



Fisheries management in the Curonian Lagoon

Tomas Zolubas¹, Antanas Kontautas¹ & Sergey Shibaev²

¹Klaipeda University, Lithuania,

²Kaliningrad State Technical University, Russian Federation

Abstract

The fisheries sector is an integral part of the Baltic Sea coastal regions and their economies. The fishery sector is traditionally important in terms of employment, social life and regional identity. But not all fish stocks are fished within their natural limits. The management of Baltic Sea stocks must be improved and alternatives such as aquaculture, restocking and stock enhancement should be taken into consideration. Stocking measures for recreational fisheries is one of the ways to attract tourists and help revitalize the fishery sector. Integrating aquaculture and fisheries management should improve a sustainable regional development in the Baltic Sea region. Area-based-management for fisheries aims to conserve and rebuild fish (and mussel) stocks within their natural borders through development of a regionalized regulatory structure that takes into account local biological and economic factors.

The focus of the case study is to find and to understand the linkage between fishery and aquaculture in the Lithuanian-Russian cross-border area – the Curonian Lagoon.

1 Introduction

1.1 Curonian Lagoon

The Curonian Lagoon is a shallow semi-enclosed and almost freshwater body which is located on the southeastern rim of the Baltic Sea. It is the largest Baltic Sea lagoon. The Curonian Lagoon is separated from the Baltic Sea by a narrow (0.5-4 km) sandy spit (Galkus & Jokšas 1997) having the surface area of 1,584 km² (Chervinskis 1959). Its basin area is 100,500 km². Total volume of water of the lagoon is approximately 6.2 km³. The lagoon is rather shallow - its average depth is only 3.8 m, maximum depth is 5 m. Isobaths of 3 m circumscribe more than 2/3 of the lagoon (Rainys 1978). The Nemunas river provides the main water inflow into the Curonian Lagoon, which discharges to the Baltic Sea. The Nemunas river brings 98 % of the total freshwater runoff (23 km³) and enters the lagoon in its central area, dividing the water body into different hydrological zones (Jurevičius 1959; Razinkovas et al. 2005). The Nemunas river delta with a maze of river branches, canals, polders and wetlands is protected as a wetland of international importance under the Ramsar convention and as a regional park. The Nemunas delta is important for migrating and breeding fish.

The Curonian Lagoon is a complex ecosystem with many interacting processes. It is an open system, influenced by the exchange of freshwater from the Nemunas and other smaller rivers and saline water of the Baltic Sea. Water salinity in the northern part of the lagoon may fluctuate between 0.1-7 PSU and representatives of marine, brackish and freshwater species live there. The lagoon itself is predominantly freshwater due to the discharge from the Nemunas and other smaller rivers. However, depending on wind direction, affecting brackish water inflow from the Baltic Sea, the salinity in the central and northern parts may episodically increase up to 5-6 PSU (Dailidienė & Davulienė 2007). Brackish water intrusions are most common during August to October when 70 % of the total annual input occurs (Pustelnikovas 1994).

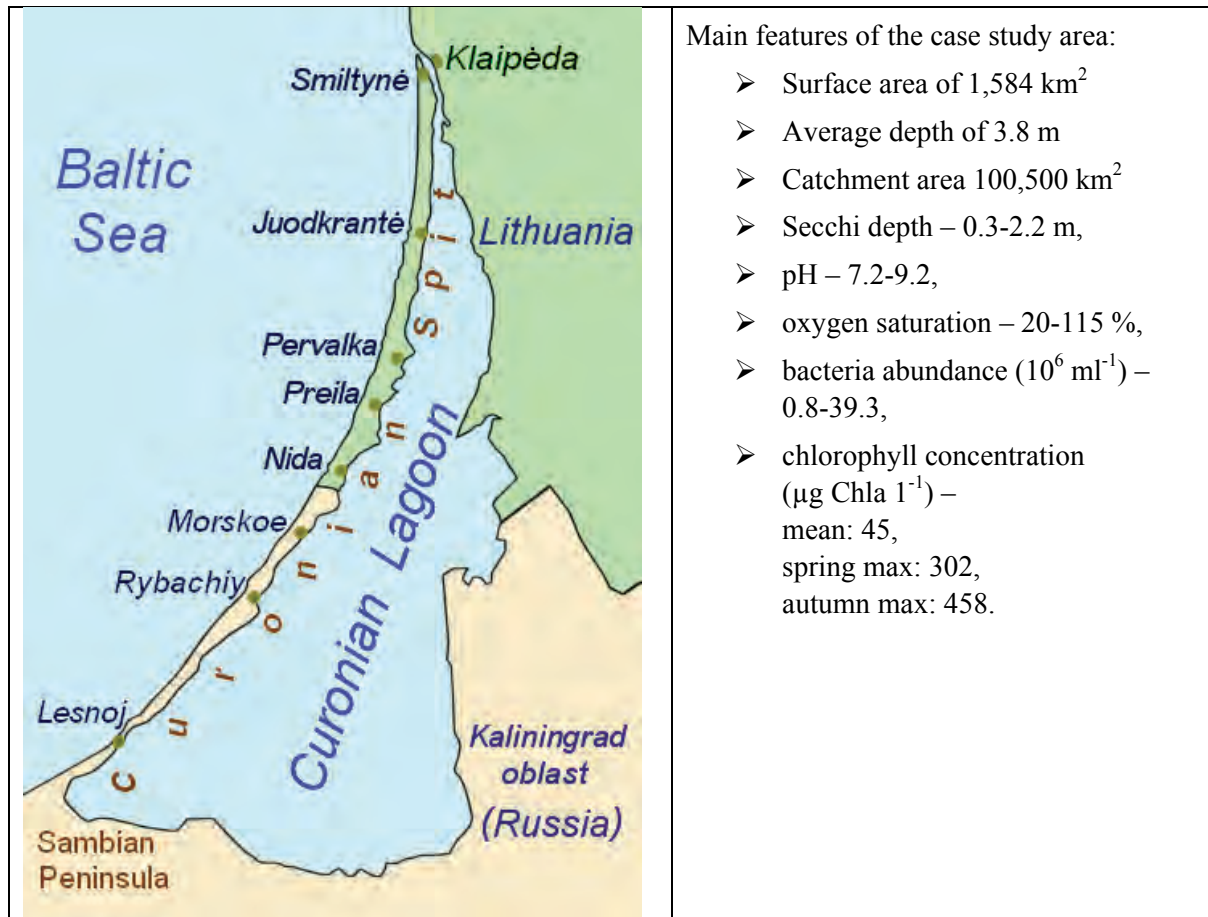


Figure 1: Main features of the case study area

A very small depth, active water dynamics and intensive sedimentation in the lagoon considerably affect the sediment distribution patterns and their changes over time. The dominant bottom substrates are sand, silt, and shell deposits. Mud only prevails in the southern part of the Curonian Lagoon, i.e. in the zone of intensive sedimentation (Trimonis *et al.* 2003). Due to the high substrate variability and the high freshwater input from the Nemunas River, the Curonian Lagoon belongs to one of the most macrozoobenthos diverse estuarine areas of the Baltic Sea (e.g. in comparison with Vistula Lagoon, Szczecin Lagoon, Boddens of Darß- Zingst) (Zettler & Daunys 2007 and references therein). The recent macrofauna inventory compiled for the littoral zone of the lagoon includes approximately 280 benthic species (Zettler & Daunys 2007). Salinity is the main factor determining benthic species distribution in the Curonian Lagoon (Daunys 2001). Benthic fauna in the strait area is a mixture of freshwater and euryhaline organisms, with a total of 49 benthic and nektobenthic species identified (Bubinas & Vaitonis 2003). The lagoon has been heavily polluted from a combination of shipping, military and industrial sources.

Due to pollution, overfishing, dam building and natural changes of the lagoon ecosystem during the last 100 years some fish species populations were violated and lost their role in fishing industry. For example, the catch of white-fish has declined from 100 t in 1934 down to zero, vimba from 265 in 1960 down to 3 t in 1994, eel from 482 t in 1966 down to 0.1 t, pike from 190 t in 1960 down to 10 t.

1.2 Description of the cross-border area

Two countries share the Curonian Lagoon: the Lithuanian Republic and the Russian Federation. The border between the two countries divides the lagoon into a smaller, northern part, in Lithuania (413 km²) and a bigger, southern part, in Russia (1,171 km²). The Curonian Lagoon siding Lithuania

occupies 413 km², an additional area of similar size can be flooded in the lower reaches of Nemunas river during spring.

Historically the Curonian Lagoon is divided into 3 parts:

- the northern part - transitory: where hydrodynamic is more active (corresponding to low residence times), due to sea-lagoon water exchange and to the river runoff (belongs to Lithuania),
- the middle part (Vidmarės) - intermediate: between transitory and stagnant (belongs to Lithuania and Russia),
- the southern part (Būduma) - stagnant or limnic: characterized by fine sediment and poor water renewal (belongs to Russia).

In the Republic of Lithuania and the Russian Federation Kaliningrad Oblast the Curonian Lagoon waters are of high fish productivity. Fishing of Lithuanian fishermen on the Russian side and Russian fishermen on the Lithuanian side is not allowed according to the law since the mid 1990s.

2 Fishery

2.1 Ecological aspects

The large water body, peculiar geological structure and geographical location of the Curonian Lagoon result in a large and multiple freshwater ichthyofauna complex, and a permanent or temporary habitat for migratory and marine fish species. As many as 58 fish species have been registered in the Curonian Lagoon, among them very rare species included in the Lithuanian and Russian Red Lists and protected, as well as fish species of importance for commercial fishery (Table 1).

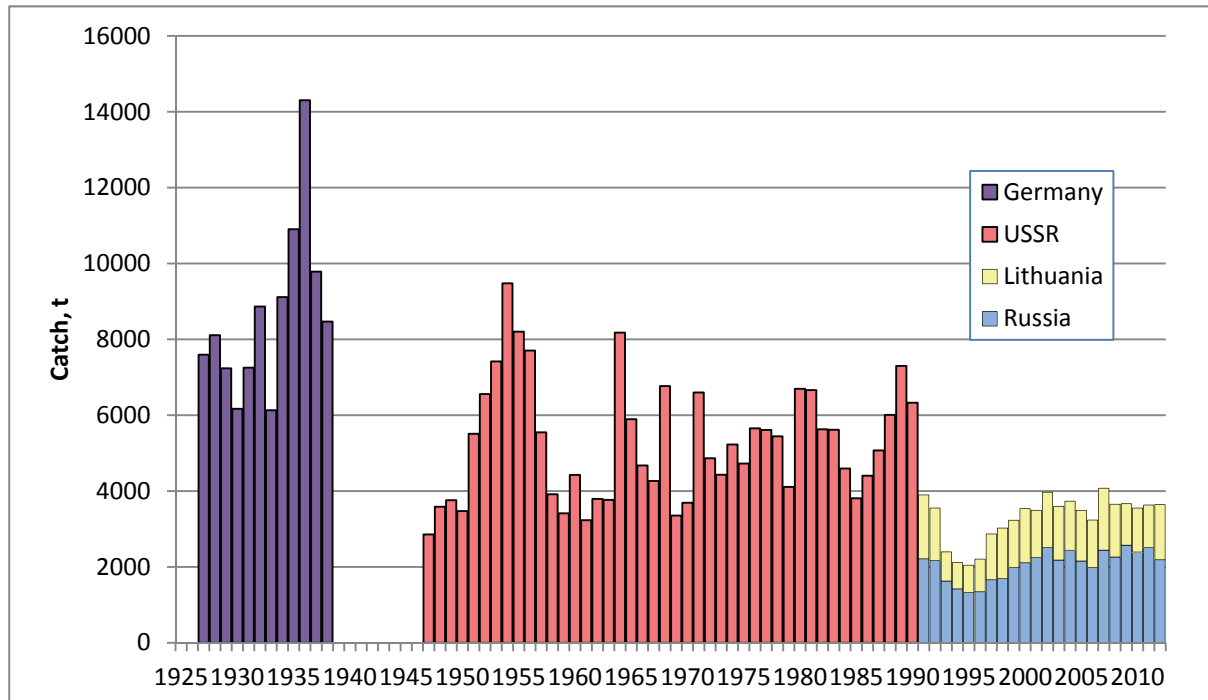


Figure 2: Dynamics of total catch of main species in the Curonian Lagoon.

The water body is fertilized by mineral and organic materials from the Nemunas river basin, therefore it typically has a huge abundance of zooplankton and zoobenthos – fish food organisms. In the Republic of Lithuania and the Russian Federation Kaliningrad Oblast frontier the Curonian Lagoon

waters are of high fish productivity. During pre-war years, in 1927-1938, when the average total catch was 51,6 kg/ha, the population part of short-cycle types – smelt, ruff, perch and roach – made even 92 %. While the catch of whitefish, pike, bream, sander and eel is only 4 %. In recent years fishing in the Curonian Lagoon has been quite intense. In current years the catches of Lithuanian fishermen in the Curonian Lagoon and the Lower Nemunas are 1.1-1.5 thousand t of various fish species, Kaliningrad fishermen catches are even greater (2.0-2.5 thousand t). 15-20 years ago in the Lithuanian part of the Curonian Lagoon commercial catches of fishes reached about 2 thousand t. The total catch in the Lithuanian part of the lagoon was 955 t, and in the Russian part 2,902 t in 2012. Since 1927 the maximum commercial catch of 14.3 thousand t was reached in 1936 and the minimum in 1995 – 2.0 thousand t. The long term average catch is about 5.2 thousand t (Figure 2). At present catches are in the stable low level.

Table 1: The most important species for fisheries are the following:

For Lithuanian fishermen	For Russian fishermen
<i>Sander lucioperca</i> (Linnaeus, 1758) – pikeperch;	<i>Sander lucioperca</i> (Linnaeus, 1758) – pikeperch;
<i>Abramis brama</i> (Linnaeus, 1758) – bream;	<i>Abramis brama</i> (Linnaeus, 1758) – bream;
<i>Rutilus rutilus</i> (Linnaeus, 1758) – roach;	<i>Rutilus rutilus</i> (Linnaeus, 1758) – roach;
<i>Vimba vimba</i> (Linnaeus, 1758) – vimba bream;	<i>Pelecus cultratus</i> (Linnaeus, 1758) – sabrefish;
<i>Osmerus eperlanus</i> (Linnaeus, 1758) – smelt;	<i>Osmerus eperlanus</i> (Linnaeus, 1758) – smelt;
<i>Perca fluviatilis</i> (Linnaeus, 1758) – perch.	<i>Perca fluviatilis</i> (Linnaeus, 1758) – perch.

Fish catches composition is provided in Figure 3, dynamics of the main fish species catches is provided in Figure 4 for both Lithuanian and Russian parts of the Curonian Lagoon.

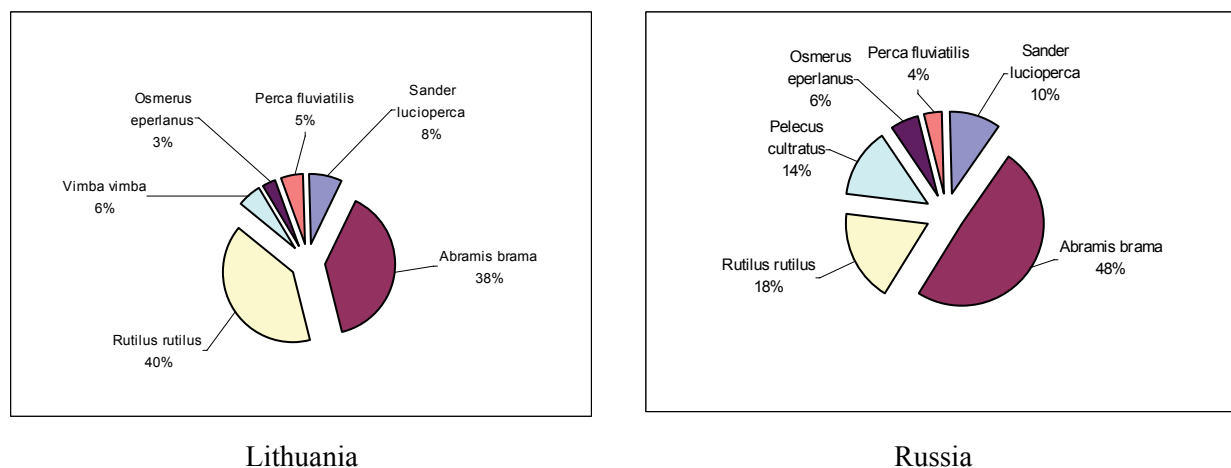


Figure 3: Fish species composition of commercial catches in the Curonian Lagoon.

The Curonian Lagoon fish community structure shows remarkable seasonal changes, associated with migrations of diadromous fish and lampreys and seasonal freshwater fish migrations to the sea (Ložys 2003). Fishes also migrate inside the Lagoon between the southern and the northern parts. The Curonian Lagoon, as other similar type estuaries, is very important not only as a feeding place for many freshwater or diadromous fishes, but also as a spawning and juveniles schooling habitat. Diadromous fishes migrate across the Lithuanian Curonian Lagoon part to spawn in the Nemunas river

basin. The Nemunas river delta is the most important spawning place for fishes in the Curonian Lagoon. It is one of the most productive water areas in Europe. In recent decades its commercial production was 36-40 kg/ha. Fishermen catch consists of about 20 commercial fish species. 60 % of catches consists of roaches and breams, 20 % of smelts and ruffs, and 20 % of other species, mostly pikeperch, perch and stickleback. At present about 70-80 % of the community consist of non-predatory fishes, while predators and migratory fishes comprise 10-15 % each. Though, recently the Curonian Lagoon fish resources are being exploited intensively, bigger changes neither in commercial, nor in experimental catch structure are noticed. Commercial catch structure changes could become possible only after constant stocking with valuable fish juveniles.

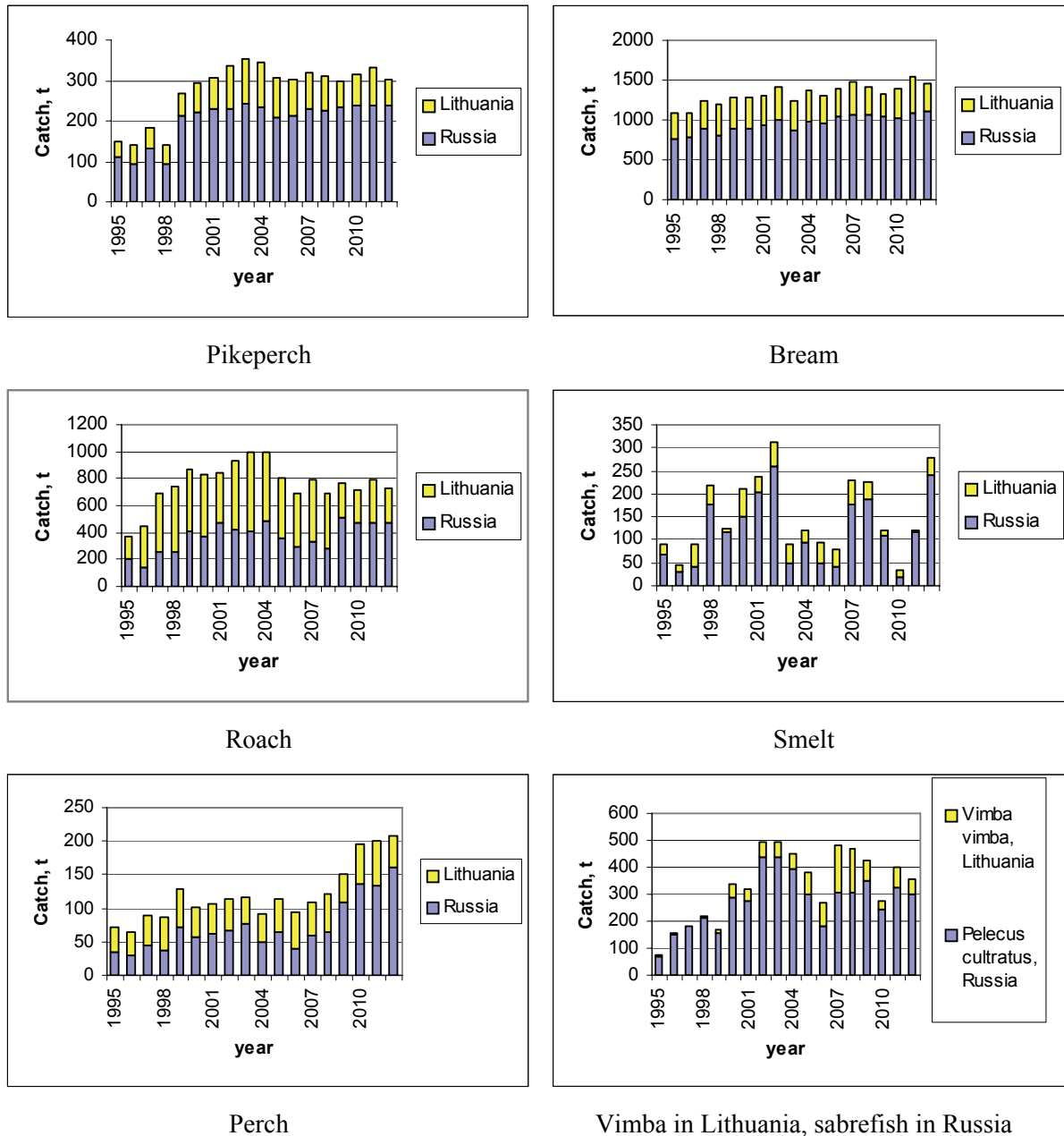


Figure 4: Dynamics of catches of main fish species in the Curonian Lagoon.

Recreational fishery

Long periods of prohibition of net fishing in spring and summer leave fishermen without work and income for long months, which is the period of high demand for recreational fisheries generated by 0.5 million Lithuanian anglers and holiday-makers. Without doubt, people should be able to use their skills and knowledge about fish until they find a new source of income. Such opportunity would be feasible if part of the fishermen could become specialists of recreational fisheries. Know-how of recreational fisheries and basic information about fisheries tourism should be relevant to businessmen of the fisheries sector who plan to pursue their operations. At least 80,000–100,000 amateur anglers may fish in the Curonian Lagoon and the lower Nemunas river every year, while the number may double during the cold winter suitable for fishing of smelt and perch. The intensification of amateur-recreational fisheries could have a negative effect on the catch and resources of predator fish species: pike, burbot, sheatfish, perch and pikeperch – in the coastal region because currently many anglers specialize on predatory fish. Therefore, the intensity of the angling mostly affects the numbers of predatory fish in the Curonian Lagoon and the lower Nemunas river. Recreational fishing business may be an alternative to earn money for fishermen, who withdraw from the commercial fishery.

On the Russian part of the Curonian Lagoon the most popular fish species for anglers are perch, roach, smelt, bream and pikeperch. The number of anglers coming to the lagoon depends on season: on wintertime weekends it can reach a few thousand per day. There is no daily limit of catch per person. Sometimes one angler can catch more than 100 kg of perch, but the average catch is about 0.5-2 kg.

2.2 Economic aspects

Fishery in the Curonian Lagoon is mostly a family business. The manual work dominates. In the same company very often people from the same family work. Resorts situated in the Curonian Spit are the main income resource in the summer time, because then smoked fish have the biggest demand and price. The majority of fishing boats are old, built 20 years ago. The Lithuanian fishermen catches during the period of 2000-2012 fluctuated between 1,000-1,400 t, Russian fishermen catches between 2,000-2,900 t. About 150 fishermen fish in the Lithuanian part and 200 fishermen in the Russian part of the Curonian Lagoon. From 2009 till 2012 the number of Lithuanian fishing companies decreased from 71 to 44. The main reason for the decrease in the number of fishing companies is that in 2009-2012 Lithuanian fishing companies used European Fisheries financial compensations for reorienting from commercial fishing businesses to recreational leisure fishing businesses. 21 fishing companies got financial support and 81 vessels withdrew from the fishing business. 6 fishing companies merged with others. On the Russian side quotas have been distributed to each company based on a historical approach for the period of 10 years. Due to this no big changes in the number of fishing companies and fishermen is possible and 36 fishing enterprises operated in the lagoon in 2012.

2.3 Fishing gears and areas

Fishing sites in the Curonian Lagoon

There are 31 fishing sites in the Lithuanian part of the Curonian Lagoon (Figure 5). Lithuanian fisherman must fish only in the sites, which are stated in the fishing license.

The most important sites for fishermen are:

- close to the Lithuanian-Russian border,
- along the Curonian spit,
- around the mouth of the river Nemunas (sites are mostly important during fish migration periods).

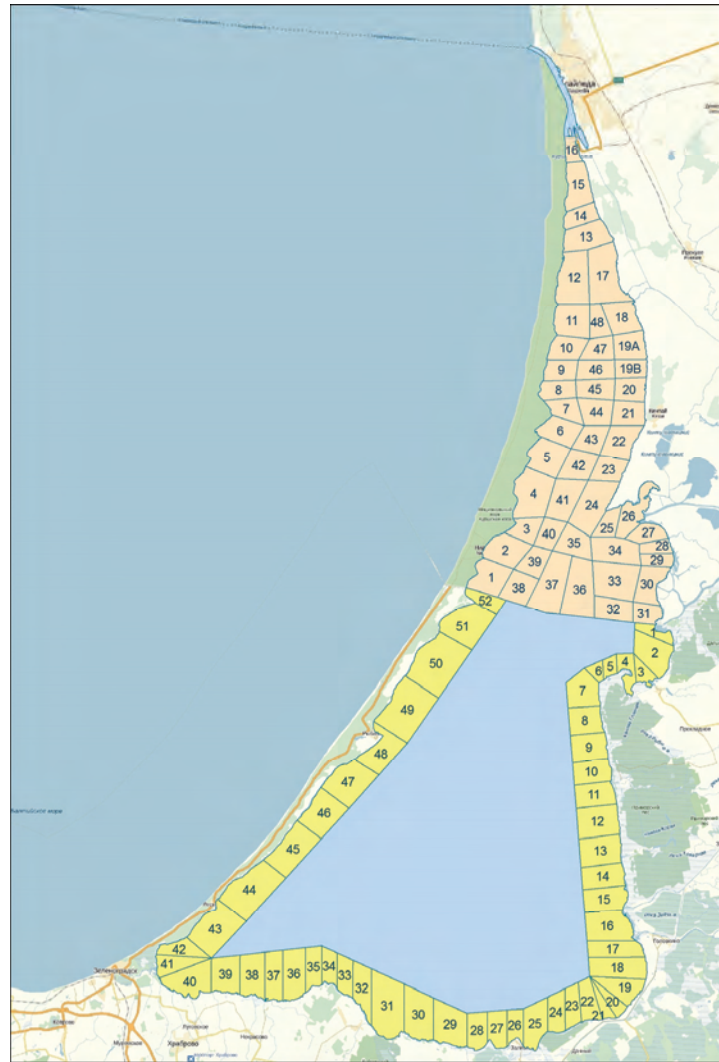


Figure 5: Fishing sites in the Lithuanian and Russian parts of the Curonian Lagoon.

There are 52 fishing sites on the Russian part of the Curonian Lagoon (Figure 5). They are remains from the Soviet period, but the status of the sites has not been clearly defined, yet. Most of them are distributed to the former Fishing Collective Farm, despite its decreasing role in the fisheries.

The mentioned fishing sites on the coast traditionally belong to the only Fishing Collective Farm. The other 36 fishing companies have no access to those sites. This fact causes some conflicts with new fishing companies.

Fishing gears

Fishermen of both countries use almost the same fishing gear types: gillnets (two types: 40-45 mm mesh size gillnets, 70-80 mm mesh size gillnets), trap-nets (five types: eel trap-net (some of them with special selective insert for juveniles bycatch decrease), smelt trap-net, lamprey trap-net, stickleback-ruffed trap-net, big mesh size trap-net), seines, long lines, drift nets. Selection of fishing gear in the Curonian Lagoon depends on the target fish species. There are four main gears, which are used in specific times and areas:

1. **70-80 mm mesh size gillnets** are used to catch bream and pikeperch in different places of the lagoon in the period from July till April;
2. **40-45 mm mesh size gillnets** are used to catch roach, perch, vimba and sabrefish. To target the latter species the net is not staked on the bottom, but in midwater position.

3. **trap-nets** (five types: eel trap-net (some of them have a selective insert), smelt trap-net, lamprey trap-net, stickleback-ruffe trap-net, big mesh size trap-net). Each trap-net differs from other types by a distinct trap-net construction and special mesh sizes in the wings and in the bags. Target species and adequate mesh size gives the fishing gear its name.
4. **seines** are used to catch smelt in spring during its spawning migration from the Baltic sea into the Curonian Lagoon and the river Nemunas (Figure 6).



Figure 6: Smelt is caught by a towed seine at night and landed (photos: Pavel Baranovski).

2.4. Restriction of fisheries

Different fishing ban periods and restricted areas are established for different fishing gears. The aim of restrictions is to guarantee free fish migrations and successful spawning. In some periods, fishing activities are restricted for all fishing gear types. Every fishing gear type has its own restriction period and/or area.

Restricted areas in the Curonian Lagoon

All year around fishing activity is prohibited in almost all Nemunas delta regional park waters, Kniapo bay; 14, 15, 16 fishing sites (Figure 5), Klaipėda Strait (Lithuania), the mouth of the river Nemunas and adjacent areas, the mouths of some important rivers for fish spawning (Russia).

Restricted periods and gear in the Lithuanian part of the Curonian Lagoon:

1. from 20th of April until 31st of August, 40-45 mm mesh size gillnets;
2. from 20th of April until 15th of July, 70-80 mm mesh size gillnets;
3. from 20th of April until 31st of August, beach seines;
4. from 20th of April until 15th of July, big mesh size trap-net;
5. from 20th of April until 1^h of December, smelt trap-net;
6. from 1st of November until 30th of April, eel trap-net;
7. from 15th of December until 15th of September, lamprey trap-net;
8. from 1st of January until 15th of October, drift nets;
9. from 1st of June until 1st of April, stickleback-ruffe trap-net;

10. from 1st of July to 31st of August fishing with gillnets is only allowed during the dark period of the day.

Restricted periods and gear in the Russian part of the Curonian Lagoon:

1. from 20th of April until 20th of June, in areas less than 2 km from shoreline by all gears excluding eel trap-nets and traps for herring;
2. from 20th of April until 20th of August, gillnets with mesh size 70 mm and beach seines;
3. from 20th of April until 31st of August, by all fishing gears, except targeting roach, perch, sabrefish.

Protected species:

All species of brown trout are included in the Lithuanian and Russian Red Lists. It is forbidden to target vimba, whitefish and twait shad, as well as smelt, when the fishes return after spawning (Lithuania). Salmon, vimba, and whitefish fishing are forbidden (Russia).

Forbidden gears:

- trawls, purse seines and other towed gears;
- towed seine, with lengths of more than 500 m;
- towed drift nets;
- drift nets, with a mesh size smaller than 70 mm (Lithuania);
- series of traps longer than 120 m with distances between series less than 100 m;
- series of bottom gillnets longer than 1,000 m with distances between series less than 200 m.

Minimum mesh size:

1. for seines, fyke nets and traps:
 - bream, pikeperch – 30 mm (Russia), bream, pikeperch, pike, burbot – 30-32 mm (Lithuania);
 - roach, perch, sabrefish – 20 mm;
 - smelt, ruff, stickleback, bleak, lamprey – 5 mm (Russia), - 5-10 mm (Lithuania);
 - herring – 12 mm;
 - eel – 14 mm (Russia), 18-20 mm (Lithuania),
2. for gillnets:
 - bream, pikeperch, pike, chub, catfish, burbot – 70 mm (Russia), 70-80 mm (Lithuania);
 - roach, perch, saber fish, tench, rudd, ide – 36 mm (Russia);
 - roach, perch, silver bream – 40-45 mm (Lithuania);
 - smelt, bleak – 16 mm (Russia);
 - smelt, herring – 16-20 mm (Lithuania).

Minimum landing size for fishes:

- eel – 45 cm;
- pikeperch – 46 cm;
- bream – 35 cm;
- pike, burbot, asp – 50 cm;
- tench – 30 cm;

- roach, perch – 18 cm;
- catfish – 75 cm;
- sabrefish – 32 cm;
- vimba – 28 cm (in the Lithuanian part of the Curonian Lagoon – 30 cm) ;
- whitefish – 36 cm.
- Not more than 10 % bycatch of undersized fish is allowed.
- Not more than 49 % bycatch of non-target species is allowed.

3 Aquaculture

3.1. Description of aquaculture in the region, importance of stocking and restocking

The artificial reproduction of water bioresources has a long history and was carried out with state funded budgets in the former Soviet Union in both countries. The transition period to the market economy demanded changes of the water bioresources management system and artificial reproduction due to: 1) implementation of a new legal framework; 2) change of ownership for hatcheries and breeding plants; 3) change in the system of financing; 4) introduction of new innovative technologies.

Reproduction is carried out with the aim to increase the number of commercial fish species and for the conservation of biological diversity. The process of artificial reproduction can be carried out in two forms:

- restocking – for preservation or restoration of biological diversity. Controlled by the Russian Federal and Lithuanian State authorities and supported by the funds of Federal and State budgets;
- stocking – for forming and increasing of commercial fish stocks. In Russia this system is close to “sea-ranching” and especially well developed in the Far East for stocking of salmon.

Currently artificial reproduction of aquatic biological resources in Russia is determined by the Federal Law "On fisheries and protection of water-bioresources" (2006-2012). Plans for artificial reproduction are approved annually for traditional commercial fish species. For example: in the Baltic Sea Region, more specifically in the Leningrad region - for salmon, whitefish and lamprey larvae; in the Kaliningrad region – for whitefish. Scientific support and environmental impact assessments are needed to add new objectives to the management plan. Prices for the reproduction at different stages of life cycle (eggs, larvae, fry, fingerlings) are set by the state. Artificial reproduction can be carried out by both state and private enterprises. To earn money with the breeding they have to submit a tender to the Federal Fishery Agency. The organizations, which get a contract, sign an agreement on releasing certain quantities and qualities of fish fry. Fisheries authorities control the process of the releasing of fish. General provisions for fisheries management in the fishery areas are defined in the Federal Law “On fisheries and protection of water-bioresources”, but the basic regulatory requirements are set in the current law "On Aquaculture" (2013).

The Federal Law “On Aquaculture” has been adapted in July, 2013. It gives new opportunities for development. The law establishes: main definitions concerning aquaculture, principles of state regulation of aquaculture, proprietary rights on aquaculture facilities and breeding fishes, governmental support of aquaculture, organization of aquaculture business.

The main problems of artificial reproduction are:

- Lack of manufactures to produce caviar. For most of the fish hatcheries in the Leningrad region it is impossible to catch the required number of fish in nature due to the low level of stocks, in particular salmon and sea trout.
- Lack of coordination and harmonization of restocking programs. Most of the water-bodies are cross-border areas, but the EU implements fisheries policies without coming to an agreement with

Russia. That reduces the efficiency of restocking efforts. For example, restocking in the Lithuanian basin of the river Šešupė may be inefficient, since a dam is built on the Russian territory of the river that could prevent the migration of eels to the Baltic Sea.

- Lack of technology exchange in aquaculture. Thus, the adoption of new technologies that could increase the efficiency of reproduction facilities in Russia is restrained.

Stocking/ restocking in Lithuania is determined by regulation of the Ministry of Agriculture and Environment “On rules of fish farming in the state water bodies.” (2013). The regulation sets rules for stocking/ restocking procedures in the state water bodies and establishes a list of minimal norms for fish and crayfish stocking/ restocking, describes the annual plans for the stocking/restocking processes in the state water bodies including preparation and confirmation. The regulation also describes the control of fish breeding and fish release to water bodies. The Minister of Agriculture has to approve the annual plan for stocking/ restocking, before it is issued. The Fisheries Service under the Ministry of Agriculture of the Lithuanian Republic implements the plan. The Fisheries Service has 7 separate divisions, which have facilities for breeding and growing fish. In 2011 the Fisheries Service bred and released 29, in 2012 30 millions of juvenile fish, 87 % of them burbot, pike, and pikeperch. One of these divisions’ aquaculture facilities is situated near the Curonian Lagoon, in the small city Rusne.

Aquaculture in the Curonian Lagoon region

Aquaculture in the Curonian Lagoon region is developed relatively weakly. Four aquaculture facilities are situated on Lithuanian and one on Russian territory.

The first aquaculture facility for stocking/ restocking purposes is located in Rusnė (Lithuania) and belongs to the governmental institution Pisciculture Division Rusnė Subdivision of Fisheries Service under the Ministry of Agriculture of the Republic of Lithuania. Address: Šyškrantės village, Rusnės parish, Šilutės District, LT- 99344, Lithuania. The facility produces: burbot, catfish, pike and juveniles of perch, eel, sturgeon, and brown trout for stocking (see Table 2).

The second aquaculture facility, an experimental whitefish breeding plant is situated on the Curonian Spit (Lesnoe village, Russia). It belongs to the governmental institution Zapbaltrybvod and was founded in 2010 for restocking of whitefish in accordance with the Russian State Program. Production: annual release 150,000 fingerlings with the weight up to 5 g.

Table 2: Quantities of juvenile fish (in thousands units) were released in the lower reaches of the river Nemunas and the Curonian Lagoon. Remarks: 0 – fish larva’s, 0p – juveniles until cannibalism phenomenon.

Year	Fish species			
	burbot	catfish	pikeperch	eel
2008	14,500 (0), 300 (0p)	-	300 (0p)	-
2009	14,000 (0), 1,500(0p)	-	-	-
2010	21,000 (0), 2,500 (0p)	3 (0p)	-	-
2011	-	-	810 (0p)	-
2012	-	-	620 (0p)	20 (0p)

The third facility for fish farming is located in Kintai town, it belongs to JSC "Kintai", address: Kintai town, Šilutė district LT-99358 Lithuania. JSC "Kintai". It has 600 ha water bodies for aquacultural purposes. The annual production is 300 t. 95 % of production consists of carps (for the market). Other production: pike, catfish, bream, grass carp (for the market and for stocking).

The fourth facility for fish farming is located in Rusne town, it belongs to JSC "Rusnės tvenkiniai", address: Šilutė district, Šilutė town, Lietuvininkų street. 33A. Status: liquidation process from 2004 until now.

The fifth facility for fish farming is located in the village Girkaliai, it belongs to JSC "Leteka", address: Artojų street 10, Girkalių village, Klaipėda district municipality. It is the most modern facility with a recirculation system for eel aquaculture. The annual company production reaches 60 t of eels for market purposes and 200,000 eel juveniles for releases. It was built with European Fisheries Fund support. The aquaculture facility started in 2013.

3.2. Future plans, scientific initiatives

The Russian new law "On aquaculture" (Jun, 2013) gives a new opportunity for aquaculture development in the Kaliningrad region. The Kaliningrad region specializes in aquaculture science, aquaculture education and receives support from regional authorities. A big aquaculture center is planned in the Kaliningrad area, with an estimated yearly production of juvenile fish of: vimba – 500 thousand, salmon – 3,7 million, sturgeon – 200 thousand.

A new common EU fisheries policy, the Lithuanian Fisheries fund for 2014-2020 and the principles set for fund use will become the main pillar for future plans and scientific initiatives in the region from Lithuanian side.

By seeking to protect and restock fish resources of the Curonian Lagoon the plans for protection and increase of fish resources should be developed. The regular monitoring of fishing, as well as the supervision of spawning grounds and migration routes in order to improve conditions of spawning and to ensure the protection of valuable fish species will be carried out. Among the efforts to increase the efficiency of fish restocking, more valuable and predatory fish species should be released. The restocking of fish resources is planned and organized in the Curonian Lagoon and in the lower reaches of the Nemunas river, and the status of fish resources is monitored. The close cooperation of both countries could improve implementation of mentioned plans.

SUBMARINER project

The project is funded by the Baltic Sea Region Programme 2007-2013. According to the EU Water Framework directive surface water has to be in a good ecological condition in the nearest future. The main ecological problem in the Curonian Lagoon is anthropogenic (of human origin) eutrophication. One of the ways to decrease the eutrophication could be the use of mollusc filters - *Dreissena polymorpha*. In a large central part of the Curonian lagoon (about 300 km²) in front of the Nemunas river mouth, natural *Dreissena* colonies grow. The creation of artificial biotopes for *Dreissena* could increase the power of its natural filter abilities. However, before starting actions, that might strongly affect the ecosystem, experiments should be done to find out more about *Dreissena*. With ecosystem modelling mollusc farming effects on energetic flows in the ecosystem can be calculated. At the moment, that kind of research is carried out by Klaipėda's University Coastal Research and Planning Institute. Outcomes of the research and the SUBMARINER project results could become one of the foundations for future mollusc aquaculture development in the Curonian Lagoon area.

4 Management aspects

4.1 Management of fishery and aquaculture

The development of fishery and fish protection in the Curonian Lagoon basin goes back to the 14th century. The rules published by the Prussian Government on January 30th, 1589, show considerable concern of local fishermen about the state of valuable fish resources. These rules indicated how to fish, sell the caught fish, and organize fish protection and environmental protection work of fishermeisters (the special kind of inspector) (Gaigalas 2001). In order to maintain and increase fish resources of the Curonian Lagoon the marked changes both in fish communities and in commercial resources and fishery of the past and recent years should be taken into account. The greatest emphasis in fish resources management is on the catches of the most valuable commercial fish species: bream, pikeperch and smelt. Recent information about small scale fishery management in coastal transitional waters was provided by Kontautas & Zolubas (2012).

Fisheries Policy in the Lithuanian Republic is defined in the Fisheries Law of the Republic of Lithuania, which regulates relations in the fishing, aquaculture, fish processing and market areas. The objectives of the law are to ensure sustainable exploitation of fish stocks, its conservation and replenishment, as well as to ensure fisheries control, taking into account the environmental and economic aspects, as well as fishermen's, fish farmers', processors' and consumers' views. The law is applicable to the land territory of the Republic of Lithuania, internal waters, territorial waters, the exclusive economic zone, as well as to the Lithuanian fishing vessels in the sea waters. Provisions of this law are in line with European Union legislation.

The law appoints institutions that execute state fisheries regulations in Lithuania: the Ministry of Agriculture is responsible for the Lithuanian Fisheries Policy and organises, coordinates and controls its implementation, it manages the state fisheries, and adopts the European Union Common Fisheries Policy. Furthermore, the Ministry organises, coordinates and controls the conservation of fish resources in the sea waters; the Ministry of Environment forms the fish stocks conservation and control policy in inland waters and organises, coordinates and controls its implementation, and carries out the state fisheries management in inland waters; the Ministry of Agriculture and the Ministry of the Environment organize, coordinate, control and replenish fish stocks, as well as carry out fisheries scientific research in the various water bodies under their jurisdiction. The Law lays down the fishing area user rights and obligations, as well as procedures for the issue of permits for the use in fishing areas.

The resource management and stocking measures in the state owned waters are carried out by the Ministry of Agriculture and the Ministry of Environment. The Fisheries Services under the Ministry of Agriculture, which owns 7 state aquaculture units, prepares annual state fish stocking plans in accordance with scientific recommendations and presents them to the Ministry of Environment for evaluation. Afterwards, the plan is harmonized between the institutions; the Minister of Agriculture confirms it.

Lithuanian universities educate biologists, ecologists and specialists for the fishery industry. The following universities offer education in aquaculture in Lithuania: Klaipėda University Vilnius University, Vilnius Pedagogical University, Vytautas Magnus University, Lithuanian Veterinary Academy, Lithuanian University of Agriculture.

The Fishery Policy of the Russian Federation is defined by the Federal Law "On fisheries and protection of water bioresources" (2004). Protection of water bioresources refers to the conservation of marine biological resources or the restoration to the levels that can ensure the maximum sustainable yield (catch) of water bioresources and biological diversity, through the implementation of science-based measures for preservation, study, reproduction, management, rational use of marine resources and protection of their habitat.

The structure and functions of fisheries management in the Russian Federation include federal and regional levels and scientific support as well.

Federal level

The Ministry of Agriculture ensures the definition of fisheries policy; the Federal Fisheries Agency (“Rosribolovstvo”) ensures legislative control of fisheries activities, monitoring and supervision of the use of water bioresources; Territorial Branches of “Rosribolovstvo” ensure control and supervision of water bioresources at the level of fisheries basin. The Baltic Sea Region belongs to the West Fisheries Basin. The West-Baltic Basin Agency for Reproduction of fish stocks is a responsible body for the implementation of the state programs for reproduction and improvement of fish habitat (melioration). Regional fisheries regulations (rules) are developed for each fishery basin, which are approved by the Federal Fisheries Agency

Regional level

The Agency for Fisheries and Fishing Industry Development of the Government of the Kaliningrad Region ensures implementation of the fisheries policy at the regional level. The agency is responsible for the following tasks: concluding agreements with fishing organization for quota allocation, organizing auctions for the distribution of fishing areas, develops and implements the regional programs. The implementation of fisheries policy is carried out by development of state programs. Currently, the state program of the Russian Federation “Development of the Fishing Industry” (2013) is adopted. There are two regional programs: “The development of the coastal fisheries” and “The development of aquaculture” are implemented in the Kaliningrad region. Fisheries science and research institutions execute the state order for the measurement of the total allowable catches (TAC) in the water-bodies in Russia. All institutions are subordinate to the Federal Fisheries Agency. There are two fisheries research subdivisions with certain areas of responsibility in the Baltic Sea Region:

Scientific support

Atlantic Research Institute of Fisheries and Oceanography (AtlantNIRO, Kaliningrad) Curonian and Vistula Lagoon, 26th sub-area of the Baltic Sea;

Kaliningrad State Technical University (KSTU), Kaliningrad) – inland waters of the Kaliningrad region;

The activities of these scientific research institutions are funded by the state on an annual basis for research and assessment of the state fish stocks and TAC.

Acquisition and loss of fishing license

In Lithuania, only companies have the right to fish that are registered in the list approved by the director of Fisheries Service under the Ministry of Agriculture of the Lithuanian Republic. The main principal of the list is that the number of fishing companies can decrease but not increase. A new company can enter the list only when another company was deleted from the list. A fishing company can be deleted from the list if it did not fish for more than two years or when it asked to be deleted from the list. The Fisheries Service allocates fishing quotas and the number of allowable fishing gear for companies. A fishing company cannot get quotas: if it was stopped because of infringement of fishing rules or law, if it did not pay for damage done on fish resources, if it did not provide data to administration according to the law requirements, or if it did not pay tax for fish resources restoration and protection. The company, which received the right to use a number of fishing gears and fishing quotas, can apply to the Ministry of Environment for a fishing permit.

In Russia, the fishery regulations are based on scientific estimations of the TAC (total allowable catch) for valuable species or the PC (possible catch) for non-valuable species every year. The TAC is divided into 10 types of quotas: commercial, coastal, scientific, educational, aquaculture, recreational, traditional, international waters, for non-residents in the EEZ, or freshwater. Each fishing company has a share of commercial quota fixed for 10 years and it can operate within this share. Every year a

company has to apply for a fishing permission (license). A company has to report about its catch every 5 days. To get permission any company has to fulfill requirements such as: ownership of a fishing vessel (for each permission), ownership of a share of a quota for commercial fishing, no tax arrears, no violations of fishing rules in the previous season. A company can lose a fishing permission in the following cases: violations of fishing rules more than twice per year, no reporting of catches, using less than 50 % of its quota during two years, no license for angle fishing.

Catch and fishing effort limitations in the Curonian Lagoon

Every year common pikeperch, bream, and smelt fishing quotas for the Curonian Lagoon are allocated to both countries by decision of the Joint Lithuanian-Russian Fishery Commission (Table 3).

In Lithuania there are 4 ways of fishing limitation:

1. Common pikeperch, bream, and smelt fishing quotas are allocated to Lithuania (Table 3).
2. The common pikeperch, bream, smelt Lithuanian fishing quotas are allocated to fishing companies.
3. Lithuania sets common fishing gear units for different gear types to be used in the Curonian Lagoon. One unit of gillnet is a gillnet of 75 m length. For example, in 2013 it was allowed to use: 1 unit of towed seine with a length of less than 500 m, 230 units of 40-45 mm mesh size gillnets, 360 units of 70-80 mm mesh size gillnets, 223 units of eel trap-nets with special selective insert, 41 units of big mesh size trap-nets, 32 units of lamprey trap-nets, 67 units of smelt trap-nets, 20 units of stickleback-ruffe trap-net, 2 units of drift nets. No limitations exist for gillnets targeting smelt and the number of hooks on longlines.
4. Concrete fishing gear units for different gear types are allocated to fishing companies. Fishing inspectors supervise the process. Fishing gear can be used for fishing if it is marked with a special badge. Fishing inspectors confiscate unmarked fishing gear. Kontautas (2009) evaluated the maximum units of fishing gear to be used in the Curonian Lagoon.

In Russia there are 3 ways of fishing limitation:

1. Common pikeperch, bream, smelt fishing quotas are allocated to Russia (Table 3) .
2. Quotas for valuable species (bream, pikeperch, roach, sabrefish) are allocated to companies. Each company can operate only within its quota.
3. Any company can get a permit for the possible catch of other species. All companies fish separately until the amount for the possible catch is reached. Then fishery stops. (Olympic system).

No limitation for fishing effort exists for the Russian side of the Curonian Lagoon.

Other limitation measures: mesh size, minimal commercial fish size, maximal undersize bycatch, maximal non-target bycatch, usage of some gears (trawls, beach seines), quota for each fish species, restricted areas, restricted periods.

Table 3: The preliminary common fish quotas for the Curonian Lagoon in 2014.

Fish species	The quotas of the Lithuanian Republic	The quotas of the Russian Federation	Total
Bream	1,150	480	1,630
Pikeperch	260	110	370
Smelt	300	470	770

4.2 Responsibilities

Information about institutions and organizations responsible for fisheries management, aquaculture and research in the Curonian Lagoon are provided in ANNEX II.

4.3 Legal aspects

The main legal aspects are provided in ANNEX III.

5 Area based management

The Curonian Lagoon is rich in natural resources. Lithuanian and Russian fisheries legislations are strict and detailed. The TAC system is implemented in both countries, and fishing effort restrictions are implemented in Lithuania. Governmental institutions support restocking of valuable and protected fish species. Scientists evaluate stocks and analyse the state of fish populations annually. On the downside, the waters of the Curonian Lagoon are highly polluted, fisheries management is highly centralized (especially in Russia), regional authorities have poor management opportunities, stocking efforts depend on public funds of different countries, relatively high levels of illegal fishing still exist. From a biological point of view: eel recruitment depletion has been observed during the last two decades, catches of valuable fish species decrease; high fishing pressure negatively affects the whitefish population, high levels of juvenile sturgeon bycatch in commercial fishery may be a main obstacle for stock restoration, the highly increased number of recreational fishermen negatively affect the predatory fish populations.

The Curonian Lagoon is a transboundary water body and sustainable fisheries cannot exist without constant interaction between the two countries Russia and Lithuania. There are official platforms for interactions such as:

- Joint Russian-Lithuanian Fishery Commission (JRLFC);
- Joint Baltic Sea Fishery Committee (JBSFC).

The JRLFC was established in 1999 according to the Lithuanian Republic and the Russian Federation government agreement for collaboration in fishing areas. Collaboration areas are: rational use of the Curonian Lagoon resources and its conservation, aquaculture development, exchange of information about fishing rules, scientific studies, and fish resource utilization. One of the main aims is to create common fishing rules to be applied in both parts of the Curonian Lagoon. These rules should establish common restrictions on fishing, fish species, fishing gear, fishing time and place. Sessions of the commission are held once a year, and prior to these, working groups can meet to prepare documents to be approved during a session. The annual sessions and working groups are held alternately in Russia and Lithuania.

Another cooperation was established in 2010 by the Joint Baltic Sea Fishery Committee (EU-RU) for the purpose of efficient cooperation in the conservation and sustainable exploitation of aquatic biological resources. The parties exchange information concerning legal regulation documents already available and under preparation for fishery management in the Russian Federation and the European Union. Except for issues related to the Baltic Sea during the sessions of JBSFC the issues of importance for the bilateral cooperation of Russia and Lithuania are discussed. For example: the participation of Russia in the restocking eel program, rehabilitation of sturgeon in the transboundary rivers of Russia and Lithuania, the development of a bilateral Lithuanian-Russian eel management plan.

The level of cooperation is good for the fishery management because of the regular exchange of information about the structure of fishery authorities and legislation, fishery statistics and the organization of the fisheries. There are joint measures for fishery regulation, which are compatible with national rules of both countries. TACs for the most important species are agreed upon during the

sessions of the Joint Russian-Lithuanian Fishery Commission every year. The decision of the JRLFC concerning TACs as international rule has priority and can be approved by the Federal Fishery Agency of Russia without ecological expertise by the Russian Ministry of Natural Resources. It has stated a transboundary activity in the field of restocking of eel and sturgeon, but a wider restock and aquaculture cooperation is needed.

SWOT analysis

Strengths	Weaknesses
<ul style="list-style-type: none"> • the Curonian Lagoon is rich in natural resources, • considerable aquaculture experience in LT • strict and detailed fishery legislation, • TAC system, fishing effort restriction, • governmental support for local fishing communities, • governmental support for restocking of valuable and protected fish species, • annual stock analysis by scientists, • activity of Joint Lithuanian-Russian Fishery Commission and transboundary regulation of commercial fish catches, • LT-RU coordination of TACs, information exchange about fishing rules, research and catches. 	<ul style="list-style-type: none"> • the Curonian Lagoon is shared by an EU and a non-EU member state, • relatively high level of water pollution, • relatively high level of illegal fishing, • high level of centralization of fishery management, • poor management opportunity for regional authority, • no coordination of scientific methods and approach, • lack of LT-RU fishermen meetings, • weekly developed aquaculture in Kaliningrad region, • Russia cannot be a partner in most EU programs, like INTERREG, LIFE and others.
Opportunities	Threats
<ul style="list-style-type: none"> • established Joint Lithuanian-Russian Fishery Commission provides a political background for the cross-border action plans, • the Lithuanian Fisheries fund for 2014-2020 • Russian law “On aquaculture” (Jun, 2013) gives a new opportunity for aquaculture development in the Kaliningrad region, • cross-border cooperation programs, • development of LT-RU common eel management plan, • integration of RU into the Atlantic sturgeon reintroduction project, • LT-RU aquaculture experience exchange • innovations (mussel farming) in the lagoon • stocking/ restocking with juveniles eels and sturgeons. 	<ul style="list-style-type: none"> • eel recruitment depletion, • changes of fish market requirements, • changes of fishery and environmental legislation, • increased number of recreational fishermen can negatively affect predatory fish populations, • decrease of valuable fish catches, • stocking efforts depend public funds of different countries, • high fishing pressure is negatively affecting whitefish population, • high level of juvenile sturgeon bycatch in commercial fishery.

6 Lessons learned

The biggest problem for a common fisheries management in the Curonian Lagoon is that the lagoon is shared by an EU-member and a non-EU state. Countries implement different fisheries policies with sometimes relatively different aims. JBSFC and especially JRLFC are political instruments to define the common area-based management aims for the Curonian Lagoon. During 2005-2008 an INTERREG-TACIS project “Development of scientific-technical support for reproduction of fish stocks in transboundary waters of Lithuania and Russia (Trans-border Fish)” has been implemented together by Lithuanian and Russian specialists and gave a new impulse for the countries’ cooperation. The further organization of international projects with Russia can develop cooperation in the field of area-based management, but Russia cannot participate in most EU projects.

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Address

Tomas Zolubas
Klaipėda University
Faculty of Natural Sciences and Mathematics
Herkaus Manto str. 84
LT-92294, Klaipėda, Lithuania

tomas.zolubas@zuv.lt

ANNEX I

Lithuania (according to Vaikutis (2007, 2009))

Year	<i>Fish species</i>					
	<i>Sander lucioperca</i>	<i>Abramis brama</i>	<i>Rutilus rutilus</i>	<i>Vimba vimba</i>	<i>Osmerus eperlanus</i>	<i>Perca fluviatilis</i>
1995	37	305	161	3	23	39
1996	48	304	305	2	16	34
1997	48	350	434	3	46	43
1998	46	393	488	2	39	49
1999	52	383	449	11	10	57
2000	70	388	465	48	57	46
2001	79	380	374	40	34	45
2002	107	423	517	59	52	46
2003	108	370	585	53	40	40
2004	109	388	506	55	27	42
2005	101	354	442	76	45	51
2006	92	344	390	82	38	56
2007	89	411	456	178	52	50
2008	82	346	398	161	38	57
2009	67	290	261	73	11	43
2010	76	360	249	30	16	61
2011	94	439	314	73	3	67
2012	64	360	259	57	39	47

Russia

Year	<i>Fish species</i>					
	<i>Sander lucioperca</i>	<i>Abramis brama</i>	<i>Rutilus rutilus</i>	<i>Vimba vimba</i>	<i>Osmerus eperlanus</i>	<i>Perca fluviatilis</i>
1995	112	769	203	69	67	34
1996	94	782	141	152	29	30
1997	133	882	249	179	43	45
1998	93	804	254	215	178	38
1999	214	892	414	157	115	72
2000	223	899	368	290	152	56
2001	228	929	466	278	203	61
2002	230	999	418	436	259	67
2003	244	879	411	440	50	77
2004	235	987	489	394	93	49
2005	207	955	358	303	49	64
2006	212	1039	297	184	42	39
2007	230	1069	333	306	177	60
2008	227	1067	287	305	187	64
2009	232	1042	508	349	111	109
2010	239	1022	471	244	17	135
2011	238	1097	478	324	116	133
2012	238	1101	475	299	240	160

ANNEX II

THE MAIN RESPONSIBLE AUTHORITIES FOR FISHERIES MANAGEMENT IN THE CURONIAN LAGOON

Lithuania:

1. Fisheries Service under the Ministry of Agriculture of the Lithuanian Republic: responsible for fishing gear number limit and fishing quotas allocation to fishing companies. Fisheries Service certify list of fishing companies, which have the right to fish in the Curonian Lagoon. Fisheries Service is responsible for fish resources monitoring in the Baltic Sea. Director Vytautas Grušauskas, Lelevelio g.6. Adress: LT-01102 Vilnius, Lithuania, e-mail: Vytautas.Grusauskas@zuv.lt.
2. Ministry of Environment of the Lithuanian Republic: responsible for fishing rules in inland waters. Minister Gediminas Kazlauskas. Adress: A. Jakšto g. 4/9, LT-01105 Vilnius, Lithuania, e-mail: V.Mazuronis@am.lt.
3. Klaipėda Wildlife Protection Inspectorate of the Klaipėda Regional Environmental Protection Department under the Ministry of Environment of the Lithuanian Republic (Chief V. Marozas, e-mail: V.Marozas@klrd.am.lt) and Šilutė Wildlife Protection Inspectorate (S.Sudeikis@klrd.am.lt) of the Klaipėda Regional Environmental Protection Department under the Ministry of Environment of the Lithuanian Republic: responsible for fishing control in the Curonian Lagoon. The director of the Klaipėda Regional Environmental Protection Department under the Ministry of Environment of the Lithuanian Republic Andrius Kairys. Adress: Birutės g. 16, LT-91204 Klaipėda, Lithuania, e-mail: A.Kairys@klrd.am.lt.
4. Klaipėda University. Address: Herkaus Manto str. 84, Lt-92294, Klaipėda Lithuania. e-mail: antanas.kontautas@ku.lt; zita@corpi.ku.lt. Responsible for monitoring of biological resources, socio-economic aspects of fishery in the Curonian Lagoon.
5. Institute of Ecology of the Nature Research Centre, Address: Akademijos str. 2, LT-08412 Vilnius-21, Lithuania, e-mail: ekoi@ekoi.lt. Head of Institute of Ecology Sigitas Podėnas. Responsible for fish resources monitoring in inland waters.
6. Asociation of fishing companies „Lampetra“. Adress: Lietuvininkų g. 26-3, LT-99179 Šilutė, Lithuania, e-mail: info@lampetra.w3.lt. Chairman Sigita Jakūbauskienė. Reponsible for lobbying for their interests on the national and regional level.

Russia:

1. West-Baltic Territorial department of the Federal Agency for Fisheries – permit, control, collection of fishery statistics, control of water environment. Chairman Maxim Buduratsky. Kaliningrad, 236000, Kirova, 15
2. West-Baltic department for fish-breeding and organization of fishery – fish breeding, monitoring of fishing activity, protection and restoration of water environment. Chairman Vladimir Lakashev, Kaliningrad, Morehodnaya, 4.
3. Agency for fisheries and development of the fishing sector of the Government of the Kaliningrad oblast – promotion of fishing sector and aquaculture development, allocation of fishing sites, allocation of shares of quotas. 236000, Kaliningrad, Moskowsky prosp., 76.
4. Atlantic Scientific Research Institute for the Fishery and Oceanology – monitoring of water bioresources in the lagoon, state of water environment, assessment of TAC, preparation of fisheries rules. 236000, Kaliningrad, Dmitria Donskogo street, 5.

5. Kaliningrad State Technical University - monitoring of water bioresources in the catchment area of the lagoon, state of water environment, assessment of TAC, preparation of fisheries rules for rivers and lakes in the catchment area. 236000, Kaliningrad, Sovietsky prosp., 1.
6. Kaliningrad Union of Fishing Collective Farms – association of fishermen responsible for lobbying of their interests on the federal and regional level.
7. Baltic Scientific-Fishing Industrial Council – a council of representatives of local authorities, scientific institutions, fishery companies, border guard and fishery organizations of Kaliningrad and Leningrad oblasts for the development of fishery policy in the Baltic region.
8. Federal Agency for Fishery in the Ministry of Agriculture (Moscow) – development and implementation of fishery policy and management.

ANNEX III

THE MAIN LEGISLATIONS FOR FISHERIES MANAGEMENT IN THE CURONIAN LAGOON

THE LITHUANIAN REPUBLIC LEGISLATIONS:

Laws:

Law on Fisheries of the Republic of Lithuania,

Law on Amateur angling of the Republic of Lithuania.

Resolutions:

Resolution of the Government on Agreement of Republic of Lithuania and the Russian Federation on Cooperation in the field of fisheries approval.

Orders of the Minister of Agriculture of the Republic of Lithuania:

On the approval of inland fishing quota allocation rules,

On the approval of the list of fish stocks users which has right to fish in Curonian Lagoon and in the Kauno marios heap.

Orders of the Minister of Environment of the Republic of Lithuania

On Fishing logbooks issue and rules for logbook filling,

On rules of commercial fishing Lithuanian fisheries in inland water bodies,

On the approval of amateur fishing rules,

On the description of seal and gear marking procedure,

On the approval of the list of strictly protected animal, plant and fungi species in Republic of Lithuania,

On the commercial fishing limit in Curonian Lagoon in 2013.

RUSSIAN FEDERATION LEGISLATIONS

Laws:

Federal Law “On fisheries and water bioresources conservation” (issues 2004, 2008, 2011, 2012).

Federal Law “On aquaculture”, 2013.

Fisheries rules for the Western Fishery Basin (issues 2006, 2008, 2012, 2013)

Annual Orders of Federal Fishery Agency:

List of water biological resources related to objects of fisheries.

List of water biological resources, which set the total allowed catch.

On approval of the total allowable catch of water biological resources in inland waters.