrak, Kattegat and Baltic Sea (2004:36) and National Board of Fisheries regulations on fishing in freshwater areas (2004:37). Rules for the labelling and marking of passive fishing gears can be found in National Board of Fisheries regulations on the labelling and marking of fishing gears and aquaculture facilities (1994:14).

No registration or reporting requirements similar to the statutes applicable to commercial fishermen exist for anglers. Nor is any form of general fish conservation charge or state fee is mandatory for recreational fishing in public waters.

The Regulation (1994:1716) on fishing, aquaculture and fisheries indicates who can oversee of existing fishing regulations. The Swedish Coast Guard has clear responsibility within his area of activity to inspect and oversee compliance with provisions on fishing. The Swedish Coast Guard is active along the coasts and in lakes Vänern and Mälaren.

The regulation also states that the county administrative boards can appoint fishing inspectors. More detailed provisions on this can be found in National Board of Fisheries regulations (FIFS 1985:3) on fishing inspectors.

Within their area of service, fishing inspectors must monitor compliance with provisions on fishing and fish conservation in the fishing legislation. The fishing inspection carried out by fishing inspectors essentially relates to small-scale fishing and recreational fishing or hospitality based on recreational fishing. Unlike fisheries inspection, this inspection is entirely operational and physical. The administrative follow-up of commercial fishing carried out as part of fisheries inspection has no equivalent for recreational fishing.

In accordance with their public and general responsibility for fishing and fish conservation, the county administrative boards have taken on responsibility for fishing inspection to a great extent. The county administrative boards' appropriation directions include an annual feedback requirement for the Swedish Agency for Marine and Water Management with regard to completed fishing inspection. The county administrative boards organise and, to a varying extent, conduct inspections with their own staff and in conjunction with appointed inspectors and fishery conservation associations. In some areas, there is also more or less developed interaction among county administrative boards, fishing inspectors, the coast guard service and the police.

Anyone who owns the rights to fishing is also responsible for fishing inspection. This is applicable to most of the lakes and waterways in the freshwater area, where there are often management organisations in associations of fishing rights holders. Some coastal and archipelago areas also have such management organisations.

5.3 Need for greater knowledge

Knowledge of the ecosystems and the utilisation of the same, e.g. the scope of recreational fishing, anglers and catches, are necessary for the management of fish, seas and inland-waters. There is varying knowledge of the spread of various fish species and the sizes of the populations in Swedish waters. For natural reasons, the interest in exploitation has led to species of commercial interest becoming relatively well known. Other species which have no commercial value but do have conservation value, are classified as rare or are genetically valuable are also studied, but often with relatively low geographical focus. With the present gaps in our knowledge, preserving, utilising and managing a relatively large number of fish species, and a considerably larger number of populations, in a sustainable and structured manner presents a major challenge.

The National Board of Fisheries' study entitled "Småskaligt kustfiske och insjöfiske”[7] [Small-scale coastal fishing and fishing in inland lakes] highlights the fact that monitoring of resources in the sea, at coasts and in lakes and waterways needs to be improved in order to achieve utilisation of fish resources which is sustainable in the long term. Monitoring of fish resources is a costly activity, particularly when information on catch harvests and results from fish surveys have to be supplemented with information on various environmental and climate factors. Ongoing international and national efforts to implement stock assessments and management plans for fish stocks/species of particularly great interest (often commercially viable species) require supplementary background material, mainly from the influence and harvest of recreational fishing.

The reliability of the biological advice is dependent on base data from stock surveys such as standardised fish monitoring (known as fishery-independent surveys with nets, fish traps, trawls, hydroacoustics, electrofishing, etc.), but also from reports of catch sizes and scope from commercial fishing operations. Further knowledge and model development are required in order to improve such data. Supplementary surveys from recreational fishing, primarily in the great lakes and along the coast – where both the gap in knowledge and the intensity of recreational fishing are greatest – are required as a foundation for advice as well as for stock conservation measures. Improvements may be made to the knowledge base by means of more targeted studies of stock development, developed submission of information, improvement of fishery statistics and repeated surveys concerning the scope of recreational fishing. For species for which there is currently no good data from either commercial or recreational fishing or from fish monitoring, gathering accurate catch statistics should be of particular interest.

[7] The National Board of Fisheries, 2001. Småskaligt kustfiske och insjöfiske: en analys.

6 Management of our fish and crustaceans stocks

6.1 National stock monitoring

One fundamental problem as regards knowledge of fish stock size is the fact that there are a large number of stocks for most species in coastal areas and freshwater, and many are limited to the local area. The present national stock monitoring in coastal areas and freshwater is based mainly on monitoring long-term changes by means of standardised methodology. At SLU Aqua, this primarily takes place by means of fish monitoring, which provides relative measurements in the form of a density index which is evaluated annually (known as trend monitoring). Trend monitoring takes place in areas considered to be relatively unaffected by human activity (reference areas) and in areas which are affected. These fish monitoring activities are considered to reflect similar environments within a reasonable geographical scale with similar environmental conditions.

The present methodology does not permit monitoring of all water bodies; instead, individual initiatives are implemented in new areas from year to year. These fish monitoring activities are primarily project-controlled, various financial backers order or grant funding for individual fish monitoring activities. But as the methodology is often standardised, comparisons are made possible between such individual initiatives and the reference areas which are sampled each year.

Fish data is often related to various environmental variables, such as bottom habitat structures, wave exposure, water transparency and various types of human impact such as eutrophication and fishing pressure. This makes it possible to create models which take into account how stocks or numbers of certain species relate to their environment. Models can then be used to extrapolate – i.e. calculate with reasonable precision – these measurements outside their actual measurement range. To monitor resources in a broader sense, therefore, geographically detailed information on various influence factors is required. Fishing pressure is an influence factor of major interest, but at present it is hard to access this information.

Besides the international estimates of major open-sea stocks which are regulated and managed by collective EU rules, there are many species which are important for both commercial coastal and deep sea fishing as well as for recreational fishing. SLU Aqua produces the biological advice for management of these species. This is often done using trend analyses of various stock indicators. Together with analyses and evaluation of catch data from commercial fishing, for some species this results in relatively useful tools for estimating the stock situation and how stocks relate to historical data. Further catch data from recreational fishing would be capable of considerably reinforcing such analyses.

6.2 International cooperation in respect of stock estimates

The objective for the EU Common Fisheries Policy is for fishing to take place in a manner sustainable in the long term, and also to build on scientific assessments of the size and development of the stocks exploited. As a basis for fisheries management, therefore, the member states carry out annual surveys and stock estimates of a number of commercial fish stocks in accordance with Council Regulation (EC) 199/2008. The Data Collection Framework (DCF) constitutes the foundation for the advice of the EU and the International Council for the Exploration of the Sea (ICES) in respect of fishing, and this forms the basis for international recommendations on maximum catch quotas, for example (Table 1). Advice for international and national management of aquatic fish and crustacean resources is one of SLU Aqua's primary task. Support from the authorities in respect of international management is mainly provided in that researchers at the department participate in the International Council for the Exploration of the Sea (ICES) and the European Inland Fisheries and Aquaculture Advisory Commission (EIFAAC). Various working groups manage the data collected in different countries in order to estimate the size, growth rate and options for fishing for various stocks. The work of these working groups is reviewed by various quality assurance groups before decisions on the final advice are made by the ICES Advisory Committee (ACOM). Each year, the International Bottom Trawl Survey (IBTS) is carried out in the Skagerrak and Kattegat, while the Baltic International Trawl Survey (BITS) and Baltic International Acoustic Survey (BIAS) take place in the Baltic Sea. These surveys are used as data for stock estimates and, ultimately, in respect of management-related issues.

Similarly, SLU Aqua operates on a national level, providing advice mainly to the Swedish Agency for Marine and Water Management. This may involve – for example – biological data for local stocks or consequences of existing or proposed national or international management measures for stocks or the environment.

The Helsinki Commission (HELCOM) also works regularly with stock estimates of coastal fish species. This work is controlled mainly within the HELCOM FISH PRO project, where fish monitoring is evaluated simultaneously within the Baltic Sea basin and coastal species are described on the basis of their occurrence, spread and status.

ICES has a special working group, the Working Group on Recreational Fishing Surveys (WGRFS), which deals with issues related to recreational fishing. This primarily involves gathering and managing data on the species prescribed by the EU Data Collection Framework (DCF) and passing this data onto other working groups within ICES. Secondary targets for the working group involve harmonising and developing the quality and standard of national recreational fishing surveys.

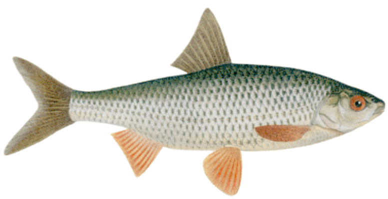
There are no international stock estimates for inland waters which provide data on fish harvests; all such information is regulated nationally. Waters shared by two or more nations are excepted from this, but in this case it is more a question of bilateral agreements than international rules, monitoring programmes and/or analysis methods. Examples of such waters include Peipsi (Estonia/Russia), Bodensee (Switzerland/Austria/Germany), Torne älv river (Sweden/Finland), Enningdalsån (Sweden/Norway) and the Danube (Romania/Bulgaria/Serbia). Environmental monitoring in inland waters is governed partly by the Surface Water Directive, which obliges countries to survey fish fauna in terms of age, species and size.

Table 1. *Species in each water type which are covered by the EU Data Collection Framework (DCF), and whether stocks of these are estimated internationally in working groups within ICES or nationally by SLU Aqua. [1] Describes species included in the DCF list with requirements in respect of collection from recreational fishing.*

		Included in the EU Data Collection Framework (DCF)	Stock estimated internationally (ICES)	Stock estimated nationally SLU Aqua
Skagerrak and Kattegat				
Sand lance	*Ammodytidae*	X	X	
European eel	*Anguilla anguilla*	X[1]	X	X
Atlantic herring	*Clupea harengus*	X	X	
Roundnose grenadier	*Coryphaenoides rupestris*	X	X	
Grey gurnard	*Eutriglia gurnardus*	X	X	
Atlantic cod	*Gadus morhua*	X[1]	X	
Witch flounder	*Glyptocephalus cynoglossus*	X	X	
European lobster	*Homarus gammarus*			X
Common dab	*Limanda limanda*	X	X	
Haddock	*Melanogrammus aeglefinus*	X	X	
Whiting	*Merlangius merlangus*	X	X	
European hake	*Merluccius merluccius*	X	X	
Blue whiting	*Micromesistius poutassou*	X	X	
Norway lobster	*Nephrops norvegicus*	X	X	
Northern shrimp	*Pandalus borealis*	X	X	
European plaice	*Pleuronectes Platessa*	X	X	
Saithe	*Pollachius virens*	X	X	
Turbot	*Psetta maxima*	X	X	
Atlantic mackerel	*Scomber scombrus*	X	X	
Brill	*Scophthalmus rhombus*	X	X	
Common sole	*Solea solea*	X	X	
European sprat	*Sprattus sprattus*	X	X	
Norway pout	*Trisopterus esmarki*	X	X	

Table 1 *(cont.)*

		Included in the EU Data Collection Framework (DCF)	Stock estimated internationally (ICES)	Stock estimated nationally SLU Aqua
Baltic Sea				
European eel	*Anguilla anguilla*	x[1]	x	x
Atlantic herring	*Clupea harengus*	x	x	
Vendace	*Coregonus albula*			x
Common whitefish	*Coregonus maraena*	x		x
Northern pike	*Esox lucius*	x		x
Atlantic cod	*Gadus morhua*	x[1]	x	
Common dab	*Limanda limanda*	x	x	
European perch	*Perca fluviatilis*	x		x
European flounder	*Platichtys flesus*	x	x	x
European plaice	*Pleuronectes platessa*	x	x	
Turbot	*Psetta maxima*	x	x	x
Atlantic salmon	*Salmo salar*	x[1]	x	x
Brown trout	*Salmo trutta*	x	x	x
Pike-perch	*Sander lucioperca*	x		x
Brill	*Scophthalmus rhombus*	x	x	
Common sole	*Solea solea*	x	x	
European sprat	*Sprattus sprattus*	x	x	
The great lakes				
European eel	*Anguilla anguilla*			x
Vendace	*Coregonus albula*			x
Common whitefish	*Coregonus maraena*			x
Northern pike	*Esox lucius*			(x)
Burbot	*Lota lota*			x
Signal crayfish	*Pacifastacus leniuscu-lus*			x
European perch	*Perca fluviatilis*			x
Atlantic salmon	*Salmo salar*			(x)
Brown trout	*Salmo trutta*			x
Arctic char	*Salvelinus salvelinus*			(x)
Pike-perch	*Sander lucioperca*			x



7 Problem areas in current research/management

One objective of this report is to attempt to identify species where there is a strong link between recreational fishing, research and management. One natural way in which to do this is to describe what species are of interest for recreational fishing, which ones are monitored at a national/regional level and which also have a spread that can be managed within reasonable geographical levels. Most species that are handled within international research teams have stocks that migrate over wide geographical areas and are traditionally analysed and evaluated by means of catch statistics from commercial fishing in combination with fish monitoring. These species are often subject to quotas, and the responsibility for stock assessment is generally shared among member countries.

It is therefore particularly important to highlight species that are linked to restricted geographical areas such as waterways, lakes and coastal areas within the national borders of Sweden. Describing these from a recreational perspective, but also from a commercial fishing perspective, and also by illustrating and demonstrating the restrictions which affect status reporting and stock estimates, may help to improve the national monitoring methods currently in use and illustrate points for improvement in respect of current data collection.

7.1 Target species for commercial fishing

Commercial harvesting of fish in Sweden is studied and monitored effectively. Reliable stock estimates created within international working groups exist for the majority of commercial species. As there are sound national regulations with requirements concerning reporting obligations, it is relatively easy to study trends over time as regards the occurrence status of individual stocks for species fished using approximately the same method and effort over time.

It is harder to form a clear overall picture for other species. This is especially the case for species that used to be heavily exploited but that are not fished as much nowadays for various reasons, such as changes in consumption patterns, changes in the pricing of catches sold or declining stocks. In this case, it is harder to link the total harvest of fish and convert this into stock terms as it is difficult to know exactly why the fish have been harvested less extensively over time. It does not necessarily relate to a decline in the biological resource, but may in fact relate to a decline in the financial resources of fishermen, reflected in lower effort (which in turn results in smaller reported catches).

Below is a list of the species on which commercial fishing focuses in the Skagerrak and Kattegat (Table 2), Baltic Sea (Table 3) and Inland waters (Table 4).

Table 2. *Landed commercial catches in the Skagerrak and Kattegat between 2000-2013, sorted in order of size (total catch in tonnes). Species for which fewer than 100 tonnes in total have been caught throughout the period have not been included in the list. Data from the Swedish Agency for Marine and Water Management.*

Skagerrak and Kattegat															
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**Total**
Atlantic herring	13775	17388	20446	21999	22716	31274	27348	19640	14888	14025	16206	9061	13674	17400	259840
European sprat	4456	5462	4244	2585	4526	5615	3318	2693	1512	1685	1609	2167	1556	778	42207
Northern shrimp	1890	1838	2038	2097	2149	1989	2218	2157	2235	2146	1526	1522	1340	1103	26249
Blue whiting	2369	1460	11396	4029	1261	317	12	5	4	3	0	1	2	20	20878
Norway lobster	1168	1020	1006	882	894	1035	1126	1378	1394	1292	1287	961	1379	1150	15973
Atlantic cod	2229	1717	1296	1139	1025	767	681	449	352	449	505	485	461	512	12067
Sand lance species	95	1971	4558	290	69	6	0	0	0	0	0	0	0	0	6989
Saithe	150	281	330	593	622	460	654	389	255	424	737	475	362	482	6214
Witch flounder	544	560	568	543	548	554	366	275	247	145	115	107	164	188	4924
European plaice	388	369	333	385	309	236	343	297	292	149	182	114	178	169	3743
Edible crab	133	139	155	170	194	167	142	161	162	189	225	220	202	245	2504
Atlantic mackerel	139	99	100	104	115	142	166	107	136	189	254	259	280	316	2407
Haddock	193	194	264	99	104	140	123	130	189	127	109	114	208	199	2193
European eel	147	219	211	191	215	213	237	168	109	107	107	88	0	0	2013
Dogfish	104	211	247	260	237	168	145	95	74	92	6	1	1	1	1640
Whiting	155	219	135	91	77	72	86	79	49	31	30	21	10	15	1069
Horse mackerel	742	57	0	20	35	1	22	13	6	0	0	0	0	0	895
Norway pout	18	779	2	1	0	0	0	0	0	0	5	0	0	1	806
Roundnose grenadier	8	226	301	46	0	45	27	8	0	0	0	0	0	0	661
Monkfish	24	45	53	52	55	63	47	35	44	40	44	26	47	36	610
Pollack	23	39	33	14	32	150	28	30	26	33	29	24	32	27	519
European hake	10	34	25	34	48	44	43	33	73	40	43	31	26	27	511
Greater weever	5	26	9	7	8	7	17	17	11	15	8	43	25	255	453
Lumpsucker	21	29	56	111	75	12	13	14	14	8	15	46	7	13	434
Common sole	28	23	14	14	28	24	29	33	28	26	43	40	25	43	398
European lobster	22	18	19	32	30	27	21	26	34	36	32	37	26	25	385
Atlantic wolffish	73	48	42	37	40	34	28	17	16	7	7	2	3	4	357
Lemon sole	50	49	32	29	28	37	31	14	8	6	13	6	12	9	325
Common ling	13	24	30	31	30	31	28	18	18	21	20	17	17	12	310
Brill	14	11	11	16	16	12	14	21	26	23	15	13	14	13	219
Poor cod	57	160	0	1	0	0	0	0	0	0	0	0	0	0	219
European flounder	19	19	27	24	10	9	12	14	15	24	14	12	6	7	212
Ray species	2	12	8	13	20	8	16	11	6	2	10	2	0	0	110

Table 3. *Landed commercial catches in the Baltic Sea between 2000-2013, sorted in order of size (total catch in tonnes). Species for which fewer than 100 tonnes in total have been caught throughout the period have not been included in the list. Data from the Swedish Agency for Marine and Water Management.*

Baltic Sea

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total
European sprat	27863	21187	25098	19688	23090	40884	48167	36161	33118	27148	23659	19958	22598	21906	390524
Atlantic herring	32590	20702	23818	15949	18602	26000	22588	24937	23868	19689	18343	19036	24759	16538	307419
Atlantic cod	17782	17815	13757	13517	13834	11856	9927	12042	11165	11722	11340	12854	12684	7223	177516
Vendace	582	718	1022	1590	1818	1195	1645	914	628	982	1042	1148	1348	1483	16114
Atlantic salmon	498	415	332	285	607	271	454	252	268	329	270	299	267	191	4740
European eel	254	294	268	272	241	361	343	417	385	317	310	278	239	270	4250
European flounder	324	446	335	277	203	203	319	186	219	202	178	205	178	517	3793
Common whitefish	290	267	251	288	301	201	250	157	148	144	136	132	141	117	2823
European perch	99	99	107	114	106	107	100	94	86	74	75	79	83	93	1315
European plaice	43	57	48	85	60	91	74	161	154	163	109	88	85	82	1300
Lumpsucker	16	53	102	85	68	68	19	70	97	43	98	82	24	32	859
Whiting	29	33	43	17	47	189	96	60	65	44	49	79	65	32	848
Northern pike	71	60	42	41	40	48	43	42	41	29	23	34	37	44	595
Turbot	94	58	49	38	27	32	36	30	46	36	35	43	25	33	584
Brown trout	62	42	37	31	31	27	31	23	27	24	27	21	22	18	423
Pike-perch	40	29	26	37	31	35	37	42	28	27	18	15	18	12	395
Bream	7	6	5	8	9	7	15	10	3	14	4	5	3	4	100

Table 4. *Landed commercial catches in the five biggest lakes between 2000-2013, sorted in order of size (total catch in tonnes). Data from the Swedish Agency for Marine and Water Management/Statistics Sweden. *=for 2000 and 2001, there was no separation of Atlantic salmon and brown trout in inland water catches. The total value is based on both species.*

Inland waters

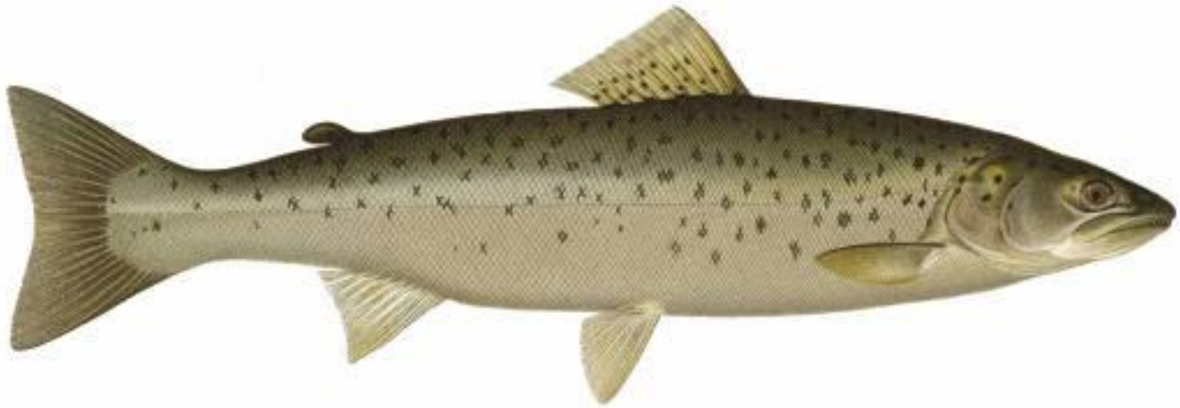
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total
Pike-perch	291	241	371	420	421	490	649	537	532	438	517	502	456	401	6266
Vendace	261	182	194	270	291	220	276	221	262	204	174	347	320	317	3539
Other	196	155	179	174	128	136	64	131	121	355	101	103	137	115	2095
Northern pike	175	145	168	151	123	107	121	118	119	109	100	96	113	103	1748
European perch	150	135	169	172	118	114	122	141	142	99	103	97	92	83	1737
Crayfish	17	37	49	42	59	95	124	134	175	168	177	184	161	186	1608
European eel	113	118	102	96	106	111	125	111	113	96	108	85	100	93	1477
Common whitefish	171	123	124	116	106	107	126	117	104	63	55	44	26	13	1295
Atlantic salmon	60*	80*	43	21	19	18	20	20	29	18	22	13	64	18	566*
Brown trout			20	13	10	8	8	10	9	10	5	6	14	8	
Arctic char	24	18	17	15	12	11	9	6	8	4	6	8	10	10	158

7.2 Target species for recreational fishing

As already specified, there is a lot of interest in recreational fishing in Sweden[8]. Besides the million Swedish people who enjoy recreational fishing, Sweden also welcomes tourists from other countries. These figures are constantly increasing thanks to the growing market for fishing tourism in Sweden. The scope of recreational fishing and its major financial and social significance are documented in detail and have been analysed in many parts of the world. Recreational fishing using handheld tackle in particular is considered to be both a very valuable leisure activity and an important financial driver for trades such as the manufacture of fishing equipment and boats, tourism with accommodation, guides and tour boats. The significant consumption value of the fish caught can also be added to this.

However, knowledge of the size of catches and the effect of recreational fishing on stocks is very limited; with the exception of certain smaller geographical or administrative areas, where catch data is gathered more or less systematically. A study by Coleman et al.[9] showed, for example, that marine recreational fishing in the USA in 2002 accounted for just 4% of the total catch harvest, but in certain regions is accounted for no less than 23-64%, and in excess of 90% for many desirable species.

Recreational fishing in Sweden over the last few years has been highlighted by means of surveys of various types which indicate that recreational fishing represents the majority of the harvest for a number of the species fished in inland waters and the coastal zone. The surveys have altered in nature and scope over the last few years, but the last two national studies dating back to the 2006 and 2010 catch years provide an indication – despite relatively large measures of dispersion – that recreational fishing, compared with commercial fishing, now represents the biggest harvest of a number of the species fished in the coastal zone and inland waters (Table 5). For example, recreational catches of European perch, Northern pike and pike-perch in the Baltic Sea account for 90-95% of the total harvest, according to available data.



[8] The National Board of Fisheries, 2009. Fritidsfiskets nätfångster av öring i Bottenhavet och Bottenviken. Chapter in Fem studier av fritidsfiske 2002-2009, Finfo 2009:1.

[9] Coleman, F. C., Figueira, W. F., Ueland, J. S. and Crowder, L. B. 2004. The impact of United States recreational fisheries on marine fish populations. Science, 305: 1958-1960.

Table 5. *Recreational catches according to National Board of Fisheries/Statistics Sweden surveys in 2006 and 2010. The figures relate to retained catches in tonnes for each water area. The species are sorted in descending order in respect of total catches. Figures in bold type indicate which recreational activity is responsible for the greatest harvest of fish or crustaceans.*

	Handheld tackle	Passive gears	Total		Handheld tackle	Passive gears	Total
Baltic Sea							
Atlantic herring	496	**1106**	1602	European perch	**446**	341	787
Northern pike	**529**	496	1025	Northern pike	**583**	73	656
European perch	439	**536**	975	Other species	**541**	59	600
Other species	176	**331**	507	Atlantic herring	**224**	155	378
Common whitefish	70	**327**	397	Common whitefish	46	**215**	260
Flat fish species	37	**281**	318	Pike-perch	**125**	63	188
European eel	7	**226**	233	Atlantic cod	**122**	37	159
Brown trout	71	**117**	188	Brown trout	63	**64**	127
Atlantic cod	**104**	70	174	Flat fish species	21	**85**	106
Atlantic salmon	53	**82**	135	Atlantic salmon	31	**32**	64
				Vendace	2	**18**	19
Skagerrak and Kattegat							
Atlantic mackerel	**1073**	244	1317	Atlantic mackerel	**1105**	91	1196
Atlantic cod	**618**	101	719	Edible crab	38	**309**	347
Other species	**324**	50	374	Atlantic cod	**249**	24	273
Edible crab		**269**	269	Flat fish species	**151**	71	222
Flat fish species	86	**135**	221	Other species	**103**	3	105
Atlantic herring	81	**92**	173	Sea trout	**86**	3	88
Sea trout	**116**	17	133	Atlantic herring	**81**	5	86
European lobster		**79**	79	Other cod types	**62**		62
				European lobster		61	61
Inland waters							
Northern pike	**1976**	502	2478	Northern pike	1007	**1855**	2862
European perch	**1584**	519	2103	European perch	**1217**	246	1463
Brown trout	**603**	135	738	Pike-perch	**396**	152	548
Cyprinids	**354**	279	633	Rainbow trout	**523**	9	532
Rainbow trout	**576**	21	597	Crayfish		**433**	433
Crayfish		**535**	535	Brown trout	**357**	42	399
Pike-perch	**420**	106	526	Arctic char	**316**	29	345
Common whitefish	95	**401**	496	Cyprinids	**110**	67	177
Arctic char	**354**	41	395	Common whitefish	24	**99**	123
Grayling	**269**	92	361	Other species	**78**	31	109
Other species	**156**	121	277	Grayling	**85**	16	101
Atlantic salmon	**184**	46	230	Atlantic salmon	**45**		45

7.3 Targeted species, national environmental monitoring

Sweden has a long history of monitoring fish communities in coastal areas and the great lakes. Regular sampling in seemingly unaffected national reference areas has been taking place in coastal areas since the late 1980s and in inland waters since the 1990s. Long time series are often required in order to identify changes beyond the normal interannual variability of species presence. The presence of fish and crustacean stocks normally fluctuates over time, depending on a variety of factors. If the early summer has been a warm, productive period, for example, the survival rate increases for the fry of many species. This often has an impact for several subsequent years in terms of the presence of adult fish. In the same way, weak recruitment years may result in several years of poorer catches of adult fish. Excessively high fishing pressure, poorer spawning habitats or reduced food resources are other factors which may affect the presence of species. Several years of monitoring using standardised methodology provides an opportunity to establish or determine baselines for the area. This then makes it possible to determine whether the status of individual species of fish communities is declining or increasing over time.

There are a number of species for which there are no representative catches due to the fact that standardised environmental monitoring methodologies are used in order to keep as many variables as possible constant. The fish monitoring methodology often has inherent restrictions and is suited to a certain type of fish with similar behaviour. As the activity and behaviour of the fish controls, in many regards, the numbers of the fish caught using passive gears such as nets or traps, for example, catches of certain species will be so low that it is not possible to monitor stock development in a reliable manner (Tables 6, 7, 8 and 9). Fish monitoring is carried out by means of standardised fish monitoring, generally during the month of August. This is the time at which the average water temperature is most stable, and the temperature-dependent variation in catches between years is low. The majority of all species also spawned and there is no risk of disturbing migratory movements in the area, which also affects the catchability.

Photo: Barbara Bland

Table 6. *Catches of various species, expressed in numbers per year, in a standardised fish monitoring procedure in the month of August between 2000 and 2013, in Fjällbacka (using fyke nets) for the Skagerrak. The species are sorted according to the total number of individuals caught in the measurement series.*

Number/year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**Total**
Corkwing wrasse	1162		2109	58	364	652	169	793	1065	249	77	30	177	110	7015
Goldsinny wrasse	476	287	657	305	205	202	158	260	293	294	167	230	192	361	4087
Yellow eel	93	148	337	238	169	194	165	152	227	186	105	139	68	185	2406
Viviparous eel-pout	181	117	92	80	113	219	159	36	48	66	70	238	202	345	1966
Atlantic cod	66	32	10	13	107	36	7	137		193	45	36	128	61	871
European plaice	36	6	36	13	66	39	66	38	10	57	48	12	12	97	536
Shorthorn sculpin	109	40	85	5	49	54	26	24	35	17	52	48	73	74	691
European flounder	45	14	48	25	19	46	30	24	20	21	19	36	57	69	473
Black goby	52	15	51	49	24	33	23	19	32	33	23	42	17	20	433
Whiting	39	15	7	10	100	4	15	44		97	28	24	34	16	433
Saithe	17	4						5					84	8	118
Sea trout	1	2	4				1	2	2		2	1	6	4	25
Ballan wrasse	3				4	3		1		3	3		5	3	25
Longspined bullhead			15		1		2		1				2	1	22
Pollack								4				1	4		9
Greater pipefish						1		3	3		3				10
Broadnosed pipefish		5			1										6
Sea stickleback			6												6
Fivebeard rock-ling	2			1				1							4
Common dab					1		1			1					3
Common sole									2						2
Lemon sole	1				1										2
Rock gunnel	1				1										2
European seabass										1					1
Common dragonet	1														1
Atlantic herring						1									1
Common shore crab	3518	5160	4549	3752	3207	4675	2727	2374	4201	2812	1771	4956	5320	3763	52785
Hermit crab									2		4				6
Great spider crab	3		1	1											5
Japanese spider crab			4												4
Common lobster						1		2							3
Edible crab											2				2

Table 7. *Catches of various species, expressed in numbers per year, in a standardised fish monitoring procedure in the month of August between 2000 and 2013. Sample area Kvädöfjärden (net fishing) for the Baltic Sea. The species are sorted according to the total number of individuals caught in the measurement series.*

Number/year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**Total**
European perch	1532	1032	1148	1183	1486	925	653	902	881	693	738	792	1664	1517	12097
Common roach	2059	741	794	1141	348	548	572	1083	1007	955	871	374	988	523	9422
Silver bream	764	311	647	493	85	150	116	467	156	292	255	64	328	208	3364
Bream	2	6	7	15	32	16	40	54	87	52	42	32	10	61	393
Ruffe	169	53	41	42	34	11	23	7	41	24	31	35	15	30	357
Atlantic herring	6	8	8	0	19	65	5	15	7	54	56	2	98	30	337
Pike-pearch	6	2	4	16	6	2	3	12	9	84	19	41	81	84	279
Northern pike	31	25	32	25	28	29	31	21	10	16	19	9	7	2	252
Common rudd	35	25	7	14	6	3	13	11	56	3	2	31	10	18	181
European flounder	14	13	14	12	6	5	5	5	9	6	11	13	18	12	117
Ide	3	7	3	2	6	3	1	18	23	10	5	1	1	3	80
Tench	2			3	1	3	20	5	17	7	5	12		1	73
Vimba bream	3	1	2					5		1					9
European smelt	3										6		1		7
Shorthorn sculpin										1		3			4
Common whitefish		3	1												4
Crucian carp					1		1	1							3
Yellow eel			1												1
Burbot				1											1
Great sand eel													1		1
Broadnosed pipefish												1			1

Table 8. *Catchable species, expressed in numbers per year, in a standardised fish monitoring procedure in the month of August between 2000 and 2013. Sample area Holmön (net fishing) for the Gulf of Bothnia. The species are sorted according to the total number of individuals caught in the measurement series.*

Number/year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**Total**
European perch	1718	709	697	1281	4179	1753	4662	2929	1388	1396	1453	850	2933	3661	29609
Common roach	481	712	1893	1635	1178	1070	2099	2746	2185	2195	1529	1383	1515	2329	22950
Atlantic herring	112	191	181	42	55	113	81	282	107	32	148	146	75	172	1737
Ruffe	89	35	75	46	241	30	24	23	50	43	35	23	47	8	769
Common bleak	17	4	2	70	20	22	19	71	65	46	25	58	21	41	481
Common whitefish	12	27	18	10	15	6		8	3	2	25	10	12	23	171
Northern pike	1	5	2		1	1	1		1	2	2	5	5	1	27
Common dace		1	5					1							7
Ide						1			1						2
Silver bream														1	1
Burbot						1									1
Crucian carp										1					1
Viviparous eelpout	1														1

Table 9. *Catchable species, expressed in numbers per year, in a standardised fish monitoring procedure in the month of August between 2000 and 2013. Sample area Vänern (net fishing) for the great lakes. The species are sorted according to the total number of individuals caught in the measurement series.*

Number/year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**Total**
European perch	1098	2080	1691		64	1809	52	187	1229	1113	6527	6250	2711		27811
Common roach	371	1098	720		19	934	587	1008	611	2243	6361	6092	2523		22567
Ruffe	683	815	1020		191	734	97	131	256	788	2024	2305	1013		10057
Silver bream	454	387	700		46	1578	854	619	654	479	2492	494	540		9288
European smelt	104	29	227			12	7	29	23	319	2861	1126	1709		6446
Common bleak	161	47	46		1	1131	125	153	194	504	1946	879	639		5738
Bream		495	422		9	583	27	32	84	252	1536	481	367		4449
Cyprinid un-identified							2	891		222	375	1718	386		3594
Vendace	12	5				1			9	380	627	1225	60		2319
Pike-perch	45	91	159		28	101	52	101	19	7	780	336	198		1917
Common whitefish										94	595	379	421		1489
Burbot										2	430	189	124		754
Blue bream	20	155	70						18	274	21	37			595
Common rudd	1					1		19	24	31	23	35	15		149
Northern pike	14	2	4			5		5	5	14	17	14	12		92
Asp		2				5		3		10	22	11	10		63
Common dace										2	6	22	2		32
Tench								2		7	3	6	1		21
Vimba bream			2								7	4			11
Ide								1			1	3	1		6
Brown trout											2	3			5
Atlantic salmon											1		2		3
Common minnow													2		2
European bullhead											2				2
Spined loach												1			1
Crucian carp												1			1

7.4 Identification of focus species requiring increased management data

One aim of this report is to attempt to describe and identify fish and crustacean species which are subject to significant fishing pressure from recreational fishing, and to attempt to relate these to management aspects and find out whether current catch statistics or evaluation work meet the requirements for long-term decision data. From a national standpoint, it is also appropriate to take into account the stock structure and ecology of the various species as this reflects the level or geographical scale at which it is possible to work in order to improve the knowledge base, and also the scale on which management measures should be undertaken.

Tables 10, 11 and 12 rank species according to common points of contact in respect of data collection concerning recreational fishing. The species are sorted according to a focus species index, which indicates the need for better management data. Species for which it is currently considered particularly important to acquire better stock estimates have a high index value, and species which are currently monitored in a satisfactory manner have a low index value. Different variables of significance to stock estimates are summarised on the basis of Tables 1-9. High index values are achieved if there is a data collection requirement, if there is a stock estimate for the species at a national level and not in major international working groups, if there is high fishing pressure, or if national environmental monitoring as well as international monitoring programmes do not capture species in such quantities that it is possible to calculate using the data collected. The spread of a species is very important; this affects the scale on which it is possible to work with management measures, and also the scale on which changes may possibly be seen. On the basis of this, species with relatively small population spread patterns are ranked more highly than species which move over large areas and where management is shared between different regions, such as neighbouring countries.

The idea behind the tables below is not to present the focus species as being of a definitive nature. It is a way of describing and demonstrating where the knowledge is in most demand on a rough spatial scale. On a smaller spatial scale, it is necessary to take into account local stocks and area-specific species. This means that the relationship between focus species will probably shift depending on the approach applied and the perspective from which the issue is tackled.

Photo: The Swedish Agency for Marine and Water Management.

Table 10. *Focus species index for species in the Skagerrak and Kattegat requiring improved stock data. The relative significance of the variables for the index is specified in brackets*

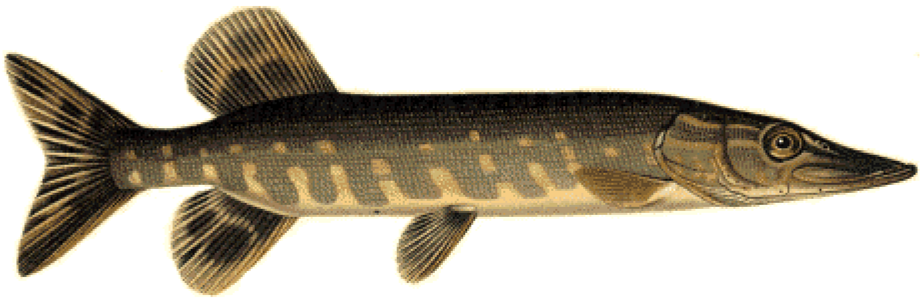
Species	Data collection requirements National/international	Stock-estimated	Target species, commercial fishing	Target species, recreational fishing	Precision, national environmental monitoring	Precision, international trawling surveys	Population spread/ Management	**Focus species INDEX**
Common lobster	Yes (1)	Nationally (1)	High (3)	High (3)	Low (3)	Low (3)	Small (3)	**17**
Edible crab	Yes (1)	Nationally (1)	High (3)	High (3)	Low (3)	Low (3)	Medium (2)	**16**
Sea trout	Yes (1)	Nationally (1)	Low (1)	High (3)	Low (3)	Low (3)	Large (1)	**13**
Norway lobster	Yes (1)	Internationally (0)	High (3)	Medium (2)	Low (3)	Low (3)	Large (1)	**13**
Atlantic mackerel	Yes (1)	Internationally (0)	High (3)	High (3)	Low (3)	Medium (2)	Large (1)	**13**
Atlantic herring	Yes (1)	Internationally (0)	High (3)	High (3)	Low (3)	High (1)	Large (1)	**12**
Northern shrimp	Yes (1)	Internationally (0)	High (3)	Low (1)	Low (3)	Low (3)	Large (1)	**12**
Turbot	Yes (1)	Internationally (0)	Medium (2)	Medium (2)	Medium (2)	Low (3)	Medium (2)	**12**
Atlantic cod	Yes (1)	Internationally (0)	High (3)	High (3)	High (1)	High (1)	Medium (2)	**11**
Haddock	Yes (1)	Internationally (0)	High (3)	Medium (2)	Low (3)	High (1)	Large (1)	**11**
European hake	Yes (1)	Internationally (0)	High (3)	Low (1)	Low (3)	Medium (2)	Large (1)	**11**
European plaice	Yes (1)	Internationally (0)	High (3)	Medium (2)	Low (3)	High (1)	Large (1)	**11**
Common sole	Yes (1)	Internationally (0)	High (3)	Medium (2)	Low (3)	High (1)	Large (1)	**11**
Sand lance	Yes (1)	Internationally (0)	Low (1)	Low (1)	Low (3)	Low (3)	Large (1)	**10**
Roundnose grenadier	Yes (1)	Internationally (0)	Low (1)	Low (1)	Low (3)	Low (3)	Large (1)	**10**
Grey gurnard	Yes (1)	Internationally (0)	Medium (2)	Low (1)	Low (3)	Medium (2)	Large (1)	**10**
Witch flounder	Yes (1)	Internationally (0)	High (3)	Low (1)	Low (3)	High (1)	Large (1)	**10**
Common dab	Yes (1)	Internationally (0)	Medium (2)	Medium (2)	Low (3)	High (1)	Large (1)	**10**
Blue whiting	Yes (1)	Internationally (0)	High (3)	Low (1)	Low (3)	High (1)	Large (1)	**10**
Saithe	Yes (1)	Internationally (0)	High (3)	Medium (2)	Medium	High (1)	Large (1)	**10**
Brill	Yes (1)	Internationally (0)	High (3)	Low (1)	Low (3)	High (1)	Large (1)	**10**
European sprat	Yes (1)	Internationally (0)	High (3)	Low (1)	Low (3)	High (1)	Large (1)	**10**
Norway pout	Yes (1)	Internationally (0)	High (3)	Low (1)	Low (3)	High (1)	Large (1)	**10**
Whiting	Yes (1)	Internationally (0)	High (3)	Medium (2)	High (1)	High (1)	Large (1)	**9**
European eel	Yes (1)	Internationally (0)	Low (1)	Low (1)	High (1)	Low (3)	Large (1)	**8**

Table 11. *Focus species index for species in the Baltic Sea requiring improved stock data. The relative significance of the variables for the index is specified in brackets*.

Species	Data collection requirements National/international	Stock-estimated	Target species, commercial fishing	Target species, recreational fishing	Precision, national environmental monitoring	Precision, international trawling surveys	Population spread/ Management	**Focus species INDEX**
Northern pike	Yes (1)	Nationally (1)	High (3)	High (3)	Low (3)	Low (3)	Small (3)	**17**
Pike-perch	Yes (1)	Nationally (1)	High (3)	High (3)	Low (3)	Low (3)	Small (3)	**17**
Common whitefish	Yes (1)	Nationally (1)	High (3)	High (3)	Medium (2)	Low (3)	Small (3)	**16**
Atlantic salmon	Yes (1)	Internationally (0)	High (3)	High (3)	Low (3)	Low (3)	Medium (2)	**15**
Sea trout	Yes (1)	Internationally (0)	High (3)	High (3)	Low (3)	Low (3)	Medium (2)	**15**
European perch	Yes (1)	Nationally (1)	High (3)	High (3)	High (1)	Low (3)	Medium (2)	**14**
Turbot	Yes (1)	Internationally (0)	High (3)	High (3)	Medium (2)	Medium (2)	Medium (2)	**13**
Atlantic cod The Sound	Yes (1)	Internationally (0)	Medium (2)	High (3)	Low (3)	High (1)	Small (3)	**13**
Brill	Yes (1)	Internationally (0)	Low (1)	Low (1)	Low (3)	Low (3)	Small (3)	**12**
Common sole	Yes (1)	Internationally (0)	Low (1)	Low (1)	Low (3)	Low (3)	Small (3)	**12**
Atlantic herring	Yes (1)	Internationally (0)	High (3)	High (3)	Medium (2)	High (1)	Large (1)	**11**
European flounder	Yes (1)	Internationally (0)	High (3)	High (3)	Medium (2)	High (1)	Large (1)	**11**
European plaice	Yes (1)	Internationally (0)	High (3)	Medium (2)	Low (3)	High (1)	Large (1)	**11**
Atlantic cod - rest of Baltic	Yes (1)	Internationally (0)	High (3)	Low (1)	Low (3)	High (1)	Large (1)	**10**
European eel	Yes (1)	Internationally (0)	High (3)	Low (1)	High (1)	Low (3)	Large (1)	**10**
Common dab	Yes (1)	Internationally (0)	Low (1)	Low (1)	Low (3)	Low (3)	Large (1)	**10**
European sprat	Yes (1)	Internationally (0)	High (3)	Low (1)	Low (3)	High (1)	Large (1)	**10**

Table 12. *Focus species index for species in the great lakes requiring improved stock data.* The relative significance of the variables for the index is specified in brackets.

Species	Data collection requirements National/international	Stock-estimated	Target species, commercial fishing	Target species, recreational fishing	Precision, national environmental monitoring	Precision, international trawling surveys	Population spread/ Management	**Focus species INDEX**
Northern pike	Yes (1)	Nationally (1)	High (3)	High (3)	Low (3)	Low (3)	Small (3)	**17**
Arctic char	Yes (1)	Nationally (1)	Medium (2)	High (3)	Low (3)	Low (3)	Medium (2)	**15**
Pike-perch	Yes (1)	Nationally (1)	High (3)	High (3)	Medium (2)	Low (3)	Medium (2)	**15**
Crayfish	Yes (1)	Nationally (1)	High (3)	High (3)	Medium (2)	Low (3)	Medium (2)	**15**
European perch	Yes (1)	Nationally (1)	Medium (2)	High (3)	Low (3)	Low (3)	Medium (2)	**15**
Atlantic salmon	Yes (1)	Nationally (1)	Medium (2)	High (3)	Low (3)	Low (3)	Medium (2)	**15**
Sea trout	Yes (1)	Nationally (1)	Medium (2)	High (3)	Low (3)	Low (3)	Medium (2)	**15**
Asp	Yes (1)	Not stock-est. (2)	Low (1)	Medium (2)	Low (3)	Low (3)	Medium (2)	**14**
Vendace	Yes (1)	Nationally (1)	High (3)	Low (1)	Medium (2)	Low (3)	Large (1)	**12**
European eel	Yes (1)	Nationally (1)	Low (1)	Low (1)	Low (3)	Low (3)	Medium (2)	**12**
Burbot	Yes (1)	Nationally (1)	Low (1)	Low (1)	Low (3)	Low (3)	Medium (2)	**12**
Common whitefish	Yes (1)	Nationally (1)	Medium (2)	Low (1)	Low (3)	Low (3)	Medium (2)	**12**
Grayling	No (0)	Not stock-est. (2)	Low (1)	Low (1)	Low (3)	Low (3)	Medium (2)	**12**
Rainbow trout	No (0)	Not stock-est. (2)	Low (1)	Medium (2)	Low (3)	Low (3)	Large (1)	**12**



As indicated in Tables 10-12, there are fewer species in the Skagerrak and Kattegat achieving high values than in the Baltic Sea (~15). As the majority of species are internationally stock-assessed and most are not targeted species from a recreational perspective and are also regulated, managed and have a population distribution on a rough scale, only ***European lobster*** and ***edible crab*** emerge as focus species where an improvement in recreational fishing statistics could help to significantly improve the stock data. For other species in the Skagerrak and Kattegat which are subject to high fishing pressure from both commercial fishing and recreational fishing, commercial fishing is often of much greater magnitude than recreational fishing. This means that increasing collection from recreational fishing would not help much with the improvement of the stock data. For European lobster however, the situation is the opposite. In a survey of both commercial and recreational lobster fishermen in 1995[10], a rough estimate indicated that recreational fishing was responsible for more than 80% of the total annual lobster landings (140 of 168 tonnes) via more than 7500 recreational lobster fishermen, compared with 158 commercial fishermen. Furthermore, edible crab and trout are two species which are not included in the EU Data Collection Framework (DCF) in the Skagerrak and Kattegat. For the edible crab, which is a target species in commercial fishing but also a target species in recreational fishing using passive gears, an improved reporting system from recreational fishing would significantly improve the biological research data and hence management decisions as well. ***Sea trout*** on the west coast is interesting in that it is a target species for recreational fishing but not for commercial fishing. However, trout stocks along the west coast generally have a good status. Good access to spawning grounds, relatively productive waterways, low predation and extensive fish conservation in the form of habitat restoration and liming programs and fishing controls have resulted in a good stock status along the coast. Other species such as ***Atlantic cod***, ***turbot*** and ***European plaice*** also have local stocks along the west coast. These stocks are weak at present, and commercial fishing is passably controlled. For these stocks, there is a clear need for extended collection of data on recreational catches.

The primary focus species requiring improved data for stock estimates and management measures in the Baltic Sea are ***northern pike***, ***pike-perch*** and ***common whitefish***. These species stand out as there is pressure from recreational fishing which is considerably greater than the effect of commercial fishing (e.g. harvesting) at stock level. These species are stock-assessed and managed at a national level as they occur only in relatively isolated coastal populations. For pike-perch, access to appropriate spawning and nursery areas along the coast is very limited, which means that stocks are local and particularly susceptible to high fishing pressure. Like pike-perch, northern pike have local stocks and are experiencing declining stock trends. Recreational fishing for these species represents 90-95% of the total number of catches. Common whitefish also have a complex stock structure and are showing declining trends in some sea areas. ***Atlantic salmon*** and ***sea trout*** in the Baltic Sea could also be categorised as focus species, but as the DCF defines requirements for the collection of data from commercial fishing as well as recreational fishing, these species are handled within ICES working groups. Migration statistics and electrofishing data from rivers are also used. Further statistics from recreational fishing may help to improve data within working groups, but for the coast at least the data and frameworks that currently exist work relatively well. Furthermore, ***Atlantic cod*** is a species that could be characterised as a focus species for increased collection of recreational statistics. However, Atlantic cod is included

[10] Ulmestrand, M. & Loo, L.-O. Fritidsfisket efter hummer hösten 2007 Chapter in Fem studier av fritidsfiske 2002-2009, Finfo 2009:1.

in the recreational fishing data collection defined by the data collection regulation, as one of few species for which statistics have to be collected nationally. This has been done since 2011 in Öresund by asking skippers of tour boats to estimate daily Atlantic cod catches[11]. ***European perch*** is a species characterised as a target species for recreational fishing, but it does not quite reach the levels of the species with the highest point scores in the focus species index. This is mainly due to the fact that environmental monitoring programmes are considered to capture the species in such quantities that large-scale changes can be described by analysing such data. However, it is important to point out that this does not mean it is less important to monitor recreational fishing harvests and influence on such species. It is necessary to study local differences between areas with high and low recreational fishing pressure, for example, and to view these in relation to environmental monitoring and results from fish monitoring.

In inland waters, many species are monitored poorly, and this has been the case historically as well. Moreover, the monitoring which does take place is often based on more or less irregular efforts. This, together with the fact that many stocks are located in individual lakes and waterways, means that it is much more difficult to provide a view of how stocks are affected and/or how they have developed over the years. Char in Vättern are one exception, for which data is available for commercial fishing landings from 1914 onwards. At the same time, work is in progress on improving the stock estimate models in the great lakes, primarily in respect of pike-perch and crayfish. ***Northern pike***, ***Arctic char***, ***pike-perch***, ***crayfish***, ***European perch***, ***Atlantic salmon*** and ***brown trout*** are focus species which need better data for stock estimates.

Rare species such as asp are not normally caught in the standardised fish monitoring carried out. In this case, data collection from recreational fishing may provide a good complement. Benefiting from the interest of the general public in data collection and research, known as "citizen science", has proven to be a valuable complement to more traditional methods. This can also be developed in order to monitor alien/invasive species.

7.5 Where do people do their recreational fishing?

Most recreational fishing takes place in waters near to people's homes. More than half of people's fishing days take place within 30 kilometres, and more than 80 per cent within 100 kilometres of their place of residence[12]. This means that the greatest fishing pressure can be found close to centres of population, i.e. urban areas. Interest in fishing among the population also varies within the country, peaking in Northern Sweden and at considerably lower levels in counties such as Skåne. Interest also varies between rural areas and urban areas, for example. People who fish using handheld tackle are more mobile than fishermen who mostly are using passive gears. A study of fishing patterns among members of "Västkustens husbehovsfiskares förening" carried out by the National Board of Fisheries in 2005[13] showed that 50 per cent of catch areas were within a maximum distance of seven kilometres and 80 per cent were within a distance of eleven kilometres from the fishermen's home harbour. Therefore, it is possible to use the population size as an indirect measure of how vulnerable an area is to recreational fishing pressure. A number of other factors are of significance for the evaluation of fishing pressure.

[11] Øresland, V. (2012). Cod catches onboard Swedish tour boats in the Sound during 2011. Aqua reports 2012:2. Swedish University of Agricultural Sciences, Lysekil, 19 pp

[12] Paulrud, A. & Waldo, S. 2008. Fritidsfiskebaserat företagande i Sverige. Finfo 2008:2.

[13] Thörnqvist S. Husbehovsfiske i Skagerack. Chapter in Fem studier av fritidsfiske 2002-2009, Finfo 2009:1.

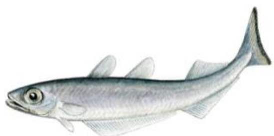
Access to target species, their general presence or the opportunity for trophy fish, has a part to play. The accessibility of the body of water is also a prerequisite. Regulations and restrictions on fishing are another aspect which should be taken into account. It is easy to imagine that areas where large numbers of fish gather in order to spawn, for example, and that are close to larger towns with lots of boat ramps or other structures which allow people to reach the fishing sites, and which also have no regulations on how much recreational fishing may take place, may be considered to be subject to high recreational fishing pressure.

The cumulative scope of recreational fishing is most widespread during the summer months, when most people are on holiday and so have time to devote to fishing. However, it is easy to imagine that there are other times of year which have greater scope and influence on specific species. Catches per effort, for example, are certainly higher – i.e. more fish are caught – during the spawning season in spring for species which gather at specific locations, such as the Northern pike. For other species which have limited geographical spread and are protected during certain parts of the year, such as the common lobster, fishing pressure peaks during specific periods and in specific areas, namely during the permitted fishing period around 20 September to 30 April in the area from Bohuslän to north Halland.

In a summary of the national recreational fishing survey relating to recreational fishing practitioners and significance in 2006, the pattern indicates that the Central Baltic and the Skagerrak have the highest fishing pressure in terms of both the number of practitioners and the number of fishing days per area[14]. The majority of the population of Sweden is also centred on a relatively small area here. 15% of the population fished in the great lakes in 2006, and 9% of the total number of fishing days were spent there. This also correlates very well with the population found in municipalities adjacent to the great lakes. Fishing tourism is practised to a particularly high level inland in Northern Sweden, and so fishing pressure here is higher than would be expected from the population density.

Areas with identified high number of recreational fishing days according to the summary from the 2006 survey include Stockholm/Mälardalen and the Gothenburg area, as well as Öresund, Blekinge archipelago, Gävleborg, the coast of Northern Sweden and Östersund (Storsjön).

To use population as an indirect measure of recreational fishing pressure at municipal level, for example, we need to weight the population against the interest in fishing in the area in question and against the area of the municipality. The denser the population per unit of area, the higher the fishing pressure on that particular unit of area. The counties of Northern Sweden, which cover a large area, are thus relatively sparsely populated and fishing pressure may indeed be extensive within the entire municipality, but as most fishing takes place near to people's homes, it is conceivable that fishing is relatively widespread compared with dense clusters of people within relatively short distances (Fig. 1).



[14] Thörnqvist S. Fritidsfisket utövare 2006. Chapter in Fem studier av fritidsfiske 2002-2009, Finfo 2009:1.

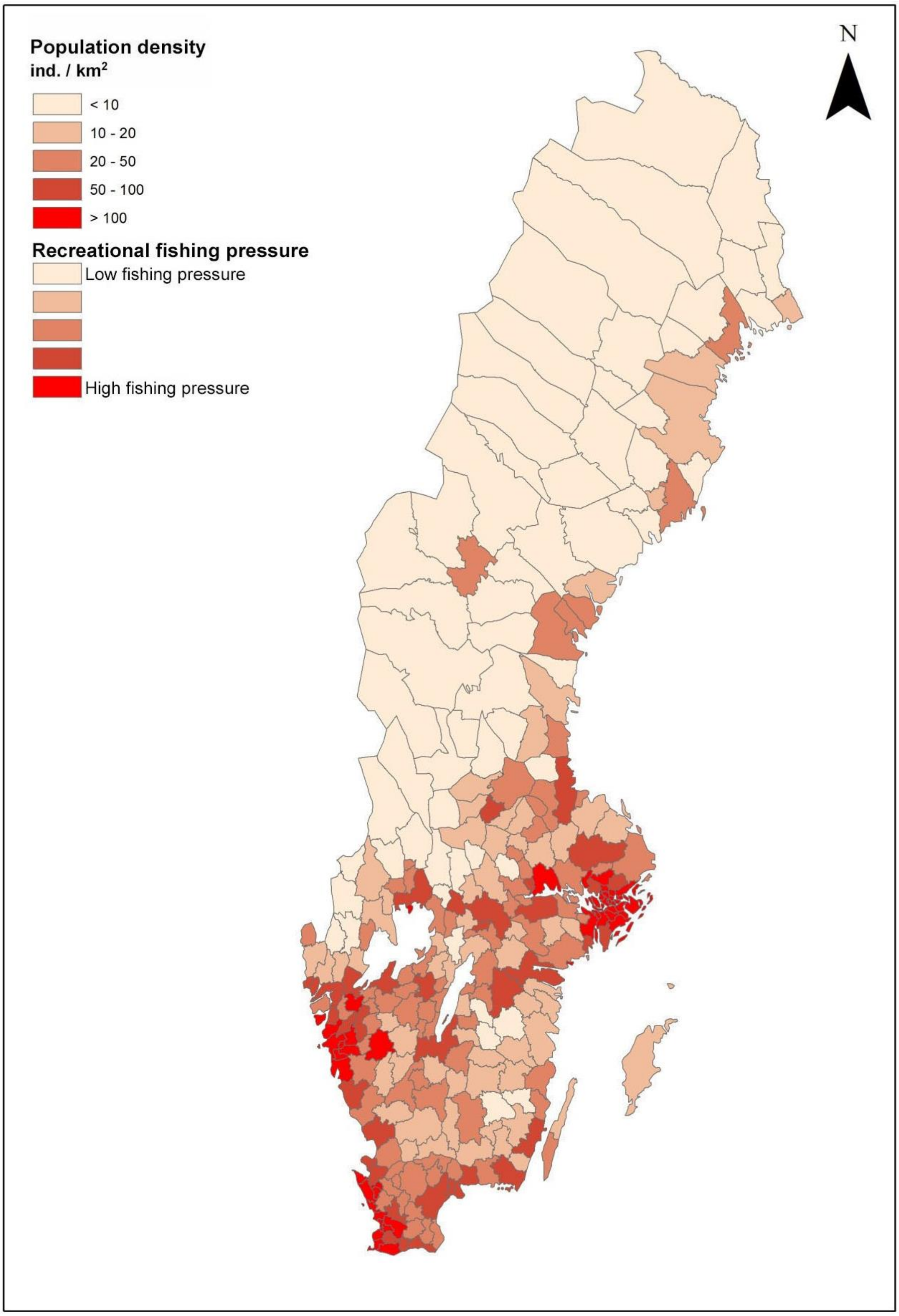


Fig. 1. Population density per municipality as an indirect measure of fishing pressure.

8 Where are fish communities monitored?

Monitoring of fish communities often takes place in specific areas or locations. There is often a desire to study areas from a time series perspective in order to capture natural fluctuations and inter-annual variability. The monitoring of coastal fish along the coast largely takes place in regional and national reference areas and around recipient controls (Fig. 2). These have often continued for a number of years. The same is applicable to lakes and waterways, where fish monitoring is carried out with nets, as well as electrofishing monitoring (Fig. 3). Besides these, there are individual initiatives which aim to describe the spread and composition of fish communities or individual species in the areas. Such fish monitoring can be referred to as fish inventories, and these often have no temporal detail.

Photo: Martin Karlsson

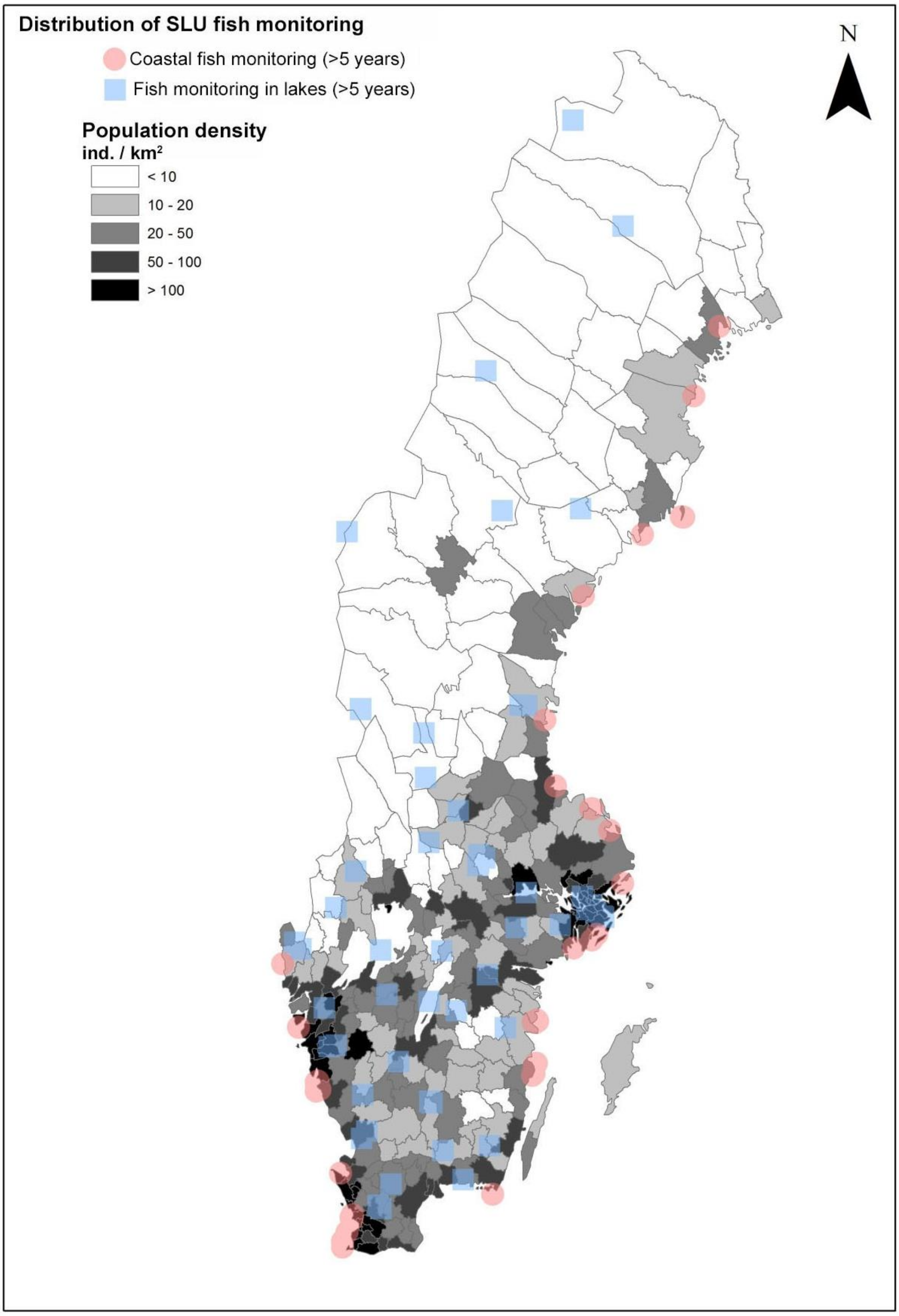


Fig. 2. The distribution of the fish monitoring carried out by the Department of Aquatic Resources at SLU. The figure only includes locations where fish monitoring has taken place for at least 5 years over the past 20 years. The greyscale used for the municipalities indicates population density as an indication of the scope of recreational fishing in the area.

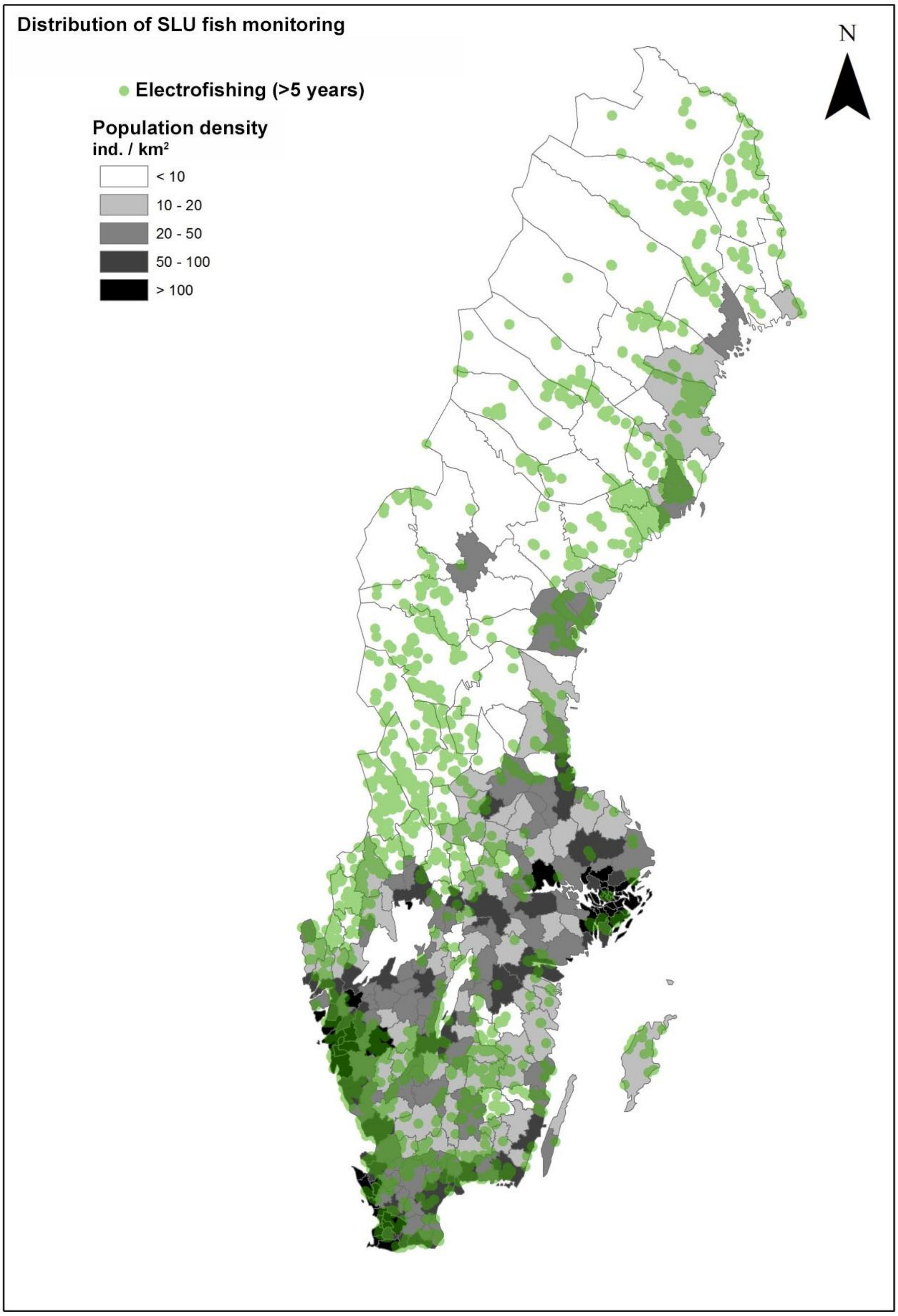


Fig. 3. The distribution of the electrofishing monitoring carried out by the Department of Aquatic Resources at SLU and other stakeholders. The figure only includes locations where fish monitoring has taken place for at least 5 years over the past 20 years.

8.1 How do we describe the development and structure of fish communities, and is there any link with the effect of recreational fishing in the area?

Fish monitoring areas are evaluated constantly, and having access to data which describes the composition and function of the fish community is a benefit from a recreational fishing perspective, with a view to understanding and describing recreational fishing harvests. Conversely, for certain species better information on the scope and significance of recreational fishing in the area may increase understanding of the factors which govern the development of the fishing society over time. The structure, function and development over time of the fish community is described by means of a range of explanatory variables and supporting parameters, often with strong links to local influence factors such as fishing pressure. By being able to quantify fishing pressure with sufficient precision, it should be possible to assess more accurately whether changes in fish stocks or the fish community are due to changes in the environmental conditions or whether they are caused by – for example – excessive or declining recreational fishing pressure.

8.1.1 Fish community diversity

Diversity is a measure of biodiversity. The distribution of species in the catch, often based on biomass, indicates whether there is strong dominance by any one species in an area, or whether more species make a more balanced contribution to the overall catch. A change in diversity in a fish monitoring area over time may indicate changes in the fish community caused by factors such as eutrophication, overfishing, loss of habitat or climate change. Diversity may also change due to the propagation of alien and invasive species. It sometimes takes time to detect such species in fish monitoring as the catchability is often linked with how much of the species there is. Before they have started to occur in such quantities that they are caught, it appears that recreational fishing – which is often more widespread in terms of both time and scope over a year period – can act as an "early warning" system.

8.1.2 Fish community quantity and structure

Catches per unit effort of all species together provide a view of how productive the area is. This is expressed in terms of both the number of individuals and the biomass per effort. The biomass divided by the number provides a rough indicator of the size distribution in the stock subject to fish monitoring. Changes in quantity and size distribution may indicate that the fish community is being affected by overfishing, a change in predation, climate change and/or varied recruitment success. Areas subject to a total ban on fishing often have a higher general presence and considerably more large individuals than areas without restrictions[15].

8.1.3 Fish community function – trophic level

The trophic level for a fish species refers to the position of the species in the food web, determined by the number of energy transfer level up to species in question. Thus the trophic level for the fish community as a whole can act as a measure of the ecological role of the fish community. Low trophic level values indicate that a small proportion of the fish community appears at a high level in the food web and that the community largely consists of fish that feed on plankton, plant parts, benthic fauna, etc. A reduction in trophic level over time could indicate a large fishing pressure of predatory fish such as

[15] Bergström, U. 2013. Fiskefria områden kan gynna både fiske och miljö. Formas fokuserar 21.

perch, pike-perch and pike. A higher proportion of predatory fish may indicate a richer fish community[16]. Recreational fishing often focuses on predatory fish, and the proportion of predatory fish in fish monitoring catches may thus provide an indicator of the effect of fishing in a community[17]. The proportion of predatory fish has proven to be highest in medium-productive areas in the Baltic Sea, which is largely due to a high proportion of perch. As high nutrient levels place perch at a disadvantage, the proportion of fish-eating fish falls as the nutrient load increases. At very high nutrient levels, the proportion of fish-eating fish may increase again as these benefit pike-perch[18].

8.2 Geographical problem areas

8.2.1 Fishing pressure from recreational fishing

Fishing pressure is partly dependent on the number of residents in an area, as people mostly fish close to where they live. However, this is not true of all fishing or all species. Salmon in the Baltic Sea are fished by people from all over the country, and in various regions recreational fishermen move around to follow the fish, and so the highest numbers of recreational fishermen are found in areas where the best fishing is to be had. However, it is essentially possible to generally estimate fishing pressure according to population density, and hence also to identify hotspots (Fig. 1). Known locations where the fishing is exceptionally good, or at least was good, are other hotspots. Areas in which fish gather for spawning or to search for food, or narrower passages which the fish have to pass during their spawning migration may also generate higher fishing pressure at certain times of the year. Examples of such areas include Öresund during the cod spawning season in January-March, trolling in the areas around Simrishamn in April-June and Northern pike fishing in the archipelagos of Blekinge and Stockholm in the spring during the spawning season. Areas experiencing particularly high fishing pressure from passive gears include the Bohuslän coast down to north Halland in September-April and coastal fishing for common whitefish, trout and salmon along the coast of Northern Sweden in spring.

As there is a strong link between the degree of recreational fishing and fish community status, it is advantageous to be able to quantify both of these in one area, ideally with development over time in respect of the scope of recreational fishing and the status of the fish community. From the maps in Figs. 2 and 3, it is immediately apparent that some areas probably experience major recreational fishing pressure but have no time series from fish monitoring:

- Hanöbukten
- Lakes along the coastal area of Northern Sweden.
- The area around Storsjön in Jämtland.
- The Halland coast
- Östra Svealand

[16] Hjerpe, J., U. Bergström, A.-B. Florin and K. Grip. 2004. Bakgrundsmaterial för utredning av möjligheten att införa fiskestopp i ett skyddat marint område. Finfo 2004:4. 62 p.
[17] Trenkel, V.M. and M.-J. Rochet. 2003. Performance of indicators derived from abundance estimates for detecting the impact of fishing on a fish community. *Canadian Journal of Fisheries and Aquatic Sciences* 60: 67–85.
[18] Persson, L., S. Diehl, L. Johansson, G. Andersson and S.F. Hamrin. 1991. Shifts in fish communities along the productivity gradient of temperate lakes - patterns and the importance of size-structured interactions. *J. Fish Biol.* 38: 281–293.

However, some areas have been studied by means of individual initiatives or at sparse intervals. As far as coastal areas are concerned, Hanöbukten underwent inventories in 2013 and 2014. However, it is likely that the most extensive recreational fishing in the area takes place further out to sea and mainly involves species such as salmon, sea trout and cod. The southern coast of Halland, which is characterised by relatively shallow, expansive sandy areas but relatively few marinas, probably experiences relatively limited coastal recreational fishing using boats. However, estuaries and – above all – angling on the Fladen bank, Lilla Middelgrund and Stora Middelgrund are all local hotspots. Storsjön is an area which also has no fish monitoring with a continuous time series perspective, but it does have high recreational fishing pressure. Surveys which could work to establish baselines of fish stocks in Storsjön are the fish monitoring programmes carried out in 1979, 1980, 1984, 1985 and 2011[19]. However, monitoring methods have varied over these years.

8.2.2 Fish monitoring

Fish monitoring is carried out by SLU Aqua, county administrative boards and municipalities. Fish monitoring is carried out using standardised methods, and information from the fisheries is stored and made available by the data host SLU Aqua. Many locations have been subject to regular fish monitoring for many years, in some cases over 25 years, while other locations have been subject to irregular fish monitoring over the last few decades. Calculations which we have carried out have indicated that four to five years' worth of data is required in respect of electrofishing and sea fish monitoring at least, in order to gain a good idea of the fish density and the number of species in an area.

The fish community alters over time, partly due to human activity (hard fishing, habitat fragmentation, eutrophication, power plants, roadbuilding, deforestation, etc.) which affects fish stocks, and partly due to changes in climate and habitat. This means that older data may not provide a current view of the fish community. This is why we have only included the locations which have been subject to fish monitoring five times (years) over the past 20 years in order to illustrate where fish monitoring data is available which can be used to assess the stock and community status.

8.2.3 Temporal and spatial detail of recreational fishing data

As the majority of species on which recreational fishing focuses are local, this makes stringent demands in terms of the detail of the recreational fishing data so that economic valuations of the fish and assessment of effects on stock can take place. The more spatial and temporal detail, the better. However, the calculations must also take into account the fact that greater effort is often required to implement very detailed recreational fishing data.

Briefly, data is required for the following areas (gradually increasing level of detail):

- Number of people fishing and number of fishing days
- Total catches of various species per year
- Catches of various species per effort

[19] Axenrot, T., Andersson, M. and Degerman, E., 2013. Fisksamhället i Storsjön, Jämtland. Undersökningar med ekolodning, trålning och nätprovfiske år 2011. Aqua reports 2013:6 Swedish University of Agricultural Sciences, Drottningholm. 35 p.

9 Case studies relating to the collection of recreational fishing data

9.1 Case study 1. Estimation of Danish recreational fishing catches of cod and eel[20].

Data used:

- **Surveys:** Letters were sent out to 4835 randomly selected recreational fishermen with recreational fishing licences (which are mandatory in Denmark). This figure equates to approximately 1.85% of all holders of recreational fishing licences. If there was no response to the letter, attempts were made to contact these people by telephone. Up to six attempts were made to contact them by telephone. Responses from 3514 licensed recreational fishermen were eventually received.
- **Telephone interviews**: People from the entire population were selected at random in order to identify people who fish without a licence. A total of 2883 people were contacted in this part of the survey.

In both of the cases above, people were asked specifically about retained catches, not fish thrown or put back. In case study 1), respondents were able to indicate either the weight caught or the number of fish caught. In the latter case, the number of fish caught was converted into weight on the basis of results from commercial fishing catches.

The results of the survey showed that recreational fishing catches of cod accounted for 4.8% of the total catch, but that there were major differences between different areas. At most, recreational fishing accounted for 30% of the total cod catch. For eel, recreational fishing accounted for 19% of the total catch.

The study also showed that 20% of recreational fishing catches were taken by people who had no recreational fishing licence.

The authors include common sources of error in their discussion: (1) Numeric preference; there is a tendency to round catches to the nearest 0 or 5, a tendency which usually increases as people attempt to remember events further back in time. This can lead to both overestimation and underestimation of catches, as well as the increased size of the estimated variance. (2) One related source of errors is the fact that recreational fishermen are unable to state how many times they were out fishing over a specific period, which means that people use "guesstimates" for the number of fishing trips several years back in time. (3) Extension of time periods; people include special events such as the catching of a record fish in a specific period, even though the fish was actually caught outside the period being surveyed. (4) Skewed response frequency; particularly serious if the response frequency is low. Recreational fishermen who rarely fish may refrain from responding. When the catches for all recreational fishermen are then added together, this leads to an overestimate.

Could a similar study be conducted in Sweden? It would be difficult to conduct a similar study in Sweden as we do not have a licensing system for recreational fishermen. The option available to us involves skipping directly to point 2 (randomly selected individuals from the entire population) above or using the register of members from an angling organisation. However, the latter is problematic for

[20] Sparrevohn, C.R. & Storr-Paulsen, M. 2012. Using interview-based recall survey to estimate cod *Gadus morhua* and eel *Anguilla anguilla* harvest in Danish recreational fishing. ICES J Mar Sci 69(2):323-330.

two reasons: (1) Angling organisations would prefer not to "sell out" their members in this way; and (2) with this method, we would only include people who fish using handheld tackle: people who enjoy recreational fishing using passive gears would not be included.

Other information which may be of significance: In Denmark, the cost for a recreational fishing licence for 2014 is as follows: EUR 19 for a year, EUR 13 for a week and EUR 5 for a day.

9.2 Case study 2. Estimation of recreational fishing harvests of sea bass in France.[21]

Data used:

- **Telephone study, sea bass**: 172,054 national telephone calls took place in areas directly next to the coast, asking the basic question of whether there were recreational fishermen in the household and, if so, whether they would consider being interviewed. 15,091 positive responses were obtained. When asked whether they had caught sea bass at any time in the past year, 535 respondents answered in the affirmative. Finally, when the remaining 535 individuals were asked whether they would consider answering further questions, 467 agreed to do so. Questions such as "*What type of tackle were you using*? *Did you fish from land*, *or a boat*? *When did you go fishing? How many sea bass did you catch? What other species did you catch? Did you put any of your catch back?",* it was possible to describe the fishermen and analyse patterns in respect of recreational fishing for sea bass.
- **Panel study, diaries**: At the end of the telephone interview, the 467 people interviewed were asked if they would be able to keep a fishing diary in order to log their catches for the next year. 256 people gave positive responses. New diaries were sent out every three months, and the fishermen noted catch parameters, patterns and their fishing, the extent to which fish were released, etc. A total of 190 fishing diaries were received (40 diaries covering the entire year). This was equivalent to 1190 fishing days and 1383 sea bass, giving an average catch of 1.15 sea bass per fishing day. Half of these were released.
- **Telephone study, national coverage**: As the first telephone interview was aimed only at areas in France which were directly next to the coast, a second telephone study was carried out so as to be able to extrapolate the figures collated via this fishing diary study for recreational fishing in France as a whole. Therefore, a second telephone study took place with a view to collecting information on recreational fishing (not just sea bass) from other parts of the country. 15,085 households were interviewed, and by analysing the responses it was possible to identify 134 sea bass fishermen from inland areas (equivalent figure from coastal areas: 535). Weighting the data from the first and second telephone studies and then transferring figures from the panel study gives a measure of the structure of recreational sea bass fishing in France as a whole.

The results of the survey showed that the annual sea bass catch on the French Atlantic coast amounted to 3173 tonnes, of which 2345 tonnes were kept. This is equivalent to 30% of the total harvest of sea bass in France. Further results from the study showed that half of the sea bass were thrown back (mostly smaller individuals below the minimum size) and that the average length of fish caught was 46.6 centimetres. There were more catches from boats than catches from land in terms of abundance, biomass

[21] Rocklin D, Levrel H, Drogou M, Herfaut J, Veron G. 2014. Combining Telephone Surveys and Fishing Catches Self-Report: The French Sea Bass Recreational Fishery Assessment. PLoS ONE 9(1): e87271. doi:10.1371/journal.pone.0087271

and catch per effort. The authors indicate that the combination of telephone interviews and self-reporting systems works well, and that it cannot be emphasised enough that recreational fishing harvests of species must be evaluated using relatively weak data.

To further increase understanding of recreational fishing influence and mortality, the authors point out that it is necessary to take into account the fact that there is a catch-and-release mortality which is currently unknown. Furthermore, charter boats and their catches were not included in the calculations. It was noticed that there was a tendency to round off catches (length and weight). By comparing length and weight relations from the diaries with length and weight relations from scientific surveys, it was found that the data was reliable regardless of marginal rounding. The advantage of using volunteers to keep diaries, compared with making on-site estimates by means of visits (known as creel surveys) where an observer writes down the number of boats, fishermen and catches, is that this provides a relatively good measure of releases which would otherwise be easily missed. Another advantage is that this allows data to be gathered from night fishing and fishing on weekends or public holidays, i.e. at times when study areas are often not observed if observers are used.

Could a similar study be conducted in Sweden? It would be possible to implement this methodology, with a number of modifications. However, this method is costly as it requires a large number of telephone calls to identify fishermen. However, with a national register of recreational fishermen it would be possible to carry out studies similar to this one. Data from a smaller area extrapolated to a larger area is a good, recognised methodology. A national survey looking at how many people fish for certain species currently exists in Sweden. It would be possible to acquire information on how much the average recreational fisherman catches or releases by means of voluntary or mandatory registration within a defined area. However, this requires any area of this type to be representative so that the figures can be scaled up.

9.3 Case study 3. Self-recording of catches on tourist/guide boats in Norway[22]

Data used:

- **Companies in the tourist fishing** industry were contacted, and a protocol was devised together with them for self-registration of catches during certain weeks of the year. Data was compiled on species, quantity, weight, the number of people per boat and day and the area in which fishing took place. Data was not collected for all species, but just for nine focus species, as they are known.

The survey was carried out in several different stages, beginning with a pilot study (30 companies) which indicated that asking the companies to record their catches for the entire year would generate far too high a workload. Therefore, different weeks of the year were randomly allocated among the companies. Furthermore, not all companies wanted to undertake the task of collecting all the data; 53 companies just recorded the effort and the number of fish caught, 44 companies registered all the variables specified above. Fifteen companies also measured the length of cod, halibut and saithe. The companies were paid for doing this, but the article does not specify how much. A total of 445 companies which hired out 2393 boats were identified. Of these companies, 97 were selected for self-recording. However, it eventually turned out that only 51 supplied data of sufficient quality, which essentially means that the non-response frequency stood at almost 50%. A fish expert looked at some of the catches, and the species determination by the tourist companies was 98% correct. Data collected over the course of the year was adjusted; it was assumed that the effort and catches were the same for the companies which did not record data. The effort for this type of recreational fishing was estimated in total to amount to 143,000 boat days, the average catch per boat day varying between 7 and 27 kilos, peaking in spring and summer. The total catch was estimated at 3300 tonnes, combining the nine focus species. The corresponding figure for cod was 1613 tonnes. This can be compared with total commercial landings, which amounted to 243,659 tonnes in 2009, but a better comparison is provided by commercial landings from coastal fishing, which amounted to 24,800 tonnes in 2010. Recreational fishing (from tourist boats) thus constituted 6.1% of total cod catches during coastal fishing. One problem is that nobody is keeping track of all tourist fishing companies in Norway; a substudy indicated that fewer than 80% of all companies had probably been found. In addition to these are people who fish from their own boats, i.e. people who are not tourists.

Could a similar study be conducted in Sweden? A similar study could be conducted in Sweden, with certain modifications. By no means do we have such a large tourist/guide boat industry, which means that we would need more coverage than 11.5% of companies. In Sweden, such coverage would result in just a small number of companies, which would make the analyses more sensitive to random variations.

[22] Vølstad, J. H., Korsbrekke, K., Nedreaas, K. H., Nilsen, M., Nilsson, G. N., Pennington, M., Subbey, S. and Wienerroither, R. 2011. Probability-based surveying using self-sampling to estimate catch and effort in Norway's coastal tourist fishery. – ICES Journal of Marine Science, doi:10.1093/icesjms/fsr077

10 What is currently being done as regards the collection of recreational fishing data?

10.1 International comparisons

On an international level, there are fairly major differences as regards how data from recreational fishing is collected. These differences are often due to legal and administrative criteria. About half of the countries listed in Table 13 have some form of recreational fishing licence, which means that surveys can be carried out with good precision when estimating catches, at a much lower cost than if no such register is available. However, one problem is the fact that the licensing system does not function fully in many countries; information on people who have acquired licenses may be confidential in some countries, and a proportion of the population fish without licences. This means that it is necessary to supplement the information with a survey in order to estimate the proportion of the population fishing without licences. One advantage in Sweden compared with many other countries is the extensive knowledge of who lives in the country, along with the option of using the population register for posting out surveys. In many countries, using these registers for random or targeted selections for surveys is not permitted due to reasons of confidentiality. It is also worth noting that all countries use more than one method, the various methods complementing one another or highlighting different elements of recreational fishing.

Table 13. *Summary of survey methods for estimating recreational fishing catches in 17 countries. The information has been extracted from ICES WKSMRF report 2009*[23].

Method	Australia	Belgium	Denmark	France	Germany	Ireland	Italy	Latvia	Lithuania	Netherlands	Norway	New Zealand	Poland	Spain	Sweden	United Kingdom	USA
Random telephone numbers	X		X	X	X						X	X		X			X
Random question-naires										X					X		
Licence lists	X	X	X		X	X	X	X					X	X		X	X
"Captured" recrea-tional fishermen are contacted regularly for a period	X																
"Captured" recrea-tional fishermen are contacted for more details															X	X	
Voluntary logbooks, recreational fisher-men						X	X									X	
Voluntary logbooks, guide boats														X			
Mandatory logbooks, recreational fisher-men								X			X			X			
Mandatory logbooks, guide boats																	
Questionnaires to rec-reational fishing or-ganisations		X				X	X										
Questionnaires to guide boats						X			X					X			
Surveys in coopera-tion with recreational fishing organisations														X	X		

[23] ICES. 2009. Report of the Workshop on Sampling Methods for Recreational Fisheries (WKSMRF), 14-17 April 2009, Nantes, France. ICES CM 2009\ACOM:41. 231 pp.

Table 13. *Cont*.

Method	Australia	Belgium	Denmark	France	Germany	Ireland	Italy	Latvia	Lithuania	Netherlands	Norway	New Zealand	Poland	Spain	Sweden	United Kingdom	USA
Interviews at harbours, etc.				X	X						X			X		X	
Self-recording of catches					X												
Visits to recreational fishing boats					X								X				
Data from fishing competitions							X									X	
Inventories of nets, buoys, etc.											X				X		

Photo: Marcus Bryntesson

10.2 Advantages and disadvantages of various data collection methods

The data collection methods listed in section 10.1 and in Table 13 involve various advantages and disadvantages. Table 14 includes a summary of the assessments.

1. **Random questionnaires**. The advantage is that it is possible to acquire a good national overview and a good estimate of what proportion of the population indulges in recreational fishing, which fishing methods are used and what the primary target species are. The disadvantage is that it is possible to acquire a slightly skewed view of the proportion of recreational fishermen; people who occasionally indulge in recreational fishing may perhaps not respond at all. To remedy this, it is possible to carry out non-response analyses; i.e. to telephone people who have not responded in order to acquire a separate estimate of fishing patterns in this group. Sending questionnaires to a panel of people who were included in previous questionnaire mailings and stated at the time that they indulged in recreational fishing can increase the proportion of people in the survey who have been involved in recreational fishing, thereby also increasing the statistical certainty of the studies. To approach fishing instances more closely, repeated questionnaires can be sent out over the course of a year which includes questions on fishing over the past four months, for example. One disadvantage of national surveys is that they result in low levels of spatial data and that there is no good measure of fishing effort at reasonable cost. To gain better estimates of the scope and geographical spread of recreational fishing, a random survey can be completed with targeted questionnaires to fishermen (panel approach as described above, or as described in point 3).
2. **Random telephone calls**. These have approximately the same advantages and disadvantages as (1), but they are considerably more labour-intensive.
3. **Licence lists**. The advantage is that only recreational fishermen are targeted when mailing out questionnaires, which means that it is possible to gain a good measure of fishing effort and catches at a reasonable cost. The questions in the questionnaire can be more precise and detailed. To gain a good overview of the proportion of recreational fishermen in the country, this method needs to be supplemented with random surveys of people who do not have recreational fishing licences. In Sweden, this method would not work at present as we do not have a licensing system for recreational fishermen. For some recreational fishing in Lake Vänern, people are required to label their gears with a registration number provided by the county administrative board. An opportunity to voluntarily submit catch information is linked with this. One option could be to test such voluntary recording of data as an option for working in combination with systematic inspection initiatives to estimate fishing effort using certain tackle and link this to collated catch logs submitted voluntarily.
4. **"Captured" recreational fishermen are contacted regularly for a period.** The advantage is that it is easier to remember a month or two back in time compared with last year. In this way, it may also be possible to achieve good values for variations over the year, and perhaps for zero catches (i.e. fishing trips where no fish are caught) as well. The disadvantage is that this is a labour-intensive approach, and therefore it can only be used for a small number of recreational fishermen. Moreover, this method is labour-intensive in that the same people have to be contacted on multiple occasions, and with a certain degree of regularity.
5. **"Captured" recreational fishermen are contacted for more details**. In a general survey (as described in 1 or 2), it is possible to ask whether respondents want to provide more detailed information.

Anyone who agrees may be contacted at different times of the year, which would provide approximately the same information as in (4). The disadvantage is that this requires quite a lot of effort, and that it may be difficult to persuade people to assist with this.

6. **Recreational fishermen keep voluntary logbooks**. The advantage is that this can provide a good measure of catches by species/area/season/year, as well as a good measure of the effort and mobility of recreational fishermen. The difficulty is in persuading enough people to assist and regularly record their catches. This can be counteracted in part by means of personal feedback and/or some form of reward system. It may also be difficult to acquire information on zero catches. This method needs to take into account the fact that recreational fishermen who are willing to keep a voluntary logbook are probably not representative of general fishermen as regards fishing patterns and catches. Web-based catch recording systems linked with social media are currently being developed in a number of respects.
7. **Voluntary logbooks, fishing guides, tour boats, etc.**. The advantages and disadvantages are the same as for (6). In our opinion, it may be just as difficult to persuade this category of people to record catches on a voluntary basis in the long term.
8. **Mandatory logbooks, recreational fishermen**. A system of this kind would result in detailed, very valuable information which could definitely be used to provide biological data for fisheries management. It would also provide a very good overview of the spatial and temporal scope of recreational fishing. The disadvantage is that it would be difficult to administer, it would demand extensive resources as there is a "risk" of receiving responses from at least a million recreational fishermen, and there is also a risk of receiving non-reliable responses from people who do not appreciate the system. Furthermore, a very large number of people will probably not have the stamina to submit details. The practical and political difficulties with getting the whole thing off the ground are another obvious disadvantage. We are of the opinion that this methodology would not be possible as things stand at present.
9. **Mandatory logbooks, fishing guides, tour boats**. This could provide a valuable time series, a good measure of variation over the year and a good measure of fishing effort in areas involving active fishing tourism. A mandatory catch logbook/log is currently applicable to anyone carrying out commercial fishing pursuant to a fishing licence or personal fishing licence. Fishing tourism companies which have permission to use an extended number of cages when fishing for lobster, for example, have to report the amount of fishing they do, the use of tackle and their catches. It would have been easier if the same general obligation were to be introduced for people running fishing tourism companies who take recreational fishermen or others on fishing trips.
10. **Questionnaires to recreational fishing organisations**. Have approximately the same advantages as (3). However, this method requires in-depth cooperation with the recreational fishing organisations, which may involve a number of practical difficulties which must be resolved before getting started. The authorities' data requests may harmonise more or less effectively with the interests of the recreational fishing organisation (and their members), which will affect the willingness of members to participate. This method also requires the recreational fishing organisation to use its register of members, which may not be looked upon favourably by many members. This method needs to take into account the fact that members' fishing patterns and efficiency will probably not be representative of general fishermen.

11. **Questionnaires to guide boats, etc.** Provides approximately the same advantages as (6), but with less certain values for the different variables as respondents have to come up with figures for catches, etc.
12. **Surveys together with recreational fishing organisations**. May provide very good data for individual areas and/or species if the question interests the recreational fishing organisation (cf. 10).
13. **Interviews at harbours, moorings, etc**. The advantage is that this will provide a good overview of what was actually caught during the day. This method also makes it possible to achieve a good value for zero catches as well, which is usually a problem with various kinds of voluntary reporting. The disadvantage is that this method is extremely labour-intensive.
14. **Self-recording of catches**. Instead of using logbooks, attempts can be made to recruit people or fishing guides to record all catches for a short period of time (day, week or month). The advantage of using a shorter period of time is that people can be persuaded to record their catches in more detail (length, weight, photos, non-target species, etc.), as well as zero catches. This data can then be used to scale up the catches for other recreational fishing segments. The disadvantage is that it may be difficult to persuade people to take part, recording the information may be felt to take up so much time that it affects the time spent fishing, and as clients it may perhaps be necessary to provide measuring equipment, etc. This method needs to take into account that the fishing patterns and efficiency of the people recruited will probably not be representative of general fishermen.
15. **Visits to recreational fishing boats**. This method is best suited to tour boats or larger boats with several people fishing. This method provides a good snapshot of catches, effort and the people fishing. The disadvantage is that it can be perceived as an intrusion into private lives, and it is a costly method.
16. **Data from fishing competitions**. This method can provide good time series for catches per effort, if the same competition is monitored over a number of years. As these competitions often take place in the same area for a number of years, they provide good values in terms of variations over time, good effort data and, possibly, good non-target species data as well. The disadvantage is that it may require staffs out in the field who deal with much of the data collection; the people fishing want to fish (they are competing, after all) and not measure species that are not included in the competition.
17. **Inventories of nets, buoys, boats, etc**. This method may provide good information about variations over the year, good effort values, and good information on the scope of various locations. The disadvantage is that it is labour-intensive, although it may be possible to involve fishing inspectors in certain inventories. Another disadvantage is that there is no information on how much is caught, or on which species are caught. Thus the inventories need to be supplemented with interviews, questionnaires or volunteers to keep logs.

Table 14. *Different types of methods that can be used to survey recreational fishing and their advantages and disadvantages*

	Advantages		Disadvantages								
Method	Provides a good overview	Provides good catch data	Proportion of recr. fishermen difficult to assess	Skewed selection in rel. to total fishing	Low response frequency	Skewed response frequency	Extended time period ("telescoping")	Bad days forgotten	Labour-intensive	Difficult to get enough data	Requires law change
Random telephone numbers	X					X	X	X			
Random questionnaires	X				X	X	X	X			
Licence lists		X	X						X		X
"Captured" recreational fishermen contacted regularly		X	X	X					X		
"Captured" recreational fishermen contacted for details		X	X				X	X			
Voluntary logbooks from recreational fishermen		X	X	X		X				X	
Voluntary logbooks, guide boats		X	X	X		X				X	
Mand. logbooks, recr. fishermen		X	X								X

Table 14. *Cont*.

	Advantages		Disadvantages								
Method	Provides a good overview	Provides good catch data	Proportion of recr. fishermen difficult to assess	Skewed selection in rel. to total fishing	Low response frequency	Skewed response frequency	Extended time period ("telescoping")	Bad days forgotten	Labour-intensive	Difficult to get enough data	Requires law change
Mand. logbooks, guide boats		X	X								X
Questionnaires to recreational fishing organisations		X	X	X			X	X			X
Questionnaires to guide boats		X	X	X			X	X			
Surveys in coop. with recreational fishing orgs.		X	X	X					X		
Interviews at harbours, etc.		X	X	X					X		
Self-recording of catches		X	X	X		X				X	
Visits to recreational fishing boats		X	X	X					X		
Data from fishing competitions		X	X	X		X					
Invent. of nets, buoys, etc.	X		X	X						X	

10.3 Data collection in Sweden concerning recreational fishing, concluded and in progress

Some work is currently being done on collecting recreational fishing data in Sweden, but this work is not coordinated. Different stakeholders have different requirements and preferences, which makes it difficult to achieve an overall view. The following types of survey are currently being carried out:

- **National survey:** This has been carried out with varying frequency since 1975 and is currently carried out by the Swedish Agency for Marine and Water Management and Statistics Sweden, working in cooperation. Data from this survey provides a good overview of fishing patterns and what species recreational fishermen in general prefer. However, the survey has insufficient geographical detail to allow more detailed analyses to be carried out. One advantage is that the survey has taken place over a number of years, which provides data for identifying changes in recreational fishing. The questions in the survey have varied slightly over the years, depending on which issues were considered most important to highlight prior to reviews of fishing legislation, for example. The methodology has also altered slightly in the 40 years since the survey began. In all, this means that comparisons become uncertain if attempts are made to achieve greater accuracy, and the results need to be processed in order to take into account changes in the methodology, for example. The recommendation is to continue with this type of survey in order to acquire a national overview, and also in order to acquire information for more detailed surveys and data for "upscaling" these. One advantage of the national survey is that with reinforced random selection for geographical areas, it can be combined with more detailed surveys within the same selected geographical areas. Another advantage is that the responses are processed by Statistics Sweden, which has plenty of experience of evaluating surveys of this kind. It would be desirable to harmonise the geographical detail in the survey with – for example – the division used within management.
- **Reporting in accordance with the EU Data Collection Framework (DCF):** According to the Data Collection Regulation DCF 2010/93/EU, member states must estimate the total weight of cod and salmon caught by recreational fishermen every quarter:

  <u>Atlantic cod.</u> Information on cod catches is collected via the national survey and reported for the Skagerrak, Kattegat and Baltic Sea. In addition, Öresund has been selected as the survey area for extended geographical studies which are limited to recreational fishing from tour boats. Studies began in 2011 by asking tour boat skippers to keep diaries. Follow-up studies have taken place in 2012 and 2013. The results indicate that recreational fishing using handheld tackle from tour boats in Öresund amounts to 17% (2011) – 27% (2013) of the total harvest in Öresund[24]. Previous studies have not included recreational fishing using passive gears or recreational fishing using handheld tackle from private boats. These will probably be included in future years. There is also much to indicate that studies will also be harmonised between Sweden and Denmark, which is a positive factor.

  <u>Atlantic salmon.</u> There is extensive recreational fishing for Baltic salmon in Sweden. In 2013, salmon caught by recreational fishermen amounted to 41% of the total catch, of which 61% was caught in

[24] Öresland, V. 2014. Internal Report SLU Aqua. ICES Meeting: Working Group on Recreational Fisheries Surveys (WGRFS)

the rivers, 25% in the sea and 14% along the coast. Recreational fishing in the rivers takes place using rods, traditional fishing with nets, seines, etc. and in the case of fishing for brood fish, along the coast using fixed tackle and trolling in the sea. In total, the proportion of salmon caught by recreational fishermen has increased over time. This increase is not due to larger catches by recreational fishermen, however, but is explained instead by smaller commercial catches. Recreational catches are estimated by means of a number of studies which are often adapted to suit the catch area and tackle type. Catch data is collected each year from river fishing, but the collection methodology and quality of the collected data may vary both between and within rivers. For example, many rivers are organised into one or more fish conservation areas, and from some areas catch details are based on uncertain estimates carried out by local contacts, while information from other fish conservation areas comes from efficient reporting systems. Surveys are also carried out for some rivers, while for other rivers voluntary catch reports are downloaded from the Internet. To summarise, the total catches for most rivers are an aggregate of information from a number of different sources. Catches from the sea and coast, on the other hand, are based on studies carried out every four years. Catch statistics for trolling are collected by means of on-site surveys and online reports, while for coastal fishing catches are estimated by charting the amount of fixed tackle[25] [26]. The county administrative board and SLU Aqua are working on collecting and compiling catch data on behalf of the Swedish Agency for Marine and Water Management within the scope of the EU Data Collection Directive. The statistics will then be stored in Excel databases and used for SLU Aqua's biological advisory services and as data for the Swedish Agency for Marine and Water Management's decision on administration of Baltic salmon. The statistics will also be supplied each year to ICES, "Working Group of Baltic Salmon and Trout Assessment"[27]. ICES includes catch data in analyses of salmon stock status and department. As fishing-related mortality is a significant element of overall mortality for Baltic salmon, correct fishing statistics are important in order to avoid uncertainties/errors in stock analyses. Therefore, it is important to review and improve the collection of Swedish recreational fishing statistics with a view to improving the precision of ICES stock analyses.

- **County administrative board surveys**: The county administrative board is occasionally carry out their own surveys, but far too seldom do these reach outside their own counties. It would be desirable for these to be carried out in cooperation with the Swedish Agency for Marine and Water Management/SLU/a data host for recreational fishing-related data so that this work could be linked to the administration.
- **Individual surveys:** What used to be the National Board of Fisheries (and is now SLU Aqua) has carried out individual surveys in order to highlight specific species or areas. Just like the county administrative boards' own surveys, these are carried out with no purpose or intention as regards their use in a wider context. Here is a small selection of such surveys:
- **Estimation of net catches of trout along the coast of Northern Sweden**. The data used included: (i) counting of nets by fishing inspectors who were out in order to gain an overview of how many nets were set at various times of the year; (ii) catches from fixed fishing (commercial fishermen) in

25 Persson, J., Palm, S., Degerman, E. and Östergren, J. 2013. Underlag avseende fångst av lax i svenskt trollingfiske i Östersjön. Report by the Department of Aquatic Resources, Swedish University of Agricultural Sciences. 22 p.

26 Anon. 2011. Kartering av utsatta fasta redskap längs den svenska delen av Bottniska viken samt Stockholms län under 2011. Report by the Department of Aquatic Resources, Swedish University of Agricultural Sciences.17 p.

27 WGBAST. 2014. Report of the Baltic Salmon and Trout Assessment Working Group (WGBAST), 26 March – 2 April 2014, Aarhus, Denmark. ICES CM 2014/ACOM:08. 342 p

order to gain an overview of how frequently sea trout come close to the coast during various times of the year; and (iii) fish monitoring results from various parts of the coast. The results indicated that between around 214,000 and 489,000 sea trout per year are caught in nets along the coast of Northern Sweden. The results are published in the report series Finfo[28].

- **Three fishing trips**. SLU Aqua sent out questionnaires to angling shops and fishing clubs in which recreational fishermen were asked to write down the results of three fishing trips. It was pointed out specifically that they would also include fishing trips without catches, and it turned out that approximately 25% of all fishing trips caught no fish. The results are specified in a report which has not been published.
- **Questionnaire on protected areas**. A questionnaire sent out to fishery conservation area associations in which they were asked whether waters were protected from fishing, and if so for how much of the year. The results indicated that many associations protect areas for parts of the year. Protection of inflowing waterways is most common. Trout is the target species for this protection in most instances, and most associations indicate that the protection is positive. To date, these results have only been published in a report as part of the GAP project (Department of Aquatic Resources, SLU).
- **Recreational fishing in Lake Vättern**. This 2010 survey comprised two parts, a questionnaire and a field survey of fishing effort on Lake Vättern. A total of 3298 questionnaires were sent out, and 1531 people responded (46%). Of the respondents, 496 people had carried out recreational fishing in Lake Vättern in 2010, equivalent to one-third of respondents. The biggest changes which have taken place over the past 10 years are that char and signal crayfish have come to dominate recreational catches, while salmon catches have declined. Brown trout catches have increased significantly at the same time, while catches of grayling and perch have declined. Pike fishing has not changed to any great extent compared with 2003, but on the other hand catches and effort were slightly reduced in 2010 compared with 2000. Trolling and otter board catches are estimated to have amounted to around 32 tonnes of char in 2010, and so recreational fishing may have represented as much as 90% of the total harvest of char in 2010. It is estimated that around 30,000 char were put back during trolling and otter board fishing in Lake Vättern in 2010. Of these, around 26,000 were below the minimum size. Fish monitoring between 2005 and 2010 indicates positive stock development among char, even though recreational fishing has resulted in more landings. However, fish monitoring initiatives confirm at the same time that stocks are still relatively weak compared with their potential size. The advantage of this survey is that it used different types of data; questionnaire responses, commercial landings and field surveys. This provides a more detailed view of the fishing. The results were published in a report from Vättenvårdsförbundet[29].
- **Other stakeholders such as Sportfiskarna and local angling organisations also carry out individual surveys**.

[28] Petersson, E., Aho, T. and Asp, A. 2009. Fritidsfiskets nätfångster av öring i Bottenhavet och Bottenviken. Chapter in Fem studier av fritidsfiske 2002-2009, Finfo 2009:1.
29 Alenius, B. and Halldén, A. 2012. Fritidsfisket i Vättern 2010 - Sammanställning av enkätsvar och fältobservationer. Report no. 114 from Vätternvårdsförbundet

11 Effects of recreational fishing on the aquatic ecosystem

Fish stocks are important parts of the aquatic ecosystems. Fishing often represents regulatory functions and hence contributes important regulatory ecosystem services, in addition to the more obvious services; the provision of food and recreation[30].

The greatest focus in respect of effects from fishing-related activities has concentrated on the commercial sector. Widespread and intensive commercial fishing may lead to depletion of stocks or, in a worst-case scenario, overfishing to the point at which populations are unable to recover and the function of the entire ecosystem may fundamentally change, known as regime changes.

Although our knowledge of the effects of recreational fishing on aquatic systems has increased over the last few years, the ecosystem effects of recreational fishing have been studied to a relatively weak extent compared with commercial fishing[31]. Many people may find it difficult to accept that recreational fishing can affect stocks, as they often consider their own fishing without bearing in mind that a small effect from an individual fisherman may be very extensive overall when lots of fishermen affect the same stock. Fishery research's neglect of the effects of recreational fishing on the system is due mainly to the fact that no data with sufficient detail exists for estimating recreational fishing harvests to allow the effects of recreational fishing to be calculated. A further aspect of which it is necessary to be aware as regards recreational fishing harvests is that recreational fishing is the dominant utiliser of fish stocks in many coastal areas, lakes and waterways. For example, according to estimates recreational fishing represents 90-95% of the total harvest of perch, pike and pike-perch in the Swedish part of the Baltic Sea. Moreover, recreational fishing often takes place in areas where there is no commercial fishing[32]. Recreational fishing in general and angling in particular are often cited as being of less significance to fish stock status and development than commercial fishing. It is often stated that recreational fishing is self-regulating and that fishing pressure is reduced if the fish density (e.g. fish quality) declines[33], which is not necessarily true[34]. Significant technical development in the field of angling also means that the efficiency of fishing has increased considerably over the last few years.

11.1 Selectivity

Angling in particular is often selective in terms of species, sizes, age, sex or functional fish behaviours. Fishing focuses on specific species as they are of culinary value, provide more of a "sporty" challenge or otherwise interest anglers more than other species. In many countries, apex predators such as pike, pike-perch, salmon or cod are target species, while in other countries there is also extensive fishing for zooplanktivorous or benthivorous species such as bream, tench and common roach. However, in the

[30] Holmlund, CM and M Hammer, 1999. Ecosystem services generated by fish populations. Ecological Economics 29:253-268

[31] Cooke, S.J. & Cowx, I.G. 2004. The role of recreational fisheries in global fish crises. BioScience, 54: 857–859

[32] Cooke, S. J. and Cowx, I. G. 2006. Contrasting recreational and commercial fishing: searching for common issues to promote unified conservation of fisheries resources and aquatic environments. *Biol. Conserv.*, 128: 93–108.

[33] Hansen, M. J., Beard, T. D. and Hewett, S. W. 2000. Catch rates and catchability of walleyes in angling and spearing fisheries in Northern Wisconsin lakes. *N. Amer. J. Fish. Manage.*, 20: 109–118.

[34] Post, J. R., Sullivan, M., Cox, S., Lester, N. P., Walters, C. J., Parkinson, E. A., Paul, A. J., Jackson, L. and Shuter, B. J. 2002. Canada's recreational fisheries: the invisible collapse?. *Fisheries*, 27: 6–17.

majority of countries it is possible to perceive a general pattern whereby a species from the top of the food chain is subject to the greatest mortality from recreational fishing, probably because these species grow quickly and become biggest. Thus angling is often selective in terms of size and targets large fish which are often, but not always, older. Selection in terms of size is often a result of what is known as trophy fishing, but it is also a result of the introduction of minimum sizes as an administrative measure, which induces selective harvesting of the biggest/oldest fish[35].

Angling may also be selective in terms of sex as there are often differences in behaviour between the sexes[36]. Higher catches of females have been described for pike[37], carp and salmon[38]. For species where the male cares for the spawn, such as bass or pike-perch, males are particularly susceptible to angling as they are territorial and behave aggressively towards lures or bait in their vicinity[39]. Species or entire populations are often dealt with as a single unit without taking into account the fact that individual fish within a population have individual quirks. Individuals who have a higher preference for remaining close to the waterfront or individuals who are more active during hours of daylight may be subject to greater mortality if anglers themselves prefer fishing from land and during the day.

11.1.1 Consequences of selective harvesting

As fish size correlates with a number of reproduction characteristics, selective harvesting of large individuals may affect the reproductive capacity of an exploited stock even though there is increased compensatory growth among the individuals not subject to the same fishing pressure[40]. Older fish often have a higher egg hatch rate than fish spawning for the first time, which is explained by a number of different factors such as the size and quality of the eggs and spawning during the right time of the year (ideal temperature). For many of the species subject to particularly high fishing pressure, the size of the eggs is positively correlated to the size and age of the parents at maturity. This in turn results in higher survival rates for fry[41]. A female pike or cod weighing ten kilos, for example, is therefore worth much more than ten one-kilo females in terms of the number of offspring. The size of individuals is largely controlled genetically, and so many of the different fishing initiatives of today can be said to be operating a reverse breeding programme in the sea by systematically removing the fish carrying valuable genes for rapid growth. The risk of this is that once we have removed these genes from the stock, it will take a very long time to restore levels of individuals which grow quickly[42].

In particular in aquatic systems in which the strength of top-down control is higher than in terrestrial systems and the diversity of higher trophic levels is lower, removing a part of the population or trophic

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[35] Arlinghaus, R., T. Mehner, and I. G. Cowx. 2002. Reconciling traditional inland fisheries management and sustainability in industrialized countries, with emphasis on Europe. *Fish and Fisheries*, 3: 261–316

[36] Greenberg, L. A., and P. S. Giller. 2001. Individual variation in habitat use and growth of male and female brown trout. *Ecography*, 24: 212–224.

[37] Casselman, J. M. Sex ratios of northern pike, *Esox lucius* Linneaus. 1975. *Trans. Am. Fish. Soc.*, 104: 60–63

[38] Peréz, P., Izquierdo, J. I., De la Hoz, J. and Garcia-Vazquez, E. 2005. Female biased angling harvests of Atlantic salmon in Spain. *Fish. Res.*, 74: 127–133.

[39] Suski, C. D. and Philipp, D. P. 2004. Factors affecting the vulnerability to angling of nesting male largemouth and smallmouth bass. *Trans. Am. Fish. Soc.*, 133: 1100–1106.

[40] Walsh, M. R., Munch, S. B., Chiba, S., & Conover, D. O. 2006. Maladaptive changes in multiple traits caused by fishing: impediments to population recovery. Ecology letters, 9(2), 142-148.

[41] Trippel, E. A. 1998. Egg size and viability and seasonal offspring production of young Atlantic cod. *Trans. Am. Fish. Soc.*, 127: 339–359.

[42] Bergström U, Ask L, Degerman E, Svedäng H, Svenson A, Ulmestrand M 2007. Effekter av fredningsområden på fisk och kräftdjur i svenska vatten. FINFO 2007:2, 36 pp.

level may significantly alter trophic processes and community structures[43]. According to the theory of trophic cascades, the presence and species composition at peak predator level may affect lower trophic levels. Changes such as a reduction in the numbers of predatory fish or other focus species may thus have consequences for a range of trophic interactions which may affect the zooplankton community, algae propagation and nutrient cycles in marine and limnic systems, as has also been demonstrated for Swedish waters[44]. [45]

Photo: Erik Petersson

[43] Donald, D. B. and Anderson, R. S. 2003. Resistance of the prey-to-predator ratio to environmental gradients and to biomanipulations. *Ecology*, 84: 2387–2394.
[44] Casini, M, Blenckner, T, Möllmann, C, Gårdmark, A, Lindegren, M, Llope, M, Kornilovs, G, Plikshs, M & Stenseth, NC 2012, Predator transitory spillover induces trophic cascades in ecological sinks' National Academy of Sciences. Proceedings, vol 109, no. 21 pp. 8185-8189.
[45] Eriksson BK, Sieben K, Eklöf J, Ljunggren L, Olsson J, Casini M, Bergström U 2011. Effects of altered offshore food webs on coastal ecosystems emphasizes the need for cross-ecosystem management. Ambio 40:786-797

12 Proposal for a national plan

As we can see, there are various approaches when it comes to improving the supply of knowledge concerning recreational fishing in Sweden:

- To describe practitioners and their fishing. Who they are, where they come from, the legal basis for their fishing, the purpose of their fishing.
- To describe/quantify the harvest itself, i.e. recreational fishing in various geographical areas. *How extensive is it*? *What do people fish for, and when do they fish*? *How many fish are put back*? Etc.
- To use details in respect of catch per effort and size distribution in order to monitor stock development. This is primarily of interest for species and geographical areas for which we have no satisfactory stock monitoring at present.
- To understand the effect of recreational fishing harvesting and scope. *Stock development over time? Mortality aspects when putting fish back? Effect of various administrative measures? Etc.*
- A combination of 1-4.

In other words, points one and two would serve to increase the detail of the national surveys and supplement them with information about fishing not carried out by the Swedish population, i.e. by foreign fishing tourists. Being able to verify figures from large-scale surveys by means of initiatives in smaller areas would be the major gain. This fishing could then be better described and evaluated for assessment of ecosystem services and follow-up of regional environmental targets, for example. Actually knowing the size of a recreational fishing harvest is essential knowledge required to be able to implement effective administration measures and also to ensure that fishermen understand why the measures are being implemented. Commercial fishing harvests are often used and quota recommendations are based on these. If the recreational fishing harvest is unknown and extensive as well, there is a risk that the recommendations will be placed at the wrong level. In other words, it is possible to have a "hidden" harvest of fish which may have an adverse impact on stock status.

Point number three indicates the possibility of using recreational fishing data as a way of monitoring the status of stocks of target species. As recreational fishing involves species which often have local stocks and hence are difficult to monitor with good geographical coverage, this is an area offering plenty of potential for development. Moreover, recreational fishing often focuses on species for which we currently do not have such good data in respect of stock structure and development, such as pike and pike-perch in the Baltic Sea and lakes and lobster on the West coast.

Point number four serves quite simply to increase knowledge of how recreational fishing affects the aquatic ecosystem, and why. This knowledge can essentially be gleaned from any sources at all, or areas separate from one another, but it is possible to transfer knowledge between areas.

Point number five would involve studying the scope of recreational fishing within a well-defined area, but also the effects of this on the fish community. It would be advantageous to follow up on fishing over time and have some form of effective baseline in respect of the structure of the fish community in the area. If it is also possible to find areas which are representative of the fishing and the environment on a larger scale, it is conceivable that the results could be extrapolated and used to estimate harvests for considerably larger areas than just the study area itself.

12.1 Data collection

Data collection has to perform several different functions: (a) Provide an overview of what proportion of the population enjoys recreational fishing; (b) where they fish; (c) what the target species are; (d) the size of the catches; and (e) the extent of the fishing effort. A survey cannot answer all these questions; instead, different methods have to be combined.

- **National survey.** The survey used by the National Board of Fisheries/the Swedish Agency for Marine and Water Management and Statistics Sweden provides a good general overview of people who fish, where they fish and their target species. However, the estimate of the size of their catches is too uncertain to be used as a basis for biological models. Work on national surveys in their present form should continue at regular annual intervals. Reinforced selection within selected geographical areas can be used in combination with other methodology for geographical studies. A licensing system for recreational fishing in Sweden would mean considerably increased precision and greater geographical detail in the survey's estimates of recreational fishing scope and catches.
- **Voluntary or mandatory catch recording from owners of fishing tourism businesses**. This can be done in a number of different ways. It would be most appropriate to demand that people with guide boats or tour boats or running other guided tours should keep logbooks indicating when they are out, what they catch (including fish sizes), how long they are out and how many people fished. These businesses are often not run pursuant to private fishing rights, and so a requirement of this type should not be impossible to implement.
- **Voluntary or mandatory catch recording from individual recreational fishermen**. May take place via a web application, keeping a log on paper or targeted questionnaires. Earlier experience has been gained in all these variants, which indicates that this type of data collection can generate good data with a high level of spatial detail.
- **Coordinated catch recording from fishing competitions**. Insofar as fishing competitions are organised in public waters, the organisers should note the number of people fishing, the number of fish they catch and the volume of fish. Fishing competitions can be a good way of acquiring information for the species not covered by fish monitoring. This also includes inputting historical data.
- **Effort inventory within an area**. This can be carried out by means of aerial surveillance, inspection from boats or inspection from permanent buildings. Includes the counting of nets, buoys, the number of boats/fishermen, etc. There is a great opportunity to develop cooperation and methods for such data collection within the forms of cooperation developed by the county administrative board for fishing inspection. There are thousands of appointed fishing inspectors carrying out operational inspections in Sweden, alongside the coast guard service's inspection organisation and county administrative board staff. To generate useful data in respect of fish harvests, this type of survey needs to be combined with a study of actual catches, as well as ensuring how many of the people observed on a lake or along a section of coast were actually fishing for recreation purposes and not just there for other reasons.
- **Catch inventory per effort within an area**. Includes the collection of catch variables such as species, number, sizes and effort. These studies should take the form of field studies and should be aimed specifically at people who fish for recreation purposes. The target species and area must define how these detailed studies are carried out. This is an on-site inventory, and here it is possible to follow up actual catches, not just by asking for small number of people to submit information (see point 2-3).

- **Reference areas**. Fish monitoring should take place in areas experiencing high recreational fishing pressure and be compared with areas with or without low recreational fishing pressure. In these areas, good monitoring is required of the intensity of recreational fishing and its spatial and temporal scope.
- **Tagging studies.** These provide valuable information on population sizes and migratory patterns. They may also provide valuable information on mortality in the event of catching and recatching. This must be known if we are to be able to calculate total fishing mortality for a species.

12.2 Suggested areas and methods

To provide a better knowledge base and understanding of the scope of recreational fishing, we recommend that attempts be made to concentrate surveys on appropriate focus areas for which the results can be transferred to as wide a scale as possible. The idea is for a focus area to have such recreational fishing pressure and such an environment that it is possible to extrapolate the knowledge to similar areas within – we suggest – the same marine basin/lake by describing the nature of recreational fishing.

Table 15 and Figure 4 list and illustrate suggestions for focus areas within the respective sea or lake areas which are of particular interest for in-depth studies into aspects relating to recreational fishing. We also suggest specific locations within each marine basin or lake which can be used to study particular focus species. Three national focus areas with extended monitoring each year will be designated, while other areas can ideally be monitored on a rotation schedule; we suggest every three years.

Skagerrak and Kattegat: As most of the Bohuslän coast and the north part of the county of Halland experience high fishing pressure on the focus species of European lobster and edible crab, it is possible to define a focus area on the basis of practical aspects. Carrying out on-site visits during which an inventory of effort (number of pots/buoys/people fishing) is carried out, in combination with catch recording forms, will make it possible to estimate the size of the catches per effort. This information can then be scaled up. Along the west coast are local spawning stocks of fish such as cod, turbot and plaice on which no information is available via commercial fishing catches outside the coastal area. Älgöfjorden, which is designated as a focus area, is next to the 8-fjord area (some recreational fishing protection), and it is possible to study stock development for species such as sea trout, cod, turbot and plaice in and outside the protected area.

Öresund: Öresund is the local fishing area for the most densely populated region in the Nordic countries, and in comparison with surrounding sea areas it has rich fish stocks thanks to the ban on trawler fishing dating back to 1932. Recreational fishing is extensive compared with other fishing. A good supply of knowledge on recreational fishing in Öresund, with cod as the focus species, is of major value. However, it is conceivable that the methodology applied could serve several purposes, such as the recording of all catches, not just cod. The data could then be used to estimate harvests of most species. One disadvantage of this area is that the waters are shared with Denmark, and Danish recreational fishing in Öresund would also need to be monitored in order to obtain an overall view. The chances of using unilateral national administrative measures to protect and rebuild stocks are very limited.

Southern part of the Baltic Sea: Extensive fishing, particularly for pike, takes place in the county of Blekinge. We would be pleased to see more in-depth studies of the scope and influence of recreational fishing in the area around Torhamn. Torhamn is one of three national reference areas for coastal fishing on the east coast and has been monitored since 2002. More extensive recreational fishing statistics focusing on scope, effort and catches over the course of the whole year are particularly desirable. Fishing in the Blekinge archipelago resembles the fishing for pike in other places in the country experiencing high recreational fishing pressure. Studying the area more intensively could increase knowledge and transfer it to other reference areas which are studied less frequently. It is also desirable to study mortality aspects of recreational fishing. As far as we know, there are no national studies which have considered the effects of – for example – catch-and-release initiatives in natural environments over a long period. The idea is for Torhamn, or a focus area in the Stockholm archipelago (see below), to represent the areas in the Baltic Sea which experience a generally high level of recreational fishing pressure.

Baltic Proper: We suggest studies every three years in the county of Östergötland in order to study in particular the focus species pike-perch and pike, and to an extent trout as well. Recreational fishing pressure in Bråviken is known to be high, and this is also a relatively delimited and well-defined area. However, there are no time series from fish monitoring. Kvädöfjärden, with time series data dating back to 1989, is an adjacent area. Next to Kvädöfjärden is Licknevarpefjärden, where fishing has been banned since 1970. Other areas that would be of interest for following up with a certain degree of regularity, or as an alternative to focus areas with annual follow-up, are Asköfjärden, Gålö and/or Lagnö in the Stockholm archipelago. Gålö has an area in which fishing has been banned since 2009, and is an area with extensive fishing for pike-perch and pike. By studying the intensity of and catches from recreational fishing within an area in the county of Östergötland and an area in the county of Stockholm, together with the intensive study area in Blekinge (or vice versa, with intensive studies in Stockholm and less frequent studies in Blekinge) and scaling up the results by means of Statistics Sweden surveys (total effort) at national level, we believe that recreational fishing harvests can be described effectively for the areas in which fishing for pike and pike-perch is most intensive.

Gulf of Bothnia: In the Gulf of Bothnia, recreational fishing using passive gears is relatively widespread. We believe that Långvindsfjärden in the county of Gävleborg is suitable for the study of the scope of recreational fishing in a relatively sparsely populated county representative of large parts of the Gulf of Bothnia. Fishing here focuses mainly on common whitefish, trout and, to an extent, perch. There is a total protection area in the county, and common whitefish are protected throughout the county during their spawning season.

Bay of Bothnia: As for the Gulf of Bosnia, recreational fishing in the Bay of Bothnia centres on the focus species common whitefish, trout and, to an extent, perch. By following up the scope and development of recreational fishing in Kinnbäcksfjärden, near Piteå, we believe it will be possible to describe local recreational fishing patterns and then calculate catches per effort for most of the coastal strip of the Bay of Bothnia.

The great lakes: Recreational fishing is extensive in all five of the Swedish great lakes, and there is a need for data collection for all of these. There is a relatively large amount of background data for Vänern, Vättern and Mälaren. There are few fish monitoring initiatives in the two smallest lakes, Hjälmaren and Storsjön in Jämtland, and few targeted surveys have been carried out into recreational fishing.

We suggest targeted studies in the Great lakes using rotation schedules, as well as an intensive focus area in Lake Vättern. The North Vättern archipelago in particular would be an excellent area for studying recreational fishing for pike. This area is well known for its huge pike and attracts anglers from Sweden and other countries.

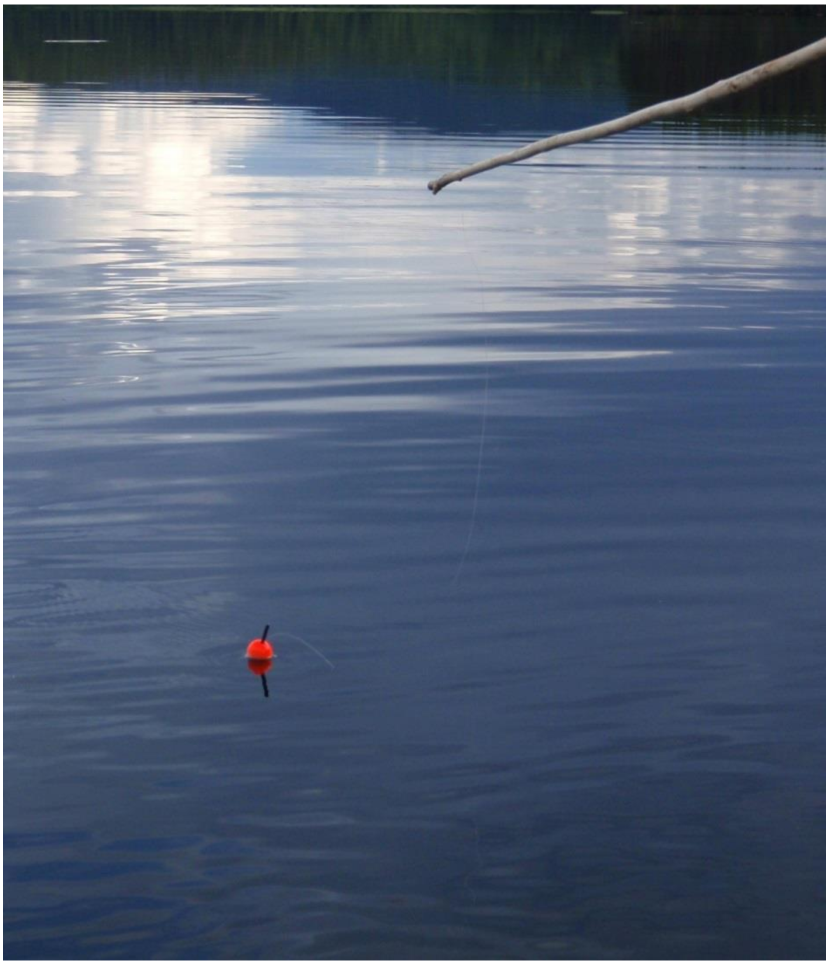


Photo: Marcus Bryntesson

Table 15. *Overview of the focus areas proposed as subjects for targeted surveys in respect of recreational fishing scope, etc. and the methods that should be used to collect data. The tagging studies should be long-term.*

						Data collection methods					
Area	**County**	**Focus species**	**Fish monitoring in the area**	**Focus area**	**Fish-free areas**	**Catch rec. (fishing tourism)**	**Catch rec. (individual recreational fishermen)**	**Fishing competition rec.**	**Invent., effort**	**Invent., catch per effort**	**Tagging studies**
West coast	V. Götaland	Lobster, Edible crab	Frequently	Älgöfjorden	Yes	Annually	Annually		Annually		
	Halland	Lobster, Edible crab	Frequently								
Öresund	Skåne	Atlantic cod	Rarely	Helsingborg		Annually	3 years	Annually	3 years		
S. Baltic Sea	Blekinge	Pike, Common whitefish, Trout	Frequently	Torhamn		Annually	Annually	Annually	Annually	Annually	Pike
	Kalmar	Pike, Pike-perch, Common whitefish, Trout	Frequently								
Baltic Proper	Östergötland	Pike, Pike-perch, Trout	Frequently	Bråviken/Kvädöfjärden	Yes	Annually	3 years		3 years		
	Stockholm	Pike, Pike-perch, Trout	Frequently	Asköfjärden/Lagnö	Yes	Annually	3 years	Annually	3 years		
	Uppsala	Pike, Pike-perch, Trout	Frequently								
Gulf of Bothnia	Gävleborg	Pike, Common whitefish, Trout	Frequently	Långvindsfjärden	Yes	Annually	3 years	Annually	3 years		
	Västernorrland	Pike, Common whitefish, Trout	Frequently								
Bay of Bothnia	Västerbotten	Pike, Common whitefish, Trout	Frequently								
	Norrbotten	Pike, Common whitefish, Trout	Frequently	Kinnbäcksfjärden		Annually	3 years	Annually	3 years		
Great lakes	Vänern	Pike, Pike-perch, Salmon, Trout	Regularly	Vänern	Yes	Annually	3 years	Annually	3 years		Salmon/ brown trout
	Vättern	Pike, Salmon, Char, Crayfish, Trout	Regularly	Vättern	Yes	Annually	Annually	Annually	Annually	Annually	Pike
	Mälaren	Pike, Pike-perch, Perch	Regularly	Mälaren		Annually	3 years	Annually	3 years		
	Hjälmaren	Pike-perch, Crayfish, Perch	Rarely	Hjälmaren		Annually	3 years	Annually	3 years		
	Storsjön	Char, Trout	Rarely	Storsjön		Annually	3 years	Annually	3 years		

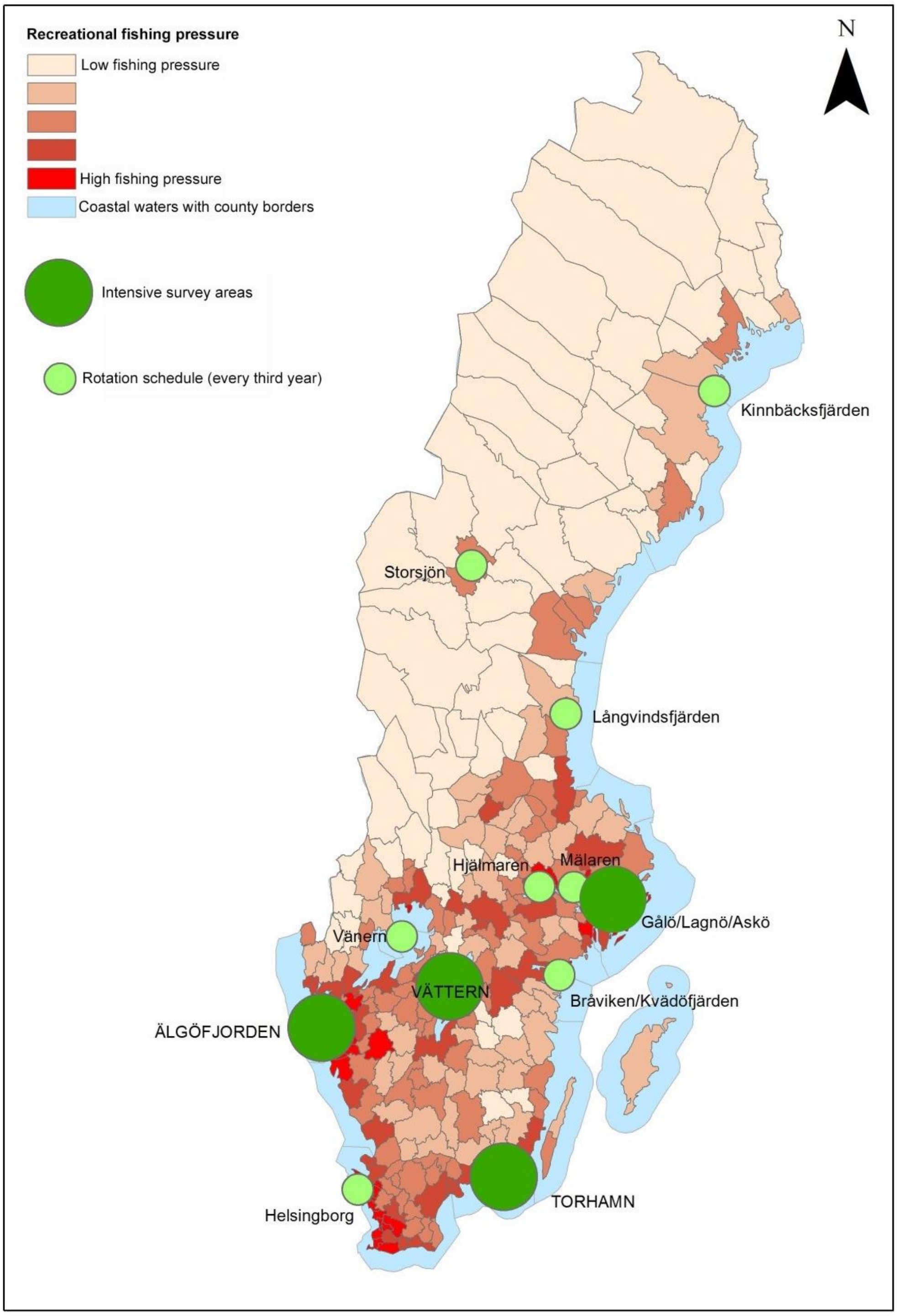


Fig. 4. This map shows the focus areas suggested for intensified data collection in respect of recreational fishing. The intention is then to use data from these areas to carry out estimates for the entire country. More information can be found in the text and in Table 15.

13 Data hosting

13.1 Data collection

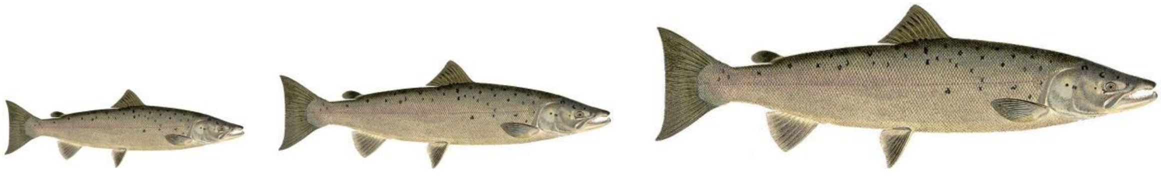
The most important thing is to harmonise data collection and data storage for information from different sources; recreational fishing, commercial fishing and Statistics Sweden surveys. It must be possible to link various sources (databases) so that good analyses of various kinds can be carried out in future, such as stock analyses which include recreational fishing catches in the models.

13.2 Data storage.

Data must be available to administrative officers at the Swedish Agency for Marine and Water Management and researchers at SLU. Whether the general public and external researchers are to have access to this data should also be discussed. A shared data portal linking data from various databases is conceivable. Data must be quality-assured, and its storage must be secure. If recreational fishing data is to have a good effect, DCF (ICES) data, hydroacoustic data, etc. should also be reviewed.

13.3 Data hosting

The Swedish Agency for Marine and Water Management is responsible for commercial fishing data at present, while SLU is the data host for fish monitoring data. A number of the fish monitoring databases which exist at present are owned by the Swedish Agency for Marine and Water Management, but data hosting rests with SLU. A similar system for recreational fishing data is conceivable, or else the Swedish Agency for Marine and Water Management could manage the data in its entirety.



14 Appendix: Quick guide for assessment of the value of data for catches and effort from external recreational fishing reporters.

Many stakeholders gather data at their own discretion, and both the Swedish Agency for Marine and Water Management and SLU receive enquiries about whether we would want this data. This data often extends a long way back in time, and such time series are always handy to view in relation to fish monitoring and commercial fishing data.

Unfortunately, not all data can be used if it is to be applicable to the models and/or analyses outlined above. Good data relating to catches, catch areas and effort is required. If data is detailed in one respect and poor in another, the data is difficult to use.

Table 16 outlines an assessment of how data should be assessed to identify whether it can be used. To be usable, data needs to receive a classification of 3 or higher in all respects. A single 2 can be accepted, but a single 1 will disqualify the entire dataset.

Photo: Martin Karlsson

Table 16. *Quick guide for evaluation of external recreational fishing data*

			Data evaluation: 1. Cannot be used	2	3	4	5. Good data	Comments
Location	Position indicated with coordinates						X	
	Lake specified	Lake name only			X			The name alone may suffice for smaller lakes (<10 ha)
		Area in lake (inlet, north/south etc.)				X		
	Coastal section specified	Within 1 km					X	
		Within 2 km				X		
		Within 5 km			X			
		Within 10 km			X			
		Within 50 km		X				
		Within 100 km		X				
		Within >100 km	X					
	Sea area specified	Direction and distance, landmark				X		
		ICES box			X			
		>ICES box	X					

NB: Data cannot be used unless the location is specified with sufficient precision

			Data evaluation: 1. Cannot be used	2	3	4	5. Good data	Comments
Effort	Handheld tackle	If number of people specified					X	
		If number of people not specified		X				
	Time for which fishing with handheld tackle took place	Number of hours					X	
		Number of days			X			It is possible to use existing knowledge to calculate how long the average fishing day is
	Number of cages						X	
	Number of nets (mesh not specified)				X			
	Number of nets (mesh specified)						X	
	Number of items of tackle (fish traps, etc.)					X		
	Resetting frequencey, nets and other fixed tackle	Resetting < 3rd day				X		
		3rd day < Resetting < 6th day			X			
		Resetting every > 3rd day		X				

Both the number of people fishing (handheld tackle) and the number of items of tackle (volume catching) must be spec
Data cannot be used unless the effort is specified with sufficient precision

			Data evaluation: 1. Cannot be used	2	3	4	5. Good data	Comments
Catch	By species	Number of individuals				X		
		Total weight			X			
		Weight of each individual					X	
	One species only (even if there are multiple species in the water)	Number of individuals			X			
		Total weight		X				
		Weight of each individual				X		
	Not divided by species	Number of individuals	X					Applicable to waters with more than one species. If single-species waters - see above
		Total weight	X					
		Weight of each individual	X					

Even if the effort and location are specified with sufficient precision, data cannot be used unless the catch is specified with sufficient precision