Iceland Liechtenstein Norway grants

COoperation for the ADVancement of Aquaculture in Norway and Croatia
COADVANCe

Sveučilište u Zadru
Universitas Studiorum
Jadertina | 1396 | 2002 |

UiT The Arctic University of Norway

WHITE PAPER

Report on aquaculture in Norway in Croatia

March, 2024

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Contents

1. Aquaculture in Croatia

Aquaculture in the Republic of Croatia is, in accordance with the legal framework, a strategic branch of the economy, and a part of other development strategies. This economic activity produces nutritional high-value products that are used for nutrition and that make up for the lack of supply fishery products that come from direct catch due to increasing fishing restrictions. Aquaculture significantly contributes to the development of sensitive rural/island communities, because it enables constant employment throughout the year, either directly or through the development of supporting activities needed for aquaculture operations. At the same time, it contributes to the development of tourist offer.

Aquaculture is regulated by the Act on Aquaculture ("Official Gazette", no. 130/17, 111/18 and 144/20), Article 5, which prescribes the adoption of a multi-year national aquaculture development plan from by the Government of the Republic of Croatia, and in accordance with Article 34 of Regulation (EU) no. 1380/2013 of the European of the Parliament and the Council of December 11, 2013 on common fisheries policy, amendment of regulations Council (EC) no. 1954/2003 and (EC) no. 1224/2009 and repealing Regulation (EC) no. 2371/2002 and (EC) no. 639/2004 and Council Decision 2004/585/EC (OJ L 354, 28 December 2013). Government at the session held on May 13, 2021, the Republic of Croatia passed the Decision on the launch of the process of creating the National Aquaculture Development Plan for the period from 2021 to 2027 (CLASS: 022-03/21-04/158; NUMBER: 50301-05/31-21-2). This started the creation process of the National Aquaculture Development Plan for the period from 2021 to 2027, which is implemented by coordinated by the Ministry of Agriculture and included the process of strategic assessment of the impact on environment, as well as informal consultations with the European Commission (EC). Given that the production extended to the last quarter of 2022, when the end of the adoption procedure is also expected, the name of the act was changed to the National Aquaculture Development Plan for the period up to 2027 (NPRA). Namely, in May 2021, the Strategic Guidelines of the EC for a more sustainable and more competitive aquaculture in the EU for the period 2021-2030 (COM (2021) 236 final) (hereinafter text: EC Guidelines), which required additional coordination with the EC and together with the unpredictable aggravating circumstances (specific way of working during the Covid 19 virus pandemic) resulted by moving the time frame for the adoption of the NPRA. The preparation of the NPRA is significant primarily in in terms of planning the development and positioning of aquaculture activities at the national level, but consequently also in the context of further sustainable development of EU aquaculture.

Although aquaculture is one of the fastest growing activities in food production worldwide, the EU aquaculture is stagnating. According to EC guidelines, the aquaculture sector is still far from realizing full potential in terms of growth and meeting the growing need for more sustainable seafood products. Namely, the EU imports more than 70% of its seafood consumption food products. Furthermore, EU aquaculture accounts for less than 2% of total world production in aquaculture, and the share of EU aquaculture products in EU consumption is only 10%. It is in the EC Guidelines also found that production in EU aquaculture is narrowly limited with respect to member states and cultivated species, and there is considerable potential for diversification, as well as for further increase environmental efficiency, which will contribute to the goals of the European Green Plan and related ones strategy. In order to take advantage of the various opportunities in the EU aquaculture sector, the future activities must be directed towards the achievement of the following interconnected goals:

1. Resilience and competitiveness;
2. Participation in the green transition;
3. Acceptance in society by informing consumers and
4. Increasing knowledge and innovation.

1.1. The state of the aquaculture sector in 2020

Croatian aquaculture includes the cultivation of aquatic organisms in the sea (mariculture) and on land waters (freshwater aquaculture). The total production in 2020 was about 21.770 tons, total value over HRK 1 billion. Aquaculture in the Republic of Croatia shows a growth trend, with breeding of marine organisms is dominant, both in terms of the amount of annual production and total value. In the total production, marine aquaculture is represented by 87% in quantity and 95% in value.

1.2. Mariculture - status

Marine aquaculture in the Republic of Croatia has a long tradition. The most important types of fish in marine farming are: European sea bass (*Dicentrarchus labrax*), Gilthead sea bream (*Sparus aurata*), Atlantic bluefin tuna (*Thunnus thynnus*), and in recent years Meagre (*Argyrosomus regius*) has become increasingly common, while bivalves are represented by Mediterranean mussel (*Mytilus galloprovincialis*) and European oyster (*Ostrea edulis*).

Species	2018	2019	2020	2021	2022*
European seabass	6.220	6.089	6.754	9.083	10.034
Gilthead seabream	5.591	6.774	7.780	7.599	7.462
Meagre	***	***	***	999	1.086
Atlantic bluefin tuna	3.227	2.747	3.323	5.104	3.270
Mediterranean mussel	882	947	503	854	1.020
European flat oyster	54	61	14	56	93
Other species**	808	725	618	81	74
Total (t)	**16.782**	**17.343**	**18.992**	**23.777**	**23.039**

**preliminary data*
***meagre, dentex, greater amberjack, rainbow trout, mediterranean scallop*
****because of data confidetiality included under Other species*

Table 1. Production in mariculture by species in the period 2018-2022.

The beginnings of oyster cultivation in the territory of the Republic of Croatia were recorded several centuries ago, while more intensive shellfish farming took place in the last century. Cultivation of marine fishes in cages started among the first in Europe, and has a tradition of almost 50 years. Tuna is also grown in the Republic of Croatia from the 90s of the last century among the first in Europe.

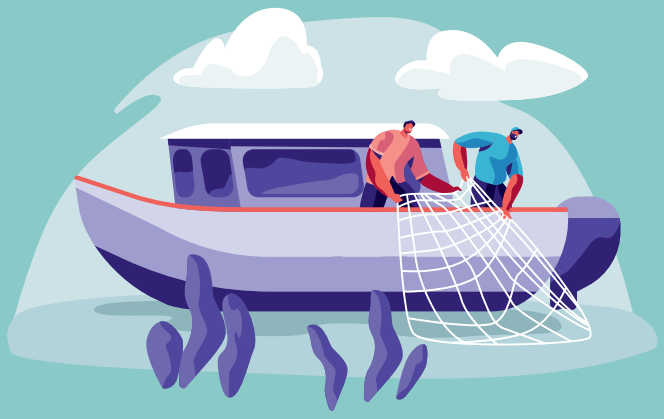
The production of sea bass and sea bream takes place in floating cages with the application of modern technologies and implies a closed breeding cycle, from controlled spawning to consumer product. Cultivation takes place in the area of almost all coastal counties, however, it is most represented in area of Zadar County. Most of the farmed white fish is marketed on the domestic market of EU, dominantly Italian market. In recent years, there has been an increase in the production of these species, thanks to constant growth in demand on the domestic and EU markets, as well as increased investments in modernization of existing and opening of new farms.

Tuna farming takes place in floating cages in semi offshore and open shore areas of the middle Adriatic, that is, in the area of Zadar, Šibenik-Knin and Split-Dalmatia counties. Farming is mostly based on the catch of tuna from nature (8-10 kg) and their further cultivation up to market size (30 and more kg). Production is almost entirely placed on the Japanese market. In recent years, tuna has been exported in smaller quantities to the EU, USA and other Asian countries. Production depends on catch quotas according to the ICCAT, so due to catch restrictions, a decline was recorded and stagnation of production, as well as renewed growth due to the increase in catch quotas.

Bivalve farming mostly takes place on small family farms with application of traditional farming technologies on floating parks. The cultivation of oysters mainly takes place in the area of the Mali ston Bay and the Little Sea (over 84% of total production), while cultivation of mussels, except in the area of the Mali ston Bay, more significantly are represented in the area of the western coast of Istria, the mouth of the Krka River, the Velebit Channel and the Novigrad Sea. Cultivation is based exclusively on the collection of spat from the nature. All cultivation areas are under permanent state control monitoring, and sales are realized mainly on the domestic market. In recent years, it has been recorded stagnation of production due to the increase in the presence of predatory fish species.

It is important to note that all the breeding grounds for marine organisms in the Republic of Croatia are located in the area adjacent to compliance with all environmental and nature conservation standards, and that all coastal counties have included areas for aquaculture in their spatial plans. Cultivation takes place in all 7 coastal counties, on approximately 400 locations. There are mostly small shellfish farms, while fish farming takes place in over 60 location.

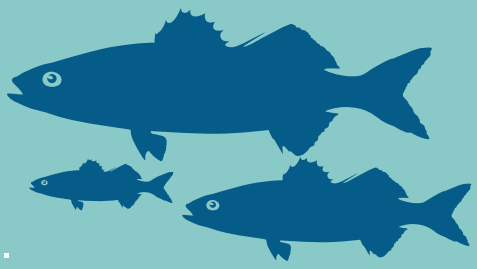
Aquaculture in Croatia



Total production in 2020
21.770 tons

Total value
over **HRK 1 billion**

Marine aquaculture is represented by **87%** in quantity and **95%** in value.



Most important types of fish in marine farming - 2022.

10.034 tons European seabass

7.462 tons Gilthead seabream

3.270 tons Atlantic bluefin tuna

1.086 tons Meagre

93 tons European oyster

1.020 tons Mediterranean mussel

74 tons Other species

Cultivation takes place in all **7** coastal counties

400 locations

Fish farming takes place in over **60** location.

1.3. Freshwater aquaculture - status

The cultivation of freshwater fish species includes the cultivation of warm-water (cyprinid, carp) and cold-water fish (salmonid, trout) species, including carp (*Cyprinus carpio*) and rainbow trout (O*ncorhynchus mykiss*) as the most important species. Breeding of carp species traditionally takes place on carp ponds, which are usually spread out on several hundred hectares, and five carp ponds exceed 1.000 ha in area. Most of carp ponds is located along larger river basins in the continental area of the Republic of Croatia. Cultivation of cyprinid species mostly implies controlled cultivation of carp (*Cyprinus carpio*) in monocultures or polycultures with other species, the most common of which are white grass carp (*Ctenopharyngodon idella*), gray head (*Hypophthalmichthys nobilis*), white head (*Hypophthalmichthys molitrix*), catfish (*Silurus glanis*), perch (*Sander lucioperca*), pike (*Esox lucius*) and tench (*Tinca tinca*). The production is mostly semi-intensive, where in addition to natural food, which is created in the pond by biological processes and whose production is encouraged by agro-technical measures (fertilization, etc.), the fish are also fed with additional food, most often cereals (maize, wheat, rye, barley). The production cycle in carp farming usually lasts three years.

Breeding of trout species mainly takes place in concrete pools with flow systems which enables multiple water changes. Trout ponds are usually located in the mountain areas of the Republic of Croatia, which are abundant with fast watercourses with a sufficient amount of high quality cold water, as a prerequisite for this type of production. Breeding of trout species almost completely refers to the breeding of the rainbow trout (*Oncorhynchus mykiss*), and with a low percentage native brown trout (*Salmo trutta*) is also present in proportion (< 1%). Cultivation of cold water species is based on controlled spawning, with a production cycle of about 2 years. Production is intensive, since natural food is negligible, the nutrition is based on a balanced complete diet industrial food.

Freshwater fish farming takes place in about 50 locations in 16 counties. Total production in freshwater aquaculture in 2020 amounted to about 2.780 tons, with a total value of around HRK 46.8 million. Of this, 2.388 tons of warm water (carp) fish were produced. The most important species in carp farming, with about 1.700 tons of realized production in 2020, is carp, followed by herbivores carp species (grey carp, white carp and white carp). Total production of cold water (trout) species in 2020 amounted to 392 tons, with a total value of HRK 11.6 million. The most important species in trout farming is the rainbow trout, with a total of production in 2020 of about 380 tons. The majority of produced freshwater fish is intended for the domestic market, although in recent years the increased placement has also been achieved on EU market (Italy, Germany, Hungary, etc.), especially in the segment of carp breeding.

In the last five years, there has been a decline in production in freshwater aquaculture, with the lowest values, both in terms of quantity and value in 2020. The mentioned movements indicate still present problems in this segment of aquaculture, which despite the steps taken in improving the regulatory framework and production investments throughout the past program period, they make it impossible to achieve greater stability in production and the expected growth. The causes of this conditions can be partly related to the recent disturbances in the market that were caused pandemic of the Covid-19 virus, but also from the issue of using basic resources in production, especially disturbances in the availability of water due to increasingly pronounced and long-lasting droughts period, as well as the problems of

predatory species (birds) on farms, and the need for more systematic by monitoring and preventing the occurrence of diseases in cultivation.

Species	2018	2019	2020	2021	2022*
Carp	1.959	2.037	1.691	2.828	2.447
Grass carp	141	122	133	282	229
Silver carp	36	141	161	212	367
Big head carp	301	344	326	414	522
Wels Catfish	23	20	32	32	61
Zander	7	7	6	5	6
Pike	7	9	2	4	3
Rainbow trout	336	364,5	379	328	533
Brown trout	34	8	12	17	14
Other species**	55	48	37	22	44
TOTAL (t)	**2.899**	**3.100**	**2.779**	**4.143**	**4.226**

**preliminary data*

*** tench, common bream, sterlet, largemouth bass, african catfish, siberian sturgeon, other*

Table 2. Production in freshwater aquaculture by species in the period 2018-2022.

In addition to its economic significance within the framework of sectoral policies, its contribution is certainly worth highlighting freshwater aquaculture to the development of rural areas, which is achieved through local employment population and the diversification of activities on breeding grounds, which enriches the hospitality and tourism industry the offer of rural areas and contributions to the development of village (rural) tourism. Also, freshwater aquaculture in the Republic of Croatia also has a distinct ecological significance, contributing to the preservation of biological diversity, considering that the spacious carp ponds, in addition to the primary production function, also represent an important habitats for numerous protected wild species (primarily birds), and as large natural areas values are within the ecological network of the European Union Natura 2000.

2. Aquaculture in Norway

Aquaculture in Norway has been in strong development and growth since early 1970s when Atlantic salmon has been successfully produced in seawater. Investments in research and development, existence of different licenses and close collaboration within industry and between industry and R&D contributed strongly to the growth of this industry. Today aquaculture is the second largest export industry in Norway and the world's largest producer and exporter of Atlantic salmon and Rainbow trout, contributing to the global production of the sustainable food. In 2023, Norway exported 1,3 million tons of sea food for 172 billion NOK corresponding to 39 million of meals daily all year round. Export in 2023 increased by 14 % in comparison to 2022 (https://nokkeltall.seafood.no/). Atlantic salmon export constituted 72% of total export value in 2023 (Figure 1.).

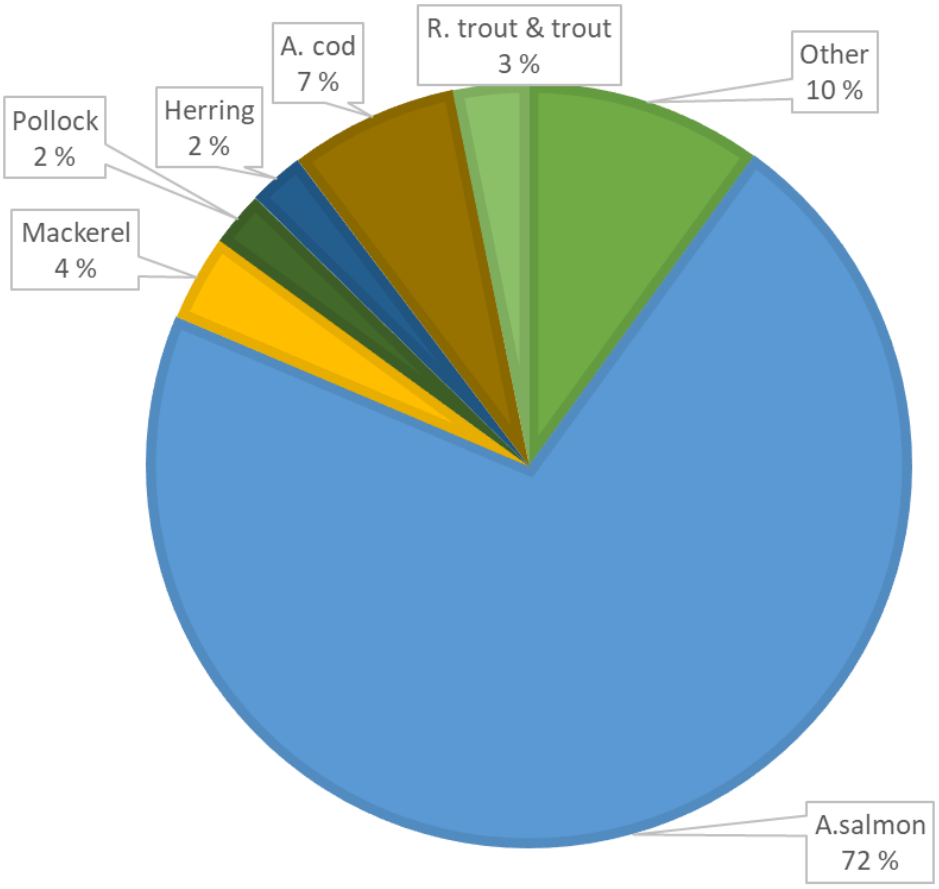


Figure 1. Value of Norwegian seafood exported in 2023 given as a percentage (%) per species.

Aquaculture industry is also very important regional industry that provides jobs and contributes substantially to the development of the rural and costal Norway. The number of employees in aquaculture industry has been increasing steadily from 4327 in 2000 to 10157 in 2022 (https://www.fiskeridir.no/English/Aquaculture/Statistics).

Most of the seafood production in Norway is based on Atlantic salmon, followed by Rainbow trout and other fish species like Atlantic cod, Atlantic halibut, Atlantic char, Wrasse, Lumpfish, turbot etc. In addition, low trophic species like molluscs, cruastaceans, echinoderms and algae are reared in Norway.

Aquaculture production in Norway is regulated in accordance to the Aquaculture Act (Aquaculture Act (fiskeridir.no)) that has the purpose to "promote the profitability and competitiveness of the aquaculture industry within the framework of a sustainable development and contribute to the creation of value on the coast" (chapter I,§ 1). It is prohibited to engage in aquaculture activities without a license granted in accordance with the Aquaculture Act.

Aquaculture in Norway

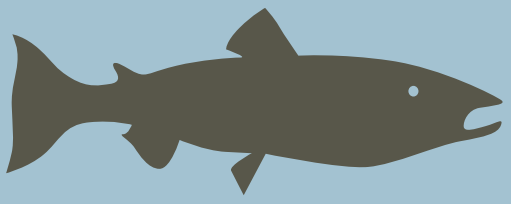
2023

1,3 million tons of sea food

172 billion NOK value

39 million of meals daily

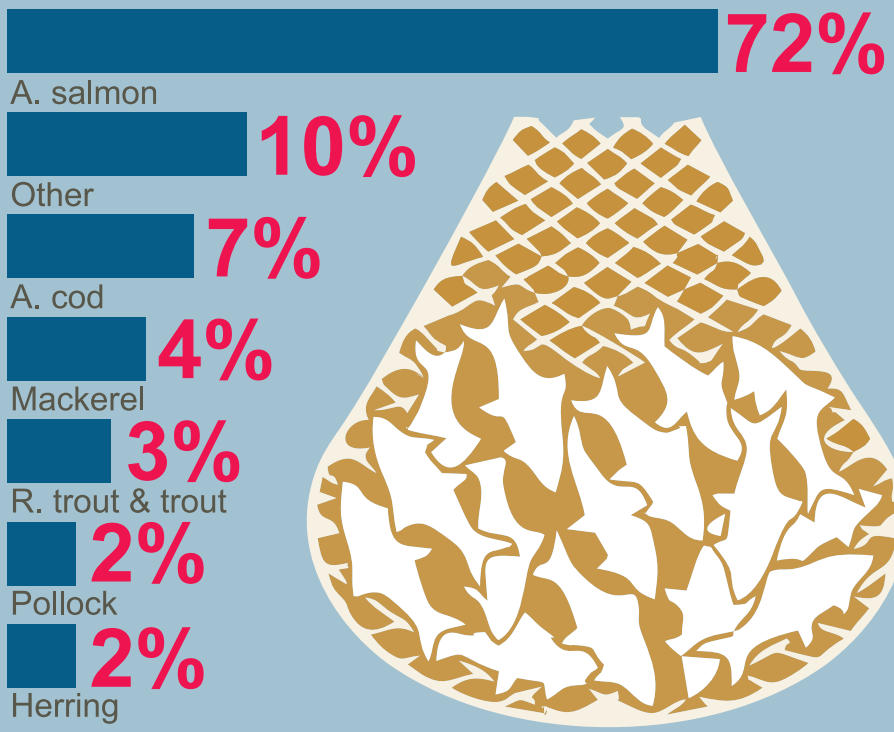
+14% Export **2023**



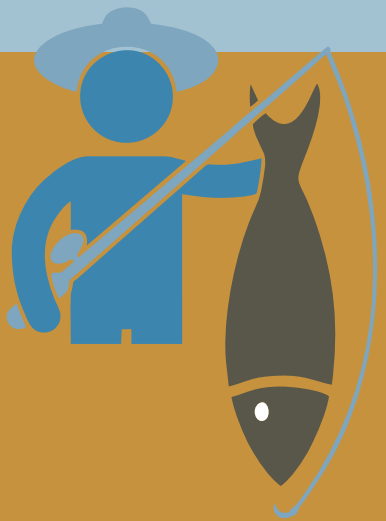
Atlantic salmon export constituted

72%

of total export value in **2023**



The number of employees in aquaculture industry has been increasing steadily from **4327** in 2000 to **10157** in 2022



2.1. Production of Salmonid species

The salmonid species including Atlantic salmon, rainbow trout and trout are the most important aquaculture species in Norway. Aquaculture licenses for salmon, trout and rainbow trout are in particular addressed in the Aquaculture act in Chapter II § 7. The commercial licenses are issued to produce juveniles on land and for grow out in the sea. In addition to those licenses, salmonids are produced in R&D, viewing, development and brood stock licenses that serve as a tool for increasing current knowledge of industry and public. At the end of 2022, total of 1366 commercial licenses (231 for production of juveniles and 1135 for grow out in the sea), 44 licenses for brood stock, 109 R&D licenses, 31 viewing and 21 development licenses were available in Norway for production of salmonid species. The number of licenses in general and for grow out in the sea have been increasing over the years while the number of sites has been decreasing as well as the number of companies with grow-out production (Table 3). Production and sale of Atlantic salmon has been increasing over the years reaching over 1,5 Mil. tons in 2022, while the production of Rainbow trout is recording slight decrease since 2020 (Figure 3). Total export value of salmonids has been increasing the last three years although the amount of exported volume has been reduced.

The use of recirculating aquaculture systems (RAS) for production of juveniles and Atlantic salmon post-smolts on land has been increasing steadily in the recent years. In 2020 approximately one half of the hatcheries used this technology in salmon production. In addition, several initiatives for grow-out production on land have been realized based on flow-through and partial re-use technologies.

Unfortunately, the mortalities of farmed salmon in the grow out phase have been high in the recent years. Increase in mortality from 58 million individuals in 2022 (16.1%) to 65 million individuals in 2023 was attributed to jelly fish attack in autumn 2023, prevention of the spread of pancreatic disease (PD) and an increase in the number of salmon in the sea in 2023 compared to the previous year (Grefsrud et al., 2024. Risk report Norwegian fish farming, ISSN:1893-4536). One of the main reasons for reduced salmon welfare during grow out phase are damages caused by non medicamental delousing, followed by complex gill diseases and winder ulcers (Sommerset I, Wiik-Nielsen J, Oliveira VHS, Moldal T, Bornø G, Haukaas A og Brun E. Fiskehelserapporten 2022, Veterinærinstituttets rapportserie nr. 5a/2023, utgitt av Veterinærinstituttet 2023, ISSN nr 1893-1480, in Norwegian).

Table 3. Statistics from Norwegian aquaculture producers of Atlantic salmon, rainbow trout and trout from the Norwegian Directorate of Fisheries (https://www.fiskeridir.no/English/Aquaculture/Statistics/Atlantic-salmon-and-rainbow-trout) and https://nokkeltall.seafood.no/

Atlantic salmon, rainbow trout and trout	2018	2019	2020	2021	2022	2023
Number of licenses*	1437	1477	1540	1550	1571	1615
Number of sites in sea water	1015	966	986	990	989	990
Total number of companies with grow out production	174	170	163	166	165	
Total number of licenses with grow out production	1160	1187	1221	1243	1250	
Sale of slaughtered fish (metric tons)						
Salmon	1282003	1364042	1388434	1562415	1564948	
Rainbow trout	68216	83290	96132	94660	85223	
Trout	129	199	132	398	392	
Export (metric tons)**	1099872	1178235	1213079	1346398	1309052	1290555

*Atlantic salmon, rainbow trout and trout include commercial, breed stock, education, research, development and viewing

2.2. Production of other fish species

The number of licenses for production of other fish species have almost doubled from 270 in 2018 to 426 in 2023 (Figure 4). Similar trend has been observed when it comes to number of sites in sea water that have increased from 42 in 2018 to 75 in 2023.

Table 4. Statistics from Norwegian aquaculture producers of other fish species than Atlantic salmon, rainbow trout and trout from the Norwegian Directorate of Fisheries. (https://www.fiskeridir.no/English/Aquaculture/Statistics/Other-fish-species)

Other fish species	2018	2019	2020	2021	2022	2023
Number of licenses*	270	272	290	310	378	426
Number of sites in sea water	42	64	36	41	48	75
Total number of companies with grow out production	47	44	54	55	53	
Total number of licenses with grow out production	86	82	127	135	141	

*Other fish species inkludes hatcheries, grow out and breading licenses

The largest number of licenses by the end of 2022 for single species were issues for production of Wrasse species (232 licenses) followed by Atlantic cod (147 licenses), Lumpfish (86 licenses) and Atlantic halibut (70 licenses). Both Lumpfish and Wrasses were in focus for number of years as cleaner fish and biological delousing method. However, since 2020 the number of cleaner fish used in sea cages with salmon has been reducing (Sommerset I, Wiik-Nielsen J, Oliveira VHS, Moldal T, Bornø G, Haukaas A og Brun E. Fiskehelserapporten 2022, Veterinærinstituttets rapportserie nr. 5a/2023, utgitt av Veterinærinstituttet 2023, ISSN nr 1893-1480, in Norwegian).

Increased interest in cod production have been evident in the last couple of years. Governmental investment and continuous support for the national cod breeding program operated by Nofima has improved the production qualities of farmed cod. The use of selective breeding provided so far better growth properties of farmed than wild cod, as well as a greater resistance to important diseases of fish. Currently the program has produced the sixed generation of farmed cod.

2.3. Production of molluscs, crustaceans, enchinoderms and algae

The production of low trophic species, molluscs, cruataceans and echinoderms has been relatively stable since 2018 with small increase in number of licenses. The most common species farmed in Norway by the end of 2022 were Blue musscel (123 licenses), European lobster (26 licenses), Great Atlantic scallop (43 licenses), Sea urchin (41 licenses), flat and cupped oyster (42 licenses) and other species (639 licenses).

Table 5. Statistics from Norwegian aquaculture producers of molluscs, crustanceans and enchinoderms (https://www.fiskeridir.no/English/Aquaculture/Statistics/Molluscs-crustaceans-and-echinoderms)

Mollluscs, crustaceans and echinoderms	2018	2019	2020	2021	2022	2023
Number of licenses	203	221	215	221	213	222
Number of sites in sea water	150	165	141	136	138	134
Number of companies	45	44	41	43	39	

Gross sale of molluscs, crustaceans and echinoderms for consumption has increased from 1721 metric tons in 2018 to 2646 metric tons in 2022. In 2018 Blue mussels constituted 96% of all production while this percentage increased to 99% in 2022.

Production of algae is slowly increasing in Norway and includes among other species production of various kelp species. The first licenses were awarded in 2014. The most common species farmed in Norway by the end of 2022 were Sea belt (119 licenses), babberlocks (106 licenses), tangle (112 licenses), dulse (96 licenses), other species (460 licenses).

In 2018 it was harvested 178 metric tons of farmed algae while the volume increased to 221 metric tons in 2022. In 2018 Sea Belt constituted 98% of whole production while this number decreased to 73% of total production in 2022. Remaining 27% of production was related to babberlocks.

Table 6. Statistics from Norwegian aquaculture producers of algae.
(https://www.fiskeridir.no/English/Aquaculture/Statistics/Algae)

Algae	2018	2019	2020	2021	2022	2023
Number of licenses	406	475	511	520	539	522
Number of sites in sea water		97	93	114	105	111
Number of companies	23	17	27	23	25	