Slaughter of farmed seabass and seabream in Europe

Literature review

Authors:
Ren Ryba (*PhD, GCert Economics, BSc Ecology*)
Koen van Pelt (*MSE Offshore & Dredging*)

Table of Contents

Cover image credit: Selene Magnolia / We Animals Media

Key points

In this report, we give a brief summary of the sea bass and sea bream farming industry in some key countries. We also discuss the technical/engineering challenges with installing electrical stunners on harvest vessels.

Our highest priority countries are Turkey (large industry + large individual farms) and Spain (very large individual farms). We are somewhat excited about Greece (large industry + close to coast, but small individual farms), Egypt (on land, but very small farms), and Italy (smaller industry). There are many other countries where implementing stunning of sea bass and sea bream would probably be impactful in absolute terms.

Country		**Turkey**	**Greece**	**Egypt**	**Spain**	**Italy**
Seabass and seabream slaughtered annually	Number	346 M	235 M	131 M	86 M	37 M
	Weight (t)	257,000 t	100,000 t	66,000 t	35,000 t	14,000 t
	Share of world	36%	25%	14%	9%	4%
	Share of EU-27	-	56%	-	21%	9%
Farms	Description of farms (% of production)	Sea cages (96%) Earthen ponds (4%)	Sea cages	Earthen ponds	Sea cages (~90%) Wetlands (~10%)	Sea cages (78%) Land-based systems (16%) Wetlands (6%)
	Main location of farms	Coastal & off-coast	Coastal	On land	Off-coast & some coastal	Off-coast & some coastal
	Number of farms in country	237 sea cage farms 173 earthen pond farms	347	?	24	24
	Average production per farm	1,040 t (sea cages) 59 t (ponds)	305 t	Low	1,270 t	350 t
Percentage of production that is exported		75%	92%	< 30%	40%	40%
Destination of exports		Mostly Italy and other EU (~80%), some non-EU (~20%)	Italy (41%) Spain (21%) France (11%) Rest mostly EU, only 5% non-EU	Nearby, non-EU countries only	Mostly EU	Mostly EU

1. Which countries are a priority?

1.1 Where are seabass and seabream farmed?

The following table shows all countries where seabass and seabream are farmed.

	Number slaughtered per year				
	Gilthead seabream	European seabass	Sum	Percent of world	Percent of EU-27
World	*530,801,229*	*423,852,044*	*954,653,273*		
EU-27	*237,673,515*	*181,737,600*	*419,411,115*	*44%*	
Turkey	166,440,000	179,660,000	346,100,000	36%	
Greece	140,758,000	94,570,222	235,328,222	25%	56%
Egypt	76,180,000	54,440,000	130,620,000	14%	
Spain	35,419,714	51,013,756	86,433,470	9.0%	21%
Tunisia	34,765,714	5,697,778	40,463,492	4.2%	
Italy	21,714,286	15,111,111	36,825,397	3.9%	8.8%
Croatia	11,717,029	11,800,044	23,517,073	2.5%	5.6%
Cyprus	14,397,143	3,371,111	17,768,254	1.9%	4.2%
France	4,000,000	4,888,889	8,888,889	0.9%	2.1%
Malta	6,346,314	86,267	6,432,581	0.7%	1.5%
Saudi Arabia	6,342,857	0	6,342,857	0.7%	
Israel	5,900,000	148,889	6,048,889	0.6%	
Portugal	3,321,029	896,200	4,217,229	0.4%	1.0%
United Arab Emirates	1,571,429	666,667	2,238,096	0.2%	
Algeria	771,429	200,000	971,429	0.1%	
Occupied Palestinian Territory	714,286	0	714,286	0.1%	
Mauritius	0	651,111	651111	0.1%	
Bosnia and Herzegovina	267,714	176,667	444,381	0.0%	
Montenegro	168,571	175,556	344,127	0.0%	
Morocco	0	297,778	297778	0.0%	
Bahrain	5,714	0	5,714	0.0%	

Assumes that seabream are harvested at a weight of 0.35 kg and that seabass are harvested at a weight of 0.45 kg.
Source: Open Philanthropy (1)

The following map shows the locations of fish farms in Turkey, Greece, Spain, and Italy. Note that only marine farms are shown, so the small proportion of land-based sea bass and sea bream farms are excluded. Teal points denote exact locations, and red points denote approximate, estimated locations. Data points are from the data published by Clawson *et al* (2). Access the map via Google Earth Engine [here](#).

1.2 How much power do these countries have in the European Union?
The Council of the European Union is one of the two legislative bodies of the EU. Typically, any legislation passed by the EU needs to be first approved by the Council.

The Council aims to represent the interests of Member States, not voters or parties (like the European Parliament, the other legislative body). This means that targeting one, or a small number of, key Member States may make the Council more supportive of animal welfare reforms, which in turn could increase both the frequency and magnitude of the EU's animal welfare reforms.

The following table shows the power of each EU Member State that farms seabass and/or seabream on the Council. See appendix for a full explanation of the NBI and PPI.

	Rank among EU-27	Normalised Banzhaf Index (NBI)	Preventive Power Index (PPI)
France	2	10.0%	65.6%
Italy	3	9.2%	60.6%
Spain	4	7.6%	50.2%
Greece	9	3.0%	19.5%
Portugal	10	2.9%	19.2%
Croatia	20	2.2%	14.3%
Cyprus	25	1.8%	11.7%
Malta	27	1.7%	11.3%

2. Description of industry in priority countries

2.1 Turkey

In 2019, aquaculture enterprises in Turkey produced a total of 137,400 tonnes (t) of sea bass and 99,730t of sea bream (3). These two species are mostly farmed using floating cages (96% of production), though a minority of production involves earthen ponds (4%) (3).

For sea bass and sea bream, there were 410 enterprises in 2018 (excluding hatcheries) (3). Of these 410 enterprises, 237 were sea cages (accounting for 96% of production) and 173 were earthen ponds (accounting for 4% of production). This means that sea cage enterprises tend to have relatively large volumes of production, with the mean sea cage enterprise producing around 1,040 t.

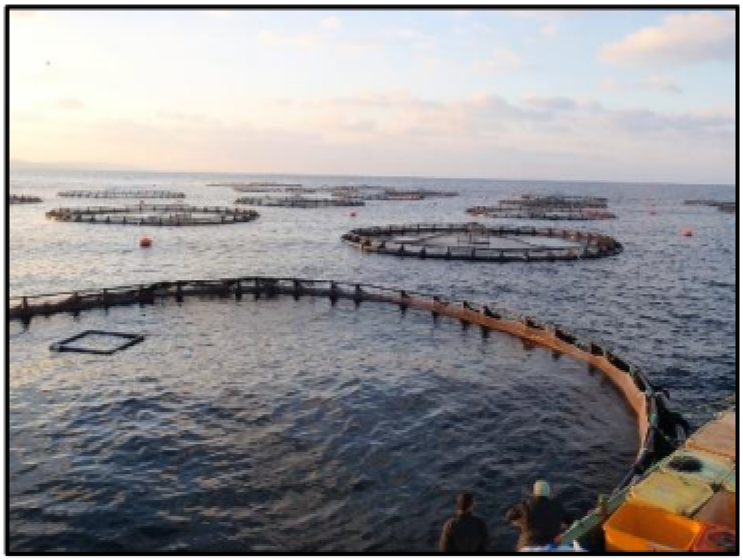
Most of the sea bass and sea bream produced in Turkey is exported. For the two species combined, Turkey exports approximately 75% of production. The major destination countries are Italy, Spain, France and other EU Member States (4), with a small amount of production going to the Far East, Middle East, Asia and the Americas (3).

The key pieces of legislation governing the welfare of fish in aquaculture in Turkey are:

- Fisheries Law No. 1380. An important regulation in this law requires that new aquaculture facilities be planned to minimise their environmental impact.
- The Aquaculture Regulation, published in the Official Gazette No. 25507 dated 29.06.2004.
- Circular on welfare of fish in aquaculture (2018/3), which is based on the Aquaculture Regulation. "This circular aims to determine the minimum standards of rearing, care and welfare of fish grown for food production and other purposes taking into account general biological characteristics and to harmonise the national regulation with the European

> Union Council Directive 98/58/EC concerning the protection of animals kept for farming purposes." (3).

Since late 2020, new farms can only be established 500+ metres from shore (1,250 metres for sensitive marine areas) at a depth of 30+ metres (40 metres for sensitive marine areas) (3). This means that Turkish fish farms would be classified as "coastal" or "off-coast".



A photo of floating sea cages in Turkey (3).

2.2 Greece

In 2019, aquaculture enterprises in Greece produced a total of 41,300 tonnes (t) of sea bass and 55,500t of sea bream (5). These two species are farmed using inshore floating sea cages (6). These cages are much closer to the shore than in Italy. Videos of seabass and seabream on Greek farms are available from Essere Animali's undercover investigations (Youtube) (7).

For sea bass and sea bream, there were 347 enterprises in 2018, with an average of eight full-time equivalent employees per enterprise (8). Most enterprises belong to larger parent companies (6,8). The industry is continuing this consolidation into larger companies.

Most of the sea bass and sea bream produced in Greece is exported. For the two species combined, Greece exported 88,700 t in 2019 (9). This represents about 92% of production. The major destination countries are Italy (41% of exports), Spain (21%), and France (11%). Overall, 95% of exports are destined for the EU, and 5% are destined for third countries.

On average, Greek fish farms are 68 metres from the coastline (10,11). This means that Greek production would be mostly "coastal".

The Greek aquaculture industry has expressed interest in fish welfare. The Federation of Greek Maricultures participates in programs to research fish welfare and establish guidelines. The 'Fish from Greece' certification scheme, which is widespread, certifies products according to six pillars - one of these pillars is fish welfare (see https://fishfromgreece.com). There has been initial, experimental interest in electrical stunning before slaughter (12). However, despite the industry's concern for fish welfare, the industry has not yet adopted a humane slaughter method like electrical stunning (12).

Charity Entrepreneurship is currently incubating a new organisation working on fish welfare in Greece. Their research report contains the following information that is relevant here (13):

- There are some pessimistic signs about the tractability of fish welfare work in Greece: farmers are concerned that they can't fit electrical stunners on the boats they currently use to harvest fish; the government seems to be pushing towards deregulation of the industry and so might not have a lot of appetite for welfare legislation; and Greece is generally seen as a laggard in the EU when it comes to animal welfare. The government is "currently trying to deregulate the market as they are competing with Turkey to try and capture the American market and so they are attracting American investment to set up aquaculture farms and trying to attract funding for facilities that wouldn't be allowed anywhere else on terms that are very friendly to investors."
- There are also some optimistic side: the Greek government took the lead in developing fish welfare guidelines which were adopted by the EU Platform on Animal Welfare; and technical experts in Greece have worked with the sector to produce detailed guidance specifically for seabass and sea bream and so perhaps they would have interest in working to improve this welfare.
- "Greece holds the presidency of the Council of the EU in July-December 2027. It will not hold this presidency again for 13.5 years. This would be the time that it would be able to have the biggest influence of EU policy and agenda setting, so it would be great if we could get Greek policymakers on the side of fish welfare and have some fish welfare legislation enshrined in legislation in Greece before this."

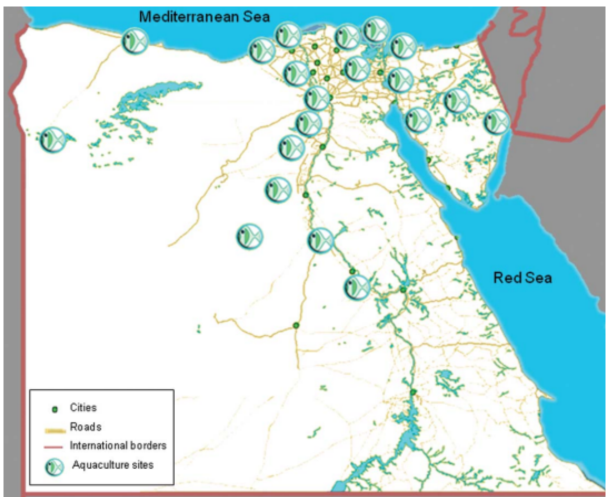
2.3 Egypt

In 2017, aquaculture enterprises in Egypt produced a total of 30,700 tonnes (t) of sea bass and 35,200t of sea bream (14). Egypt is unique in that the sea bass and sea bream industry takes place almost entirely in earthen ponds (15). Almost all of these farms are small- or medium-scale (15). Sea bass and sea bream account for only about 2% of aquaculture production (15). Most production takes place on Egypt's northern coast in the Mediterranean, with the majority taking place in Damietta Governorate and some in other areas (e.g. Alexandria, Ismaila, Port Said) (15).

The government of Egypt intends to expand production substantially by establishing new, large-scale production enterprises (16). In 2016, it was reported that Egypt was building new farms in the Suez Canal, Kafr El Sheikh, and East Port Said (17). These three projects would have a combined annual production capacity of 400,000 t of fish, including sea bass and sea bream.

Most of the sea bass and sea bream produced in Egypt is consumed domestically. Exports are modest. In 2015, 25,000 t of saltwater fish were exported, though most of these were sea bass or sea bream (17). Egypt cannot export fish to the EU, as Egypt does not comply with European Council Directive 91/493/EEC on health conditions for the production and placing on the market of fishery products (15).

Egypt has a number of laws regulating the environmental impact of aquaculture (15).



Left: A map of aquaculture enterprises in Egypt (18) Right: A photo of an Egyptian earthen pond fish farm (15).

2.4 Spain

In 2017, aquaculture enterprises in Spain produced a total of 17,700 tonnes (t) of sea bass and 17,000t of sea bream (14). These two species are mostly farmed using floating sea cages (90% of production), though a minority of production takes place in wetlands/brackish water (10%) (8). Sea bass and sea bream are the main species produced by Spain in terms of value (19), and most of the production takes place in the coast of the Mediterranean (8).

For sea bass and sea bream, there were 24 enterprises in 2018 (excluding hatcheries) (8). This means that Spain has a mean production volume of 1,270 t, higher than any other country we consider in-depth in this report (Turkey, Greece, Egypt, and Italy).

Annually, Spain exports around 13,000 t of sea bass and sea bream, while it imports around 29,000 t (20,21). This means that most (~60%) of the country's production is consumed domestically and that imported products make up almost half of the domestic market.

On average, Spanish fish farms are 1,106 metres from the coastline (10). This means that most fish farms would be classified as "off-coast", though there is a lot of variation and some farms would be classified as "coastal".

A floating-cage sea bass farm in Spain (22)

2.5 Italy

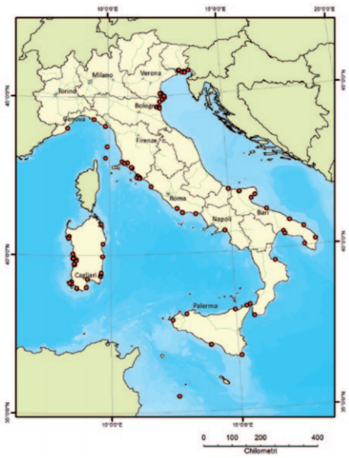
Most fish farmed in Italy belong to freshwater species. In comparison, there is a small amount of fish farming in marine (i.e., saltwater) farms. The key marine species farmed in Italy are seabass and seabream (23).

There is a complete lack of legal provisions detailing how fish should be treated. The main regulatory authority for aquaculture is the Ministry of Agriculture and Forest Policies (24); however, the focus of that Ministry is environmental sustainability and economic development, rather than fish welfare (25,26). Existing international guidelines fare no better, with international codes of conduct failing to provide any meaningful consideration for fish welfare (27). Even existing protections for the welfare of animals at the time of killing fail to extend to fish. To illustrate, the European Union's Regulation (EC) 1099/2009 (28) provides some guidelines for the slaughter of animals, but justifies a lack of recommendations for fish on the basis of ‘a need for further scientific opinion and economic evaluation in this field’. The lack of legal provisions means that farmers are incentivised to make husbandry decisions according to economic motivations, rather than the welfare of the fish.

Seabass and seabream are the two major marine fish species farmed in Italy. The majority (ca. 78%) of sea bass and sea bream are farmed in intensive, floating sea cages (see figure below) [2,7]. The size of the marine cage depends on the life stage of the fish and the water depth. During the grow out phase, the cages typically have a diameter of 30-50m and a net depth of between 12-20m (29). Beyond this, some are farmed in land-based systems (ca. 16%), and a small minority are farmed in wetlands (ca. 6%) [8], specifically in extensive brackish water 'valli', ponds, and lagoons. This generally occurs off the northern Adriatic regions and in Sardinia, Sicily, Apulia and Lazio (30).

Annually, Italy exports around 8,000 t of sea bass and sea bream, while it imports around 77,000 t (20,21). This means that most (~60%) of the country's production is consumed domestically and that imported products dominate the domestic market. Therefore, it is also important to consider the conditions in which these fish are raised in other countries, particularly Greece.

On average, Italian fish farms are 991 metres from the coastline (10). This means that most fish farms would be classified as "off-coast", though there is a lot of variation and some farms would be classified as "coastal".



Left: A map showing the geographic location of the farms that produce sea bream and sea bass in Italy. (31) Right: A photo of one such farm.

3. Electrical stunning

Electrical stunning involves exposing fish to an electric current to rapidly render the fish unconscious, either temporarily or permanently.

Electrical stunning comes in two forms: in-water and in-air. The efficacy of each depends on the electrical current and duration of the stun. Either method can potentially be followed by a secondary killing method or an additional, percussive stun. To illustrate, sea bass and sea bream are raised in cages and captured using brailing or pumping. (Brailing involves the use of a large net that is hoisted by a crane (34).) Where fish are captured by brailing, the more appropriate stunning system is in-water; fish are placed in a tank in batches and exposed to an electric field until they are permanently insensible. Likewise, where fish are captured by pumping, in-water stunning can also be used. Fish are passed along a channel through which an electrical current is passed (39). In-air stunning can be used in either case but requires the fish to be dewatered beforehand. Previous experiments by Tesco for their supply chain in the UK found that pumping systems were preferable as it reduced crowding, and thus the stress on the fish (40), while maintaining a similar rate efficiency in moving fish (41).

Several studies have found that electrical stunning produces immediate loss of consciousness or sensibility in seabass (35,42,43) and seabream (37). The use of higher currents and a longer duration generally have greater efficacy and result in longer periods of insensibility (39,44,45). It is important that current and duration are carefully selected based on the method of electrical stunning, the method of handling, and the subsequent killing method will be used.

It is important to note that no single stunning method has proved to be 100% effective. Thus, in addition to the primary stunning method, it is critical for staff to be trained to provide a backup stun when staff observe signs of consciousness. For example, a backup percussive stun can be delivered by trained staff members.

4. Equipment options

Animal Ask spoke with a number of companies offering equipment for humane slaughter in aquaculture in Europe to validate the European Commission's figures.

The following information summarises the options available for electrical stunning equipment *installed on land*. On-boat stunners for sea bass and sea bream may cost more and present greater engineering challenges [10]. We discuss on-board stunners in the next section of this report.

For stunning equipment, Animal Ask spoke to Ace Aquatec who offer in-water electrical stunners for a variety of fish species, including trout, sea bass, and sea bream. These stunners are connected to a centrifugal fish pump capturing fish from sea pens or raceways. Fish are rendered insensible in water during capture without any prior need for handling. One of Ace Aquatec's clients, Scottish Sea Farms, found that the fish are significantly easier to handle as they are only handled when unconscious. This allowed the company to double their harvest rate using the same labour [25]. This also reduced the risks faced by staff who would otherwise have to handle large, stressed fish.

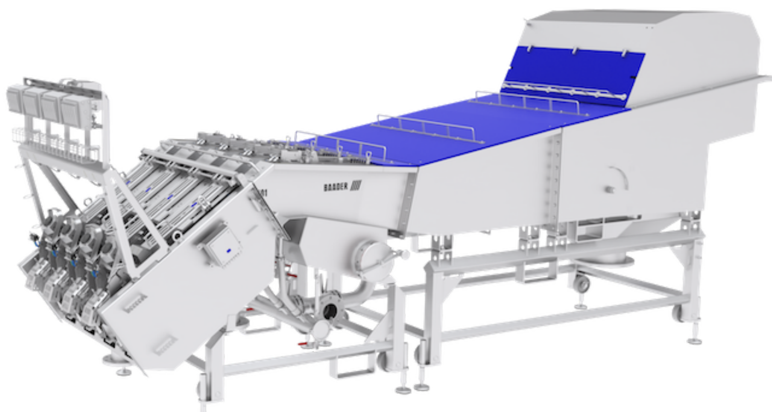
Although the true cost of this equipment will vary according to the specific context, Ace Aquatec was able to provide us with a general quote of approximately 100,000 € for a stunner for trout, and 120,000 € sea bass and sea bream.

(source: Ace Aquatec)

One alternative to this is a dry stunner, such as those available from OPTIMAR which can be outfitted for both trout and sea bass/bream (https://optimar.no). The stunner is appropriate for capture and stunning in both freshwater and sea cage aquaculture after dewatering and has been used on small vessels.

(source: Optimar)

The final method of stunning available is percussive stunners, such as those available from BAADER (https://fish.baader.com/products/baader-101). However, we were unable to obtain general quotes for either of these products.



(source: BAADER)

There are a variety of pumps that can be used to capture fish prior to stunning with one of the above systems. Brands producing these pumps include FAIVRE (http://www.faivre.fr/), VAKI (https://vakiiceland.is/pumps/), Washpower (https://washpower.com/bluecomfort/) and Milanese (http://www.milaneseitalia.com/en/185vs.htm). There are pumps suitable for trout, sea bass, and sea bream of all sizes. Depending on the particular pump, the capacity ranges from 5 to 85 tons/hour, with prices varying accordingly from 20,000 to 66,000 €. One model to highlight is the pump produced by the Italian company Milanese's Art. Their '185/Maxi' pump costs 20,800 € with a 3,000 € dewatering unit, and handles fish up to 0.9kg at 30 tonnes per hour.

(source: VAKI)

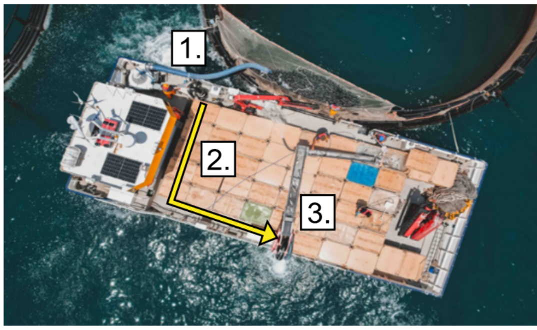
(source: FAIVRE)

5. Marine engineering challenges

If stunning equipment is to be installed on aquaculture vessels a good overview of the feasibility and costs of installing is required. Examples of stunning devices being installed on work vessels in the Mediterranean are rare, and technical information and cost overviews are not available. Of key influence on the installation costs is whether stunning equipment can be installed on a new build or existing vessel.

5.1 New build vessels

Installing stunning equipment on new build vessels, if planned correctly, would require less work, time and capital compared to refitting an existing vessel. Any necessary equipment could be installed during the general construction phase of the vessel. The figures below show a top and side view of a Greek vessel where an Ace Aquatec system was installed during ship construction. In this case the stunning device is installed along with a centrifugal fish pump and a system that can transport the stunned fish to the ice slurry crates.



1. Centrifugal fish pump
2. Below deck stunning
3. Transport to ice slurry crates

(source: VIM MEDIA) (source: aquaculturemag)

5.2 Existing vessels

Outfitting an existing vessel with stunning equipment is likely to require some changes to the vessel's structure. Considering that deck space is essential for storing fish and conducting operations, it's expected that boat operators may be hesitant to reduce the deck area currently used for fishing activities. Consequently, part of the equipment may need to be installed below deck. The feasibility and costs of installing stunning equipment depend on the type of vessel being considered. To get a clear picture, reaching out to shipyards for a price estimate is crucial. However, it can be challenging to find readily available information about the types of vessels commonly used for this purpose. Some key considerations for outfitting existing vessels with stunning equipment are:

- Can the stunning rate match the original harvest rate?
- Is the hull structure suitable for below deck equipment? (e.g. catamaran vs. monohull)
- Can installation of stunning equipment be combined with other ship maintenance, and with that reduce installation costs?
- Can the installed power generation support the stunning devices? (Is the propulsion diesel-electric, diesel or other?)

Another important aspect to consider is how well the existing operational methods on the vessel align with the integration of stunning equipment. Currently, fish are mainly brought aboard using smaller nets lifted by an onboard crane. Examples of combining this technique with stunning were not found and would likely complicate the harvesting procedure. Changing the structure and procedures on a vessel could also lead to problems with the vessels classification. Most aquaculture vessels found have a length below 24 metres. For ships below 24 m regulations specific for small service crafts apply. In the subset of small service crafts there no specific aquaculture regulations seem to exist, however it could be that regional or national regulations are present.

(Source: Esseri Animali)

Appendix: Council of the European Union

When the Council votes on a proposal, the procedure is:

- The proposal passes if it is supported by at least 55% of Member States (i.e. 15 of 27 Member States), which together need to represent at least 65% of the population of the EU.
- The proposal fails if it does not meet that criterion and if it is opposed by at least 4 Member States. In other words, a proposal can be blocked by a coalition of at least 4 Member States who represent at least 35% of the population of the EU.

This procedure can vary in a few corner cases, but those tend to be rare (51).

Our ability to study the voting process of the Council is hindered by one key fact: the results of votes are made public, but the actual negotiations on particular proposals take place behind closed doors. It is only when an agreement is reached that a public vote takes place (52). The Council members typically negotiate until they achieve a consensus - when that happens, a public vote occurs, and the vote is usually unanimous (52,53). The actual negotiations occur well before the vote, behind closed doors. Whether a Member State is able to obtain concessions on a particular proposal - and the size and nature of those concessions - depends on the power of that Member State in a forming coalition to either support or block the proposal (53). This is an informal process.

How, then, can we figure out which Member States hold the most sway over the Council's decisions? In a series of modelling studies, Kleinowski calculates the voting power of each Member State post-Brexit (51,53,54). Kleinowski calculates two mathematical metrics that describe the voting power of Member States:

- The Normalised Banzhaf Index (NBI) indicates the probability that an EU Member State will find itself in a position where a proposal's approval hinges on the support of that Member State.
- The Preventive Power Index (PPI) indicates the percentage of blocking coalitions in which an EU Member State is a critical member.

References

1. Open Philanthropy Project. Finfish numbers [Internet]. Available from: https://docs.google.com/spreadsheets/d/12pA0UxIbRDcfY5g25XZ7na4duhj6411l-1-_3tRH48k
2. Clawson G, Kuempel CD, Frazier M, Blasco G, Cottrell RS, Froehlich HE, et al. Mapping the spatial distribution of global mariculture production. Aquaculture. 2022 May 15;553:738066.
3. Çoban D, Didem Demircan M, Tosun DD, editors. Marine Aquaculture in Turkey: Advances and Management. Turkish Marine Research Foundation; 2020.
4. Bjørndal T, Guillen J. Market integration between wild and farmed seabream and seabass in Spain. Appl Econ. 2017 Sep 26;49(45):4567–78.
5. European Commission. Eurostat [Internet]. [cited 2022 Mar]. Available from: https://ec.europa.eu/eurostat/data/database
6. Pavlidis MA, Mylonas CC, editors. Sea bream: biology and aquaculture of gilthead sea bream and other species. Ames, Iowa: Wiley-Blackwell; 2011.
7. For the protection of fish in intensive farms - Fish Too - Essere Animali [Internet]. 2019 [cited 2021 Nov 23]. Available from: https://www.essereanimali.org/en/fishtoo/
8. Nielsen R, Guillen J, Virtanen J. Scientific, Technical and Economic Committee for Fisheries (STECF) - The EU Aquaculture Sector – Economic report 2020 (STECF-20-12) [Internet]. European Commission; 2021. (JRC Science for Policy Report). Available from: https://stecf.jrc.ec.europa.eu/documents/43805/2783239/STECF+20-12+-+EU+Aquaculture+economics.pdf/ef242822-3343-43f4-b0a3-dfad889dd52c?version=1.0
9. Federation of Greek Maricultures. Annual Report: Aquaculture in Greece 2020 [Internet]. Federation of Greek Maricultures; 2020. Available from: https://fgm.com.gr/uploads/file/FGM_20_ENG_PRINT.pdf
10. Hofherr J, Natale F, Trujillo P. Is lack of space a limiting factor for the development of aquaculture in EU coastal areas? Ocean Coast Manag. 2015 Nov 1;116:27–36.
11. Katselis G, Tsolakos K, Theodorou JA. Mapping of Greek Marine Finfish Farms and Their Potential Impact on the Marine Environment. J Mar Sci Eng. 2022 Feb 18;10(2):286.
12. European Commission. Welfare of farmed fish: Common practices during transport and at slaughter [Internet]. European Commission; 2017. Available from: https://publications.europa.eu/resource/cellar/facddd32-cda6-11e7-a5d5-01aa75ed71a1.0001.01/DOC_1
13. Cox V. Influencing EU fish welfare policy through strategic work in Greece. Charity Entrepreneurship; 2023.
14. Fishcount. Fishcount. 2017. Estimated numbers of individuals in aquaculture production (FAO) of fish species (2017). Available from: http://fishcount.org.uk/studydatascreens2/2017/numbers-of-farmed-fish-B0-2017.php
15. Soliman NF, Yacout DMM. Aquaculture in Egypt: status, constraints and potentials. Aquac Int. 2016 Oct 1;24(5):1201–27.
16. Feidi I. Will the new large-scale aquaculture projects make Egypt self sufficient in fish supplies? MedFAR. 2018 Jan 23;1(1):31–41.
17. Wally A. The State and Development of Aquaculture in Egypt [Internet]. USDA; 2016. Available from: https://apps.fas.usda.gov/newgainapi/api/report/downloadreportbyfilename?filename=The%20State%20and%20Development%20of%20Aquaculture%20in%20Egypt%20_Cairo_Egypt_11-6-2016.pdf
18. Shaalan M, El-Mahdy M, Saleh M, El-Matbouli M. Aquaculture in Egypt: Insights on the Current Trends and Future Perspectives for Sustainable Development. Reviews in Fisheries Science & Aquaculture. 2018 Jan 2;26(1):99–110.
19. Nielsen R, Guillen J, Carvalho N. Scientific, Technical and Economic Committee for Fisheries (STECF) - Economic Report of EU aquaculture sector (STECF-16-19) [Internet]. European Commission; 2016. Available from: https://www.bluesprout.eu/repo/docs/Economic_Report_EU_aquaculture_sector_STEC_16_19.pdf
20. Spanish Aquaculture Business Association. Aquaculture in Spain 2020 [Internet]. APROMAR; 2020. Available from: https://apromar.es/wp-content/uploads/2021/12/Aquaculture-in-Spain-2020.pdf
21. Compassion in World Farming. European seabass (Dicentrarchuslabrax) statistics summary [Internet]. Food Business; 2021. Available from:

https://www.compassioninfoodbusiness.com/media/7447727/european-seabass-in-numbers.pdf
22. Sourd P, Lopez M, Jimenez M, Pounds A. Global Seafood Alliance. 2021. Precision sea bass: New technologies at Mediterranean Seafarms. Available from: https://www.globalseafood.org/advocate/precision-sea-bass-new-technologies-at-mediterranean-seafarms/
23. FAO fisheries & aquaculture national aquaculture sector overview (NASO) [Internet]. 2006 [cited 2021 Nov 16]. Available from: https://www.fao.org/fishery/countrysector/naso_italy/en
24. Mipaaf - homepage [Internet]. [cited 2021 Nov 16]. Available from: https://www.politicheagricole.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/202
25. Mipaaf - Acquacoltura [Internet]. [cited 2021 Nov 16]. Available from: https://www.politicheagricole.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/3555
26. FAO.org [Internet]. [cited 2021 Nov 16]. Available from: https://www.fao.org/faolex/results/details/en/c/LEX-FAOC044708/
27. FAO Fisheries & Aquaculture Italy [Internet]. 2005 [cited 2021 Nov 16]. Available from: https://www.fao.org/fishery/legalframework/nalo_italy/en
28. COUNCIL REGULATION (EC) N. 1099/2009 of 24 September 2009 relating to the protection of animals during killing [Internet]. [cited 2021 Nov 16]. Available from: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:303:0001:0030:IT:PDF
29. WWF. SEA BASS AND SEA BREAM SUPPLY CHAIN STUDY: FROM TURKEY TO EUROPE [Internet]. 2021 [cited 2021 Dec 6]. Available from: https://www.fishforward.eu/wp-content/uploads/2021/07/WWF_supply_chain_study_2021_seabass_seabream.pdf
30. Italy - Eurofish.dk [Internet]. [cited 2021 Nov 11]. Available from: https://www.eurofish.dk/italy
31. Mipaaf - “The state of Italian marine fisheries and aquaculture” edited by S. Cautadella e M. Spagnolo [Internet]. [cited 2022 Jan 3]. Available from: https://www.politicheagricole.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/6412
32. Panel on Animal Health and Welfare. Species-specific welfare aspects of the main systems of stunning and killing of farmed seabass and seabream. The EFSA Journal [Internet]. 2009 Apr; Available from: https://www.efsa.europa.eu/en/efsajournal/pub/1010
33. Simitzis PE, Tsopelakos A, Charismiadou MA, Batzina A, Deligeorgis SG, Miliou H. Comparison of the effects of six stunning/killing procedures on flesh quality of sea bass (Dicentrarchus labrax,Linnaeus 1758) and evaluation of clove oil anaesthesia followed by chilling on ice/water slurry for potential implementation in aquaculture. Aquac Res [Internet]. 2013 Jan; Available from: https://onlinelibrary.wiley.com/doi/10.1111/are.12120
34. de la Rosa I, Castro PL, Ginés R. Twenty Years of Research in Seabass and Seabream Welfare during Slaughter. Animals (Basel) [Internet]. 2021 Jul 22;11(8). Available from: http://dx.doi.org/10.3390/ani11082164
35. Zampacavallo G, Parisi G, Mecatti M, Lupi P, Giorgi G, Poli BM. Evaluation of different methods of stunning/killing sea bass (Dicentrarchus labrax) by tissue stress/quality indicators. J Food Sci Technol. 2015 May;52(5):2585–97.
36. Van De Vis H, Kestin S, Robb D, Oehlenschläger J, Lambooij B, Münkner W, et al. Is humane slaughter of fish possible for industry? Aquac Res. 2003 Feb;34(3):211–20.
37. Panel on Animal Health and Welfare. Species-specific welfare aspects of the main systems of stunning and killing of farmed fish: Rainbow Trout. The EFSA Journal [Internet]. 2009 Apr; Available from: https://efsa.onlinelibrary.wiley.com/doi/abs/10.2903/j.efsa.2009.1012
38. Lines JA, Spence J. Safeguarding the welfare of farmed fish at harvest. Fish Physiol Biochem. 2012 Feb;38(1):153–62.
39. Lines JA, Robb DH, Kestin SC, Crook SC, Benson T. Electric stunning: a humane slaughter method for trout. Aquacult Eng. 2003 Aug 1;28(3):141–54.
40. Merkin GV, Roth B, Gjerstad C, Dahl-Paulsen E, Nortvedt R. Effect of pre-slaughter procedures on stress responses and some quality parameters in sea-farmed rainbow trout (Oncorhynchus mykiss). Aquaculture. 2010 Nov 22;309(1):231–5.
41. Driving Innovation in Humane Fish Slaughter: Developing an electrical stunning system for European sea bass and gilthead sea bream [Internet]. Compassion in World Farming; [cited 2021 Dec 8]. Available from: https://www.compassioninfoodbusiness.com/media/7439262/tesco-driving-innovation-in-humane-fish

-slaughter.pdf
42. Lambooij B, Gerritzen MA, Reimert H, Burggraaf D, André G, Van De Vis H. Evaluation of electrical stunning of sea bass (Dicentrarchus labrax) in seawater and killing by chilling: welfare aspects, product quality and possibilities for implementation [Internet]. Vol. 39, Aquaculture Research. 2007. p. 50–8. Available from: http://dx.doi.org/10.1111/j.1365-2109.2007.01860.x
43. Giuffrida A, Pennisi L, Ziino G, Fortino L, Valvo G, Marino S, et al. Influence of slaughtering method on some aspects of quality of gilthead seabream and smoked rainbow trout. Vet Res Commun. 2007 May;31(4):437–46.
44. Jung-Schroers V, Hildebrandt U, Retter K, Esser KH, Hellmann J, Kleingeld DW, et al. Is humane slaughtering of rainbow trout achieved in conventional production chains in Germany? Results of a pilot field and laboratory study. BMC Vet Res. 2020 Jun 15;16(1):197.
45. Robb DHF, O’ Callaghan M, Lines JA, Kestin SC. Electrical stunning of rainbow trout (Oncorhynchus mykiss): factors that affect stun duration. Aquaculture. 2002 Mar 11;205(3):359–71.
46. Kestin SC, Wotton S, Adams S. The effect of CO2, concussion or electrical stunning of rainbow trout (Oncorhynchus mykiss) on fish welfare. Quality in aquaculture, Special Publication. 1995;(23):380–1.
47. Robb DH, Wotton SB, McKinstry JL, Sørensen NK, Kestin SC. Commercial slaughter methods used on Atlantic salmon: determination of the onset of brain failure by electroencephalography. Vet Rec. 2000 Sep 9;147(11):298–303.
48. Trushenski JT, Bowzer JC, Bergman AM, Bowker JD. Developing rested harvest strategies for rainbow trout. N Am J Aquac. 2017 Jan;79(1):36–52.
49. Secci G, Parisi G, Dasilva G, Medina I. Stress during slaughter increases lipid metabolites and decreases oxidative stability of farmed rainbow trout (Oncorhynchus mykiss) during frozen storage. Food Chem. 2016 Jan 1;190:5–11.
50. Humane Slaughter Association. Humane slaughter of finfish farmed around the world [Internet]. 2018. Available from: https://www.hsa.org.uk/downloads/hsafishslaughterreportfeb2018.pdf
51. Kleinowski M. The impact of Brexit on the voting power in the Council of the European Union. Przegląd europejski [Internet]. 2018; Available from: https://www.ceeol.com/search/article-detail?id=880915
52. Sciabolazza VL. Bargaining within the Council of the European Union: An Empirical Study on the Allocation of Funds of the European Budget. Italian Economic Journal. 2022 Jul 1;8(2):227–58.
53. Kleinowski M. The impact of Brexit on the member states’ ability to build blocking coalitions in the Council. Środkowoeuropejskie Studia Polityczne. 2019 Jun 28;(2):5–27.
54. Kleinowski M. The Impact of Brexit and the New Legal Framework for European Statistics in Demography on the Voting Power of Poland in the Council of the European Union. Athenaeum Polskie Studia Politologiczne [Internet]. 2018; Available from: https://cejsh.icm.edu.pl/cejsh/element/bwmeta1.element.ojs-doi-10_15804_athena_2018_59_10