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Num. 1 technical-scientific common scheme for local data collection on fish and fish related data at very local level

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Contents

1. Common scheme for the management of fishery activities at local level

The task is oriented to identify a common scheme for the definition of specific protocols for datacollection at very local level (i.e., landing harbor level), for the proposal of local management measures for fisheries, always in the framework of national policies and EU Directives. Such data are much interesting to tailor local fishery practices, to be adopted in order to face local situationsand conflicts arising in the management of local topics (i.e., Natura 2000 sites) or the coexistenceof different fishing methods. Local data collection and evaluation of fishery practices account withact. 4.1. The common scheme is managed by WP coordinator PP13 and agreed within AAC (Act. 3.1).

Each partner involved implements data collection, also in collaboration with the local associations of operators. As a result, from local data collection, local measures will be shared and jointly discussed within AAC as well as possible speculations made at higher institutional levels (Act. 3.4)

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2. Technical scientific common scheme for local data collection on fisheries and fish related data at very local level

The establishment of long-term sustainable fishing is the goal of all fisheries policies, including theEU CFP (EC 1379/2013). A prerequisite for its establishment is a very detailed knowledge of the

state of the biological resources that are exploited, as well as knowledge of the detailed characteristics of the fisheries to which they are exposed.

In the management of marine biological resources in recent times, there is a growing shift from the classic single species assessment to ecosystem approach in fisheries (EAF) which includes notonly interactions of one species and associated fishing effort of the key fleet (or fleet), but includesresearch of the entire ecosystem.

The EU has established a system for collecting data in fisheries (EC regulations 2017/1004 and EC 2016/1251) which is common to all member states. A similar obligation to collect data exists for other non-EU countries, and is prescribed by the GFCM regulation. As Croatia and Italy are members of the EU, as well as members of the GFCM, systematic data collection in marine fisheries is carried out in both countries in accordance with the aforementioned provisions. All data are collected by a unique and agreed methodology, the data are in common databases and are used to assess the state of individual resources in the Adriatic Sea. Resource assessments areconducted on an annual basis for key biological resources within international bodies such as STECF and SAC GFCM.

As a rule, all key stocks and all key types of tools at national and EU level are covered by data collection. The type of data, sampling and processing dynamics, as well as their accuracy are prescribed in detail by Regulation EC 2016/1251. However, much of the fishing, primarily small- scale coastal fisheries, takes place on a very local scale. Therefore, data collected at the national level are not suitable for describing the situation at the local level because they are not sensitive enough. Much more detailed data is needed to manage resources at the local level. However, theyare generally not collected at that level. Therefore, there is a need to establish data collection for

the most important local types of fishing at a very local level. It is precisely one of the tasks of theARGOS project, to provide a basis for collecting this data.

In recent times, the importance of collecting data that exist on the local so-called “Local ecologicalknowledge “(LEK) is increasingly recognized. Local ecological knowledge is defined as knowledge,practices, and beliefs regarding ecological relationships that are gained through extensive personal observation and interaction with local ecosystems, and shared among local resource users.

In developing countries where data and resources are lacking, the practical relevance of “local ecological knowledge (LEK) to expand our understanding of the environment, has been highlighted. The potential roles of the LEK varies from direct applications such as gathering environmental information to a more participative involvement of the community in the management of resources they depend on. Fishers’ LEK could therefore be useful in order to obtain information on how to advance management of coastal fisheries. Many targeted fish species migrate between habitats to feed, spawn or recruit, connecting important habitats within the seascape. LEK could help provide answers to questions related to this connectivity and the identification of fish habitat use, and migrations for species and areas where such knowledge is scarce.

In addition to collecting data on the local fisheries in question through the DCF, it is extremely important to investigate all the historical data on this type of fishing. They can be found in the databases of scientific institutions and fisheries administrations. An extremely valuable part of thedata is the private data held by fishermen. Namely, a significant number of fishermen keep old data of catches and locations where it was made. Sometimes this data is in hard format, and sometimes it is even digitized. It is extremely important to motivate fishermen to make this

information available to scientists for further processing. If this data exists in a written format, it is important to conduct surveys and interviews with fishermen in order to collect this data. Specialattention should be paid to the critical area (spawning and nursery areas), as well as on the migration routes of differing species.

For each type of local fishing, the most detailed data should be collected in order to adequately describe this type of fishing, and the data collection should follow as many protocols as possible prescribed by the DCF regulations (EC 2017/1004 and EC 2016/1251). The following text lists the information that should be collected for each type of fishing, and an attempt should be made to collect as much data as possible.

3. GENERAL DESCRIPTION OF LOCAL TYPE OF FISHERIES

- History of fisheries and exploitation
  - Describe the exploitation histories of the local type of fishing on the basis of available data from the literature and through interviews with fishermen. Particular attention should be paid to changes in the gear structure, fishing methods, fishing effort and quantitative and qualitative structure if the fisheries.

- Area of exploitation
  - Area in which local fisheries occurred should be described using GIS tools. Also, temporal characteristic of fisheries should be including: in which part of day/night fisheries activities take place and in which season of year.

- Description of the fishing gear and fishing technique
  - It is necessary to describe in detail the technical and constructional characteristics of the gear used in the local type of fishing, as well as the characteristics of the vessels (if the vessels are used in that type of fishing). If it is about nets, then it is necessary to describe the length and drop of the net, mesh size (in different parts of the nets) and mesh orientation. In the case of long lines, following days should be provided: hook size, number of the hook, total length of longline, kind of bait... If it is about traps, it is necessary to describe the shape of the pot, the number of openings, pots, type of bait, etc.
  - Regarding fishing technique - a detailed description of fishing operation should be described in detail.

- Fisheries regulation measures
  - Detailed description of the fisheries regulation measures applied for this type of fisheries should be provided, and if there are spatial fisheries regulation measures in force – GIS map of regulation should be done.

- Catch structure
  - Description of the catch structure should include: qualitative and quantitative structure of catches, list of the target species, the most important species in the bycatch, structure of discard and marine litter in the catches.

- By catch of endangered species
  - A special attention should be done to describe bycatch of endangered species in the catches including birds, turtles and mammals.

- Biological description of key species
  - For the key species in the catches a general biological characteristic should be described. This description should include species morphology, spatial distribution, behavior, ecology, population dynamic parameters (growth, mortality), vulnerability to the fishing gear etc.

- Stock status
  - If official stock assessment for key species has been done by relevant bodies, all relevant information on stock status should be provided. If there is no official stock assessment, at least biomass and abundance trends should be done.

- Interaction with other type of fisheries
  - Competitive, cumulative or concurrent interaction with other type of fisheries using other fishing gear should be described, as well as interaction with sport and recreational fisheries.

- Selectivity parameters of fishing gear
  - If there exist data on selectivity of fishing gear, data should be collected. If there is no data, a scientific investigation should be organized to describe selectivity parameters of fishing gear for the most important species in the catches.

- Long term changes in catch and fisheries
  - If there is relevant historical data on catch and effort, long term trends could be described. On this way anthropogenic impact, climatic change impact or impact of invasive species can be described.

- Private fishermen's databases of catches throughout history
  - It is necessary to investigate whether there are private databases of fishermen on fishing and the state of resources. If such databases exist, they need to be digitized and standardized. If such data sets do not exist, surveys and interviews with fishermen should be conducted to collect this data.

4. BIOLOGICAL DATA COLLECTION

Collection of biological data on the local type of fishing is necessary to adapt as much as possible the protocol for data collection prescribed by the provision of the DCF (EC 2017/1004 and EC 2016/1251). Often, local fishing types are not properly covered by a national biological data collection plan, because catches from that type of fishing are small or species for which there is no obligation to collect detailed biological data are preferred. Sometimes biological data are collected on species that are the subject of a local type of fishing. However, such a method of collection is not sufficient to describe the local situation in fisheries because the data are too general.

It is necessary to try to collect data as much as possible on fishing vessels, if there are existing possibilities. If this is not possible, data are collected at landing sites. Should be kept in mind that

the landing, not the catch, is analyzed at the landing site. The catch consists of landing and dropping, and detailed analysis is usually possible only on board. Also, in order to collect as detailed data as possible, it is possible to organize sampling through scientific research fishing, using a research or commercial vessel. Part of the biological analysis is performed in the field (at the border and at the landing site) and mainly in the quantitative and qualitative structure of the catch and the measurement of the frequency of the length (catch and discard). Most detailed biological analyzes can be done mainlyin the laboratory (weight, sex, stage of maturity, aging, stomach contents, DNA analysis ...)

The collection of biological data at the local level should include the following:

- Qualitative and quantitative catch composition by species, separately landing, discard and unwanted catches. Also, information on marine litter should be registered.
- Length frequency distribution (per sex) for key species (including landing and discard).
- Laboratory analysis for representative sample of key species: individual weight, sex, maturity stage, gonad mass, fecundity, otoliths reading and stomach contents.

5. DATA ON IMPACT OF LOCAL FISHERIES ON MARINE ECOSYSTEMS

Local fisheries are most often carried out on the coastal area where the most sensitive parts of the marine ecosystem are located and inhabited by numerous highly endangered species.

Therefore, it is extremely important to monitor possible impacts on marine ecosystems during the monitoring of local fishing.

This monitoring primarily includes:

- Incidental by-catch monitoring of all birds, mammals and reptiles and fish protected - this monitoring can be organized during on-board sampling or during scientific research. Also, if important data on incidental by-catch of all birds, mammals and reptiles and fish protected, can be collected through surveys and interviews with fishermen.
- Monitoring the impact of local fishing on sensitive marine habitats - especially on Posidonia meadow beds and coral genius habitats. This includes the impact of fishing on marine protected areas.
- Monitoring the impact of fishing activities on non-commercial species and investigation of predator-prey relationships - because fishing has a negative impact not only on target species in the catch but on entire ecosystems.

6. DATA ON THE ACTIVITY OF FISHING VESSELS

These data are crucial to describe and quantify the activity of fishing vessels. Depending on the type of fishing gear and fishing technique, different variables are used.
The key variables for describing fleet capacity are Number of vessels and GT, kW and Age of vessel.

Fishing effort can be described at: Day (hours) at sea; Fishing days; kW * Fishing Days; GT * Fishingdays; Number of trips; Number of fishing operations; Number of nets/lengths; Number of hooks;Number of lines; Numbers of pots, traps.

Landing can be described through Value of landings total and per commercial species; Live Weightof landings

total and per species and prices by commercial species

7. ECONOMIC DATA ON LOCAL FISHERIES

Economic data could be collected through different variables: Income; Labor costs; Energy costs; Repair and maintenance costs; Subsidies; Capital costs; Capital value; Investments; Financial position; Employment; Fleet description (Number of vessels; Mean LOA of vessels; Total vessel's tonnage; Total vessel's power; Mean age of vessels); Effort description (Days at sea; Energy consumption); Production value per species (Value of landings per species; Average price per species).

Particular attention should be paid to the economic impact of fishing on the local community when collecting economic data.

8. SOCIAL DATA ON LOCAL FISHERIES

Social data could be collected through following usually used variables: Employment by gender; FTE by gender; Unpaid labor by gender; Employment by age; Employment by education level; Employment by nationality; Employment by employment status.

We should keep in mind that fisheries in local communities are not just a branch of the economyand cannot be viewed only through the economic component (i.e., Coast - benefit analysis). In local communities, fishing is a way of life and as such it has a distinct social component that shouldbe well described.

9. ADDITIONAL DATA COLLECTION

Given the importance of the local type of fishing for the local community, but also the extremely sensitive

coastal ecosystem in which fishing takes place, it is crucial to collect additional data for which there is no obligation to collect through DCF and conduct additional scientific research to better describe the state of fisheries and resources which are used. This is particularly important if we keep in mind the planned shift from the assessment and management of individual species to the approach to the fisheries ecosystem. Therefore, it is important to investigate what additional research is being conducted and to collect and collect data. More recently, ichthyoplankton research has been carried out, in which the determination of the early developmental stages is determined with the help of molecular analysis, more specifically by DNA barcoding. Given the exposure of the coastal area to various negative anthropological influences, it is important to collect data on organic and inorganic pollution of seawater, sediment and marineorganisms. Also, recently, data on the concentration of microplastics in the environment and marine organisms have been collected. Research on the distribution of underwater noise and theeffect of underwater noise on commercial and non-commercial species has also begun in the Adriatic Sea. Also, a very interesting area is the study of the impact of invasive and non-native species on marine ecosystems and fisheries, as a consequence of anthropogenic impact and climate change to long-term changes in marine ecosystems. Possession of long series of systematically collected data on the state of the marine ecosystem is crucial for their detection and study. The Adriatic Sea is known as the sea with one of the longest and best series of such data. It is therefore extremely important to investigate what data series exist at the local level related to fisheries. This mainly applies to private data sets that fishermen have on fishing and catches over the time. In addition to describing long-term changes in ecosystems, such data can also serve very well to locate critical areas for individual species (spawning and nursery areas) as well as to describe migration patterns and migration routes for different species.

10. DEFINITION OF FUTHER MONITORING

Based on the collected data and their critical analysis, it is necessary to define the parameter offuture monitoring of the local type of fishing as well as the dynamics of its implementation.

Special attention should be paid not only to monitoring the fishery biological and ecological status of resources and monitoring fishing effort, but also to monitoring the social and economicaspects of fisheries.

Table 1. Summary of the parameters to be collected and the sources through which the data willbe collected

Data need to be collected		Source of data
	▪ History of fisheries and exploitation ▪ Area of exploitation	Scientific data base Scientific publication Official statistical data
General description of the fisheries	▪ Description of the fishing gear and fishing technique ▪ Fishing fleet and fishing vessels description ▪ Fisheries regulation measures ▪ Catch structure ▪ By catch of endangered species ▪ Biological description of key species ▪ Stock status ▪ Interaction with other type of fisheries ▪ Selectivity parameters of fishing gear ▪ Long term changes in catch and fisheries ▪ Private database of fishermen on catches throughout history	Private fishermen data Interview Questionnaire Grey literature

Biological data	▪ Qualitative and quantitative catch composition by species, ▪ Length frequency distribution (per sex) for key species ▪ Laboratory analysis for representative sample of key species: individual weight, sex, maturity stage, gonad mass, fecundity, otoliths reading, stomach contents	On board sampling Sampling on the landing places Scientific surveys
	▪ Incidental by-catch of all birds, mammals and reptiles and fish protected	On board sampling Sampling on the landing places
Impact fisheries on marine ecosystems	▪ Impact on marine habitats and marine protected areas ▪ Impact of fishing activities on non-commercial species and investigation of predator-prey relationships	Scientific surveys Interview Questionnaire
Activity of fishing vessels	▪ Fleet capacity ▪ Fishing effort ▪ Landing	Official statistic data Interview Questionnaire

Economic data	▪ Income; Labor costs; Energy costs; Repair and maintenance costs; Subsidies; Capital costs; Capital value; Investments; Financial position; Employment; Fleet description (Number of vessels; Mean LOA of vessels; Total vessel's tonnage; Total vessel's power; Mean age of vessels); Effort description (Days at sea; Energy consumption); Production value per species (Value of landings per species; Average price per species).	Official statistic data Interview Questionnaire
Social data	▪ Employment by gender; FTE by gender; Unpaid labor by gender; Employment by age; Employment by education level; Employment by nationality; Employment by employment status	Official statistic data Interview Questionnaire
Additional data	▪ Climate change ▪ Invasive and alien species ▪ Organic and inorganic pollution ▪ Microplastic ▪ Underwater noise ▪ Molecular investigation	Scientific data base Scientific publication Official statistical data Private fishermen data Interview Questionnaire Grey literature

11.Common scheme for the management of aquaculture activities at local level

Collecting accurate data is necessary to assess and monitor the social, economic, and environmental performance of the aquaculture sector, as a first step towards developing the full potential of EU aquaculture in line with the Europe 2020 objectives: sustainability, food security, growth, and employment. In addition, verified and detailed data are essential for the local community and government to ensure proper planning of aquaculture activities and protocols in case of significant changes. Finally, transparency and data reporting are important to maintain theconfidence of consumers and other stakeholders in the sector. Negative perceptions of aquaculture activities by local stakeholders, particularly their impact on the environment and othereconomic activities, are often a barrier to the establishment of new aquaculture facilities, includingsea-cage farms. On the other hand, the benefits of aquaculture, such as job creation in remote areas, a low-carbon food source, or the provision of ecosystem services, are largely unknown to the public.

Taking all these aspects into account, the main objective of the ARGOS project is to establish a well-defined protocol for data collection at the local level, which will form the basis for the developmentof more effective local management measures. The common scheme is managed by the WP coordinator PP13 and agreed within the AAC (Act. 3.1). As a result of the local data collection, localmeasures will be shared and discussed jointly within AAC and possible proposals will be made at higher institutional levels (Act. 3.4).

12. Technical scientific common scheme for local data collection on aquaculture data at very local level

The EU has adopted a Commission Delegated Decision (EU) 2021/1167 establishing the multiannual Union Programme for the collection and management of biological, environmental, technical, and socio-economic data in the fisheries and aquaculture sector. All data are collected according to a common and agreed methodology. The data are stored in common databases and are used to assess the state of aquaculture across the EU. The nature of the data, the dynamics ofsampling and processing, and their accuracy are prescribed in EC regulations 2017/1004 document.However, data collected at national level are not always sufficient to describe all aspects of aquaculture activities at the local level. To get a better insight into some aspects of aquaculture, such as its environmental and social impacts, more detailed data collection is needed. One of the tasks of the ARGOS project is therefore to provide a basis for the collection of these data.

13. General description of the aquaculture sector

The Croatian aquaculture sector consists of both freshwater and marine aquaculture. Marine aquaculture production includes:

- Fin fish farming, which produces sea bass (*Dicentrarchus labrax*), sea bream (*Sparus aurata*), meagre (*Argyrosomus regius*), and greater amberjack (*Seriola dumerili*) in cages located in protected coastal waters, with a total number of 29 enterprises with 49 licensed production farms. The total production was 13.588 tons in 2019;
- Bluefin tuna (*Thunnus thynnus*) farming in off-shore cages where tuna from 8 to 10 kg are raised to market size (more than 30 kg), mainly for export to Japan. Today, there are 4 tuna farmswith 5 production licences. Total production of 2.747 tons of bluefin tuna in 2019 (accounts for about half of total fish exports by value);

- Longlines shellfish farming, is carried out by 112 small shellfish farms (mostly individual family businesses) with about 268 production units, which produced 1 008 tons of oysters (*Ostrea edulis*), mussels (*Mytilus galloprovincialis*), and scallops (*Pecten jacobaeus*) in 2019;
- Other fish production, including a company with 2 licensed production units that started farming trout (*Oncorhynchus mykiss*) in cages in 2010.

Aquaculture in Italy is based on a long tradition and history, of both freshwater and in particular marine species. It is characterized by a high level of specialization and large-scale production. Out of 30 species, for a total of 153.937 tons in 2019, production is dominated by:

- Shellfish farming of Mediterranean mussel (*Mytilus galloprovincialis*) and Japanese carpet shell (*Venerupis philippinarum*), for which Italy is the major producer in Europe, and a small amount of Cupped oyster (*Crassostrea gigas*) with about 399 production units for a total of 99.677 tonsin 2019;
- Freshwater fish production of rainbow trout (*Oncorhynchus mykiss*) and other Salmonids accounting for 34.480 tons in 2019;
- Fin fish farming of European sea bass (*Dicentrarchus labrax*) and gilthead seabream (*Sparus aurata*) of 17.225 tons in 2019 with a total number, both for freshwater fish and fin fish farming,of about 400 enterprises.

14.Production data collection

In Croatia, this data collection is prescribed by Aquaculture Act ("Official Gazette," No. 130/17 and111/18) adopted by the Ministry of Agriculture, and is based on an aquaculture license (one license = one logbook). The logbook is an aquaculture statistics submission form maintained by legal and natural person who is an aquaculture license holder (license holder). The institution that managesthe current data sources is the Croatian Directorate of Fisheries (DoF).

Actually, in Italy the Italian Ministry of Agricultural, Food and Forestry Policies (MIPAAF) is responsible for data collection on Aquaculture sector. This Authority is in charge of registering activities and their production, based on EU Regulation n. 762/2008. The census uses the enterpriseas a reference unit, a legal figure regularly registered to the Chamber of Commerce, Industry, Craftsand Agriculture and as a unit of analysis the facility, that is, the production unit belonging to an enterprise. Each enterprise may consist of one or more facilities. The data are collected through plant interviews, by telephone survey or by filling out survey questionnaires.

In general, questionnaires are used to collect the missing data. Data collected include company data, farm data (farm type, technology used, production volume/area or longlines), location, species (INPUT of juveniles, mortality, escapes, fish sold, market data).

For all marine facilities (except tuna farms) data collected using logbooks are as follows:

- Farming technology: the type of farming technology used;
- Farming volume: the total farming volume (expressed in cubic meters) of all farming units (cages / recirculation tanks / other farming units) used for the farming of a given species under the permit for which the report is submitted;
- Number of cages / recirculation tanks / other farming units: the number of cages / recirculation tanks / other farming units used for the farming of a given species;
- Overview of the situation of plantations by year: in this part of the register, summary data on the status of the farm at the beginning of the reporting year, the level of production during the reporting year (through sale, loss or transfer) and the status at the end of the reporting year are entered. Animals stocking during the reporting year. For all categories enter the quantity in kilograms and pieces;
- Balance 01.01. of the reporting year: the number of animals on the farm on 01.01. of the reporting year, separated by the year of stocking;

- Fish sold: the number of animals sold during the reporting period, separated by the year of stocking;
- Losses: losses incurred during the reporting period as:
  - mortality: the quantity of recorded death is entered;
  - escapes: the estimated number of live fishes that escaped from the farming facilities into the environment;
  - other: the estimated number of unrecorded mortalities treated as unmeasurable losses (e.g., due to predation) and fish excluded for other reasons.
- Transferred to other farms of the same holder: the quantity of fish transferred (transferred) by the holder to his other farm for continued farming. Refers to a transfer to a farm where farmingis carried out based on another aquaculture permit;
- Balance 31.12. of the reporting year: the estimated status of unfinished production, i.e. the quantity of fish remaining on the farm on 31.12. of the reporting year, separated by years of stocked;
- Harvest: all fish stocked on the farm during the reporting year, separated by the origin and developmental stage of the fish planted;
- Sale: the quantity (in kilograms and pieces) and value of fish sold immediately after catching,before any processing, separated by intended use, type of production and destination (the countryto which the product is sold).

In Croatia, for bluefin tuna (*Thunnus thynnus*), beside the data collected from licence holders' logbooks, additional monitoring of fishing and farming of bluefin tuna is carried out by Institute ofoceanography and fisheries as part of project PRUT (see D4.1, point 9.6.).

15.Economic data collection

In accordance with Regulation (EU) 2017/1004, economic data are collected annually and, on all enterprises, whose main activity is defined according to European Classification of Economic Activities (NACE) codes 03.21, 'marine aquaculture'. The methods and quality of data collection areappropriate for the intended purposes defined by Regulation (EU) No 1380/2013.

In Croatia, there are two main sources of data - some variables are collected from the DoF databaseand subsidy logbook, while others are taken from questionnaires. For cross-checking purposes, data (mostly linked to the balance sheet) from Croatian Financial Agency (FINA) are used, but onlyfor companies that are required to provide their data due to their size class or net profit.

In Italy, the main data source for economic data is the annual financial statements of companies inthe sector. Data are collected from the analysis of accounts and financial statements, but also through direct contacts with businesses to ensure perfect alignment between the accounting dataand variables required by EU-MAP.

In both countries the collected data include:

- Other income: income from activities other than aquaculture (e.g., recreational fishing licences) included in company financial statements;
- Input value of unpaid labor: calculated for all individual enterprises and provides data on unpaid family members employed in the sector. This is relevant for small and medium-sized enterprises that are managed at family level (which is common in shellfish farming in Croatia). Calculations will be based on the employment data (number of family members involved in the operation) and the average of "paid labor costs" calculated for the sector;
- Impairment of capital: the loss in value of an asset calculated from account information and

collected through the aquaculture economic questionnaire;

- Financial costs, net: income from the company's financial activities, net of financial costs;
- Extraordinary costs, net: extraordinary and unexpected incomes, excluded from total income, minus extraordinary and unexpected costs excluded from other cost items;
- FTE National: the number of employees converted to full-time equivalents (FTE), based on hours worked and considering the hours worked by a full-time employee for a full year. This includes persons who work less than a standard working day, less than the standard number of working days in a week or less than the standard number of weeks/months in a year.

When collecting economic data particular attention should be paid to the economic impact of aquaculture on the local community. Thus, it is necessary to classify the collected data according to the counties and make them publicly available. This could help strengthen the aquaculture- related image of the area and increase the area's attractiveness to investors.

16.Social data collection

In accordance with Regulation (EU) 2017/1004, social data refers to employment data including:

- employment by gender;
- FTE by gender;
- unpaid labor by gender;
- employment by age;
- employment by level of education;
- employment by nationality;
- employment by employment status.

However, the social impact of aquaculture cannot be assessed only in terms of employees of specific enterprises as it is often a source of additional revenue for other local businesses. Namely,the supply chain usually involves various local small and medium-sized enterprises which rely on aquaculture for part of their income, such as veterinary services, maintenance services, transportation or repair services, local processing industry, retail, etc.

Furthermore, in order to create synergies between aquaculture and local communities, it is also necessary to monitor and describe the impact of local farms on existing activities, such as:

- Local fisheries - Fish farms often act as large Fish Aggregation Devices (FADs) creating structure in the pelagic environment with great feed availability due to unexploited feed pellets lost through cage nets. Local fishermen can easily increase their catches by casting their nets and fishing rods in vicinity of cages. Unfortunately, this may also result in a higher level of bycatch.
- Tourism - Unlike areas with fishing activities, aquaculture areas are often considered less attractive due to their less “picturesque” and more industrial image, and in some areas, it negatively affects local tourism. However, the potential of fish or shellfish farms to attract visitorsshould not be underestimated. Local farms can easily become a tourist attraction by providing tasting of the products or teaching how to cook the farmed species at home.
- Shipping and nautical tourism - Although farms are established in authorized zones recognizedas safe for sea farming activities, it is necessary to monitor if and how the position and extent of sea-cages affect nautical tourism and nautical transport in general.

17.Data on impact from local aquaculture on marine ecosystems

The impacts of different aquaculture systems depend on several factors, including the hydrographic

conditions of the farm site, the type of cultured organisms, the production method, management practices, etc. All of these factors must be considered when assessing the potential risks. The level of impact of an aquaculture system on the marine ecosystem is closely related andreciprocal to the intensity of the system. Potential ecological and biological risks from hazards created by or associated with aquaculture development include: pollution from feed, drugs, chemicals, and waste; alteration of water currents and flow patterns; introduction of invasive alienspecies, exotic pests and pathogens; genetic impacts on native stocks; destruction and/or alteration of ecosystems and agricultural lands (e.g., deforestation and salinization).

Croatian aquaculture is regulated by numerous laws that have different objectives, such as mitigation of the impact of farms on the environment, avoiding conflicts between farms and otherusers of the maritime domain in the given area, the safety of the final consumer and the welfare of farmed fish. Farms may only be established in zones recognized by the Ministry of Constructionand Physical Planning as areas suitable for sea farming activities. Site selection is a critical factor in minimizing the environmental impact of aquaculture and in the acceptability of aquaculture facilities in sensitive areas (i.e. Nature 2000 sites). Zone selection is a complex process based on the analysis and interpretation of long-term data sets of numerous oceanographic, biological, environmental parameters. Thus, according to the Environmental Protection Act ("Official Gazette", No. 80/2013 and 153/2013) adopted by the Government of the Republic of Croatia, procedures for which an environmental impact assessment is mandatory include:

- finfish farms in the Marine Protected Coastal Area (CSP) with an annual production of more than 100 t;
- fish farms up to 1 NM outside the CSP with an annual production of more than 700 t;
- fish farms outside the CSP, located more than 1 NM from the coast of the island or the mainland with an annual production of more than 3500 t;
- maricultural zone planned in CSP for several marine finfish farms;
- shellfish farms in the CES with an annual production of more than 400 t.

The environmental impact assessment prescribes a continuous environmental monitoring programfor each farm including:

- total organic carbon in the sediment;
- the amount of total nitrogen in the sediment;
- the amount of total phosphorus in the sediment;
- the structure of the microalgal community;
- the state of benthic communities.

In case of disease, the Veterinary Service prescribes treatment and the concentration of active substances of certain medicament according to special protocols. Although in aquaculture practicedrugs are used in very low concentrations, treated organisms excrete medicinal substances from the body allowing these substances to enter the environment. To minimize the possible negative impact of excreted agents on other aquatic organisms or environmental microbiome, all actions regarding usage of medical substances follow legal framework (Veterinary Act NN 82/13, 148/13, 115/18 and bylaws) for the implementation of aquatic animal health control measures.

Finfish farms in the Marine Protected Coastal Area (CSP) with an annual production of less than 100 t need to assess the environmental impact, which may result in their release from the obligation to carry out the environmental impact assessment. However, in order to get complete and more accurate insight into impact of local farms on marine ecosystem, it is important to collect above mentioned data from all registered farms regardless their capacity.

Aquaculture of euryhaline and marine species, in transition environments and at sea, produces theinput or subtraction of nutrients, nitrogen, and phosphorus-based compounds. The release of nutrients into the environment by farmed fish species takes place through the release of waste, such as ingested feed, metabolic excretion products, and faces. The waste may be organic, in solidform, and/or dissolved, and inorganic. It is composed largely of carbon, nitrogen, and phosphorus. Where the release of these

compounds into the environment exceeds the natural assimilation capacity of an ecosystem, alterations may occur in the receiving ecosystem, in particular in the water column and sediments. The phenomena are usually localized and small, although in some cases and under particular environmental and breeding conditions may generate phenomena of eutrophication, reduction of dissolved oxygen, and alterations of biodiversity on a local scale. Thesubtraction of nitrogen and phosphorus is operated to the farming of molluscs that, using as a trophic resource the nutrients present in the water column, determine their reduction. This indicator provides an estimate of the contribution or subtraction of nitrogen and phosphorus by fish and mussels respectively in the coastal environment where farming activities take place. To provide an estimate of the contribution to organic enrichment in the coastal areas produced by marine aquaculture, the balance between the input of nutrients by farmed fish and the subtractionby molluscs makes it possible to estimate, at regional level, the net quantitative contribution of aquaculture in the processes trophic along the Italian coast. In Italy, the regulatory competence ofaquaculture activities is delegated to the Regions, which may assign the management to other localauthorities which, through appropriate legislative instruments, define the contents. At national level, D.Lgs. 152/2006 on environmental standards indicates the requirements that waters for mollusc farming must have. The same decree (Art. 101, Tables 1 and 2 of Annex 5 Part 3) defines the limits of nitrogen and phosphorus in the case where the wastewater of a fish farm, with a stocking density of less than 1 kg/m2 or water flow rate of 50 l/s or less, are discharged into sensitive areas. Concerning aquaculture and fish farming facilities, Art. 111 of Legislative Decree no. 152/2006 refers to a specific Decree the identification of criteria relating to the containment of the impact on the environment of such facilities. To date, it has not yet been issued. In February2013, the Ministry of Agriculture, Food and Forestry adopted D.Lgs. n. 79 (OJ no. 154, 03/07/2013) which contains the regulation for the "Rules governing the procedure for granting authorization the operation of aquaculture facilities at sea at a distance of more than one kilometer from the coast". In that decree is explicit that the implementing modalities will be defined in a subsequent decree that, however, to date, is not still been enacted. At European level, the legislation does notidentify common objectives and leaves it to the Member States to lay down rules aimed at reducingenvironmental impact. The D.Lgs.

190/2010, which implements the Marine Strategy Framework Directive (2008/56/EC), indicates as elements of pressure and impact the nitrogen and phosphorus inputs from aquaculture facilities and foresee, accordingly, the quantitative estimate. Therefore, in the course of the activities previewed from the implementation of the directive is included the carrying out of (optional) monitoring for the evaluation of the organic enrichment produced from aquaculture facilities.

Croatian Ministry of Agriculture, Directorate for Veterinary and Food Safety, has adopted the Planfor monitoring the quality of the sea and shellfish on production areas and areas for relaying live bivalve molluscs pursuant to Article 3. paragraph 1 of the Ordinance on special rules for the organization and implementation of official controls that are carried out in production areas and relaying areas for live bivalve molluscs ("Official Gazette", No. 82/14). In Croatia, there are 18 production areas where shellfish are farmed and 9 production areas where bivalve molluscs are collected, to which the Plan refers with following data collection protocol:

- Sampling of sea water to determine the qualitative-quantitative composition phytoplankton communities, every two weeks during low production season and one a week during high production season
    - Shellfish sampling for biotoxin (PSP, LT, ASP) determination, once a week.
- Shellfish sampling to determine microbiological quality (e.g., the presence of E. coli and norovirus), once a month.
- Sampling of bivalve molluscs for the determination of benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene and chrysene, every 6 months
    - Shellfish sampling to determine the presence of heavy metals (Cd, Hg, Pb), every 6 months.

The environmental monitoring program (EMP) is the tool for the collection, documentation, and communication of environmental data and information, useful for understanding and bettermanaging the

interactions between aquaculture and the environment and to mitigate potential impacts. The environmental monitoring activities envisaged in the EMP are the responsibility of the company that has the concession for the maritime state-owned area in which the production plant is installed. The concessionaire will be responsible for transmitting the results of the EMP, inthe form of an environmental report, to the Competent Authority.

Objectives of the EMP:

- Minimize the impact of aquaculture on the environment and biodiversity;
- Ensure compliance with legislation and the maintenance of the GES (Good Environment Status);
- Ensure compliance with Quality Standards Environmental (QSE), when establishes;
- Respect the ecological services provided from the ecosystem;
- Ensuring the sustainability of the activities productive in the long run;
- Ensure an environment suitable for the needs of several species relieve;
- Verify the effectiveness of good practices applied management;
- Communicate to civil society and stakeholders the quality of the marine environment in the AZA (Allocated Zone for Aquaculture).

18.Additional data collection

Given the importance of establishing environmentally sustainable aquaculture, it is necessary to collect additional data for which there is no obligation to collect through the current project, as well as to conduct additional scientific research to better describe the impact of aquaculture on the marine ecosystem. The data collected through the ARGOS project will be available to the localcommunity and decision-makers to use as guidance in developing a protocol for license holders onhow to proceed in the event of changes.

Additional monitoring should include data collection on:

- fish immunization activities at sea-cage farms and other farming facilities;
- feed ingredients and biochemical composition;
- feed conversion ratios per species/age/type of diet/densities.

Additional data collection that reflects and describes the impact of local farms on marine ecosystem should include:

- water quality parameters in respect to the organic pollution;
- impact of organic waste on Posidonia beds;
- state of natural ichthyopopulations associated with sea-cage farms;
- occurrence and frequencies of disease transmission between farmed and wild fish;
- occurrence and frequencies of parasite transmission between farmed and wild fish;
- shellfish production losses caused by fish predation.

Although the technology and farm safety have greatly been improved over the past decade, large numbers of fish escape from aquaculture installations into the wild each year. The presence of suchfish biomasses in the wild raise important concerns about the environmental risks of aquaculture onto wild fish population. To gain insight into the impact of aquaculture on the marine ecosystemthrough escaped fish, future monitoring programmes should focus on:

- monitoring of spatio-temporal distribution of escaped fish;
- development of genetic traceability tool for farmed escapees and hybrids detection into the wild (e.g., high-density single nucleotide polymorphism array);

- evaluation of genetic introgression of escaped farmed fish to wild populations.

The parameters obtained should then be used for assessing recapture strategies. Results of fish escape behavior and genetic introgression will enable development of guidelines for the management of fish escapes, including recapture models.

19. Definition of further monitoring

Given the results of the analysis of all collected data, it is necessary to develop a protocol and implementation dynamic for further monitoring of the local aquaculture. Attention should be paidon the not just only to socio-economic and environmental aspects of aquaculture, but also to integration of aquaculture within local community.

Table 1. Summary of the parameters to be collected and the sources through which the data will becollected

Data for collection		Source of data
Production data	▪ Farming species ▪ Farming technology ▪ Farming volume ▪ Number of cages/recirculation tanks/other farming units ▪ Balance of 01.01. reporting year ▪ Sold fish ▪ Losses (mortality, escape, other) ▪ Transfer to other farms of the same holder ▪ Balance 31.12. reporting year ▪ Harvest ▪ Sale ▪ Additional info for tuna (min 100 fish per 100 tons of harvested fish): length/mass	DOF - MIPAAF Questionnaire On board sampling
Economic data	▪ Income: gross sales per species, operating subsides, subsides on investments and other income ▪ Operating costs: personal costs, value of unpaid labor, energy costs, livestock costs,feed costs and other operating costs ▪ Capital costs as consumption of fixed capital ▪ Investments in tangible assets (net purchaseof assets)	DOF - MIPAAF

	▪ Financial position: total value of assets and gross debt ▪ Financial results: income and expenditures ▪ Row material weight: livestock used and fish feed used ▪ Employment: paid labour, unpaid labor,full-time equivalent (FTE) ▪ Number of enterprises	
Social data	▪ Employment by gender ▪ FTE by gender ▪ Unpaid labor by gender ▪ Employment by age ▪ Employment by education level ▪ Employment by nationality ▪ Employment by employment status	DOF - MIPAAF
Impact of aquaculture on marine ecosystem	▪ The amount of total organic carbon in the sediment ▪ The amount of total nitrogen in the sediment ▪ The amount of total phosphorus in the sediment ▪ Microalgal abundance and community structure ▪ The state of benthic communities ▪ The state of phytoplankton communities in shellfish production areas ▪ Determination of biotoxins in shellfish ▪ Determination of microbiological quality of shellfish	DOF – Italian regionsOn site sampling Scientific surveys Scientific publication

	▪ Determination of benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluorantheneand chrysene in shellfish ▪ Determination of heavy metal profile in shellfish	
Additional data collection	▪ Fish immunization activities ▪ Feed ingredients and biochemical composition ▪ Feed conversion ratio ▪ Water quality parameters ▪ Impact of organic waste on Posidonia beds ▪ State of natural ichthyo populations ▪ Occurrence and frequencies of disease transmissions at farms ▪ Occurrence and frequencies of parasite transmissions at farms ▪ Shellfish production losses caused by fish predation ▪ Spatiotemporal distribution of farmed fish escapees ▪ Genetic traceability of both wild and farmed fish origins ▪ Detection of genetic introgression	On site sampling Scientific surveys Scientific publication