# Deliverable D4.1.2

## Agenda for the standardization of data as a basis for a shared approach in the management of Adriatic biological resources and economic activities

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# Contents

# 1. Agenda for the standardization of data as a basis for a shared approach in the management of Adriatic biological resources and economic activities

Biological resources that inhabit the Adriatic Sea have several features that are extremely important and should be taken into consideration when assessing the state of resources, but also defining measures for sustainable management:

• Most of the stocks that inhabit the Adriatic Sea are biologically unique populations and their different life stages (spawning, nursery area, recruitment area, migration routes…) are located in different parts of the Adriatic. Sometimes spawning area and adult organisms are located along the east-Croatian coast, and juvenile specimens along the west-Italian coast (e.g. red mullet, sole, gurnard tub), and sometimes the main spawning area are located in the open deep sea from which migrations to shallow coastal waters and vice versa. This is the situation with the most economically important demersal species, such as hake: its main spawning and nursery grounds are located in the Jabuka/Pomo pit area, and specimens from this area migrate when they grow up in shallower areas of the open Adriatic and channel areas. The situation is similar with Norway Lobster, whose population is densest in the open central Adriatic.

Although most populations in the Adriatic Sea are biologically unique, they are economically divided between the fleets of different countries. Fishing in the Adriatic Sea is carried out by thefleets of six countries, of which three are members of the EU (Italy, Croatia and Slovenia), and three are not (Albania, Montenegro and Bosnia and Herzegovina). Therefore, fisheries policies are also different in the Adriatic Sea: The Common Fisheries Policy is applied in EU countries, while other countries have their own national fisheries policies. Recently, however, efforts have been made to establish a common fisheries policy in the Adriatic through the General Fisheries Commission for the Mediterranean (GFCM). Thus, multiannual management plans for different renewable resources in the Adriatic Sea (for small pelagic fisheries and for demersal fisheries) are already in force. Also, there is a large disproportion in the fishing fleets capacity and fishing effortin the Adriatic Sea, as well as in the realized catch, so the intensity of exploitation is different in different parts of the Adriatic. As a result, the state of resources changes among areas, and it is extremely important for common responsible management to agree to adjust measures to the state of resources and the intensity of fishing in certain parts of the Adriatic.

• Most commercial fishing in the Adriatic Sea is based on the catch of young specimens, often

juvenile specimens. Most of the catches are specimens aged 0, 1 and 2 years. Therefore, the intensity of recruitment is of great importance for the level of available biomass, and thus the catch: when the intensity of recruitment is high, there is a large biomass of young specimens in the sea, which results in high catches. This results in large interseason and interannual oscillations in the biomass and catch. Due to the large impact of recruitment on catches, it is difficult to finda strict correlation between fishing effort and resource status, which further complicates fisheriesmanagement, which is generally based on fishing effort regulation.
Apart from small pelagic fishery, in which anchovy and sardine are the main target species, fisheries in the Adriatic Sea is typical multispecies fisheries. There are up to a hundred different species of fish, crustaceans and cephalopods in trawl catches, of which about fifty are economically significant. In such conditions, some species always show a decrease in biomass, others increase, some are overfished, some show fluctuations without a clear trend. Therefore, it is difficult to determine the state of a particular type of fishing and prescribe and apply measures that will be effective for all species.

• Furthermore, exploitation in the Adriatic Sea is a typical multigear exploitation: there are many types of fishing gear in both commercial, recreational and sport fishing. Therefore, the competitive, cumulative and synergistic effects of different fishing gears are very significant.

• Due to the great diversity of catches (multispecies fisheries), but also due to the fact that fishing is based on young and often juvenile specimens, there is a big difference in qualitative and quantitative composition of catch and landing, and a significant part of catches ends as bycatch and discard. Therefore, it is extremely important to work on reducing discards and unwanted bycatch.

• Although the Adriatic Sea is one of the most investigated parts of the Mediterranean with a very long history of scientific research and data collection, some areas are still poorly explored (primarily the deep southern Adriatic). In addition, in recent times it is becoming clear that more attention needs to be paid to the impact of oceanographic features of the sea on resource status and catches, and accordingly make a shift from single species assessment and management to an ecosystem approach to fisheries.
Recent research shows that resources in the Adriatic are not only exposed to intense negative anthropogenic effects (such as fishing, anthropogenic pollution, habitat loss…), but they are increasingly changing due to long-term climate change. These changes are most noticeable in community changes due

to the arrival of new and invasive species, as well as the spread of existing thermophilic species in the Adriatic Sea.

From all the above, it is obvious that for the proper management of resources in the Adriatic Sea, we need to apply a common approach, because the resources that inhabit the Adriatic Sea are common. Only agreed measures can result in the improvement of the status of the resources in the Adriatic, some of which have been overfished for many years.

A common approach to the assessment and resource management is not possible without joint collection and modification of data collection, therefore the data collection system should be harmonized, applied and respected at the regional Adriatic level.

Through the document 4.1.1. Report illustrating and comparing the existing biological and socio-economicdatabases concerning fish-related matters provided at the institutional level in Italy and Croatia, outlining main statistical information (e.g. sample methods, data surveyed, fishing areas) a brief overview was made, to show which data sets on fisheries exist in Croatia and Italy, and basic metadata for each researchare given.
Currently, data collection in Croatia, Italy and Slovenia is carried out in accordance with the EU Common Fisheries Policy, while in other Adriatic countries it is in accordance with GFCM guidelines which are also complementary to the DCF (2017/1004 and EC 2016/1251).
Assessments of the state of resources in the Adriatic Sea are performed at GFCM and STECF level, considering GSA17 (North-Central Adriatic Sea) and GSA18 (South Adriatic Sea) as separated or joint areas depending on the stock under consideration. These estimates are based on official data sets collected through National data collection programs, and include biological data, and fishing effort data as well as economic catch data.
The official GFCM stock assessment results of different target species will be used to model the dynamic of commercial resources within the ARGOS project. The impacts of some management measures on fisheries and resources will be estimated using the DISPLACE model based on scenarios to be defined through the AAC.

In addition, each of the 9 partners of ARGOS project will conduct their own pilot action on data collection at the local level. In order for the data collected through pilot projects to be compatible and comparable between partners, as well as with the data collected through DCF, it is necessary to harmonize the methodology of their collection as much as possible. In the text that follows, IOR and CNR scientists havemade a short agenda for collecting data at the local level, both in fisheries and aquaculture.

## 2. Agenda for the standardization of data on local level in field of fisheries

Data collection at the national level is often not accurate enough to describe the state of resources and fisheries at the local level. Also, it sometimes happens that certain types of fishing that are extremely important at the local level do not exceed the threshold value at the national level and are not included in the detailed data collection. Therefore, to get a detailed picture of the local type of fishing and its impact on resources and the local community, it is necessary to design and implement a special type of samplingadapted to the local specificities. Also, we should keep in mind that the data collected should be as compatible as possible with the data collected at the national level, and that the methodology of data collection, processing and standardization is compatible with that at the national level.

Although each data collection at the local level has its own specifics, there are certain guidelines and procedures that should be followed to make the data as useful as possible.

### • Defining the local type of fishing

It is necessary to precisely define which type of fishing will be explored through the pilot action of ARGOSproject. It is desirable that this is a type of fishing that is characteristic and significant for a particular community, from the biological and economic, social and traditional point of view. Sometimes it is a fishing with a certain type of fishing gear used exclusively in that local community (e.g. collecting shells with hand tools), sometimes it is a local biological resource that is collected with different gears (for example collecting sponges, worms, corals), sometimes a segment of the commercial fishing fleet operating in thelocal community (for example open sea bottom longlines), and sometimes complete small-scale fishing inthe local community. It is also possible to decide to investigate fish communities in the area of the local community and fishing activities that take place in those settlements. Which local type of fishing will be chosen depends on what the local community wants to explore and get to know better at their local level.

### • Defining the aim of local fishing sampling

Before elaborating the methodology and starting the data collection, it is necessary to precisely define theaim of the research so that data collection would not be an end in itself. The aim of the collection may be, for example, to collect data to describe a poorly known local fishery, to describe the state of fishery resources in an area, to examine the socio-economic significance of a particular fishery for the local community, to improve local sampling dynamics, collecting data as a basis for proposing fisheries regulation and resource protection measures or proposing a local management plan…

## • Collection of existing data on local type of fishing

Before starting data collection activities, it is extremely important to investigate which historical data

already exist for the local type of fishing, which research and data collection have already been conducted and where the collected data are located. It is also important to investigate what data is recently collectedon the local type of fishery through official national data collection, but also through various national andinternational projects. Critical analysis of sets of existing data will show where research is sufficient and where research needs to be intensified or modified.

## • General description of the local type of fishing

A general description of the local type of fishing should include as much information on fishing that exists from different sources. It needs to be described history of local type of fisheries and exploitation patterns. Particular attention should be paid to changes in the gear's construction and their modification, fishing methods, fishing effort and quantitative and qualitative structure of catches. It is very important to describe area of exploitation (if it is possible using GIS tools). Also, temporal characteristic of fisheries should be included (in which part of day/night fisheries activities take place and in which season of year).It is necessary to describe in detail the technical and constructional characteristics of the gear used in thelocal type of fishing, as well as the characteristics of the vessels (if the vessels are used in that type of fishing). Regarding nets, it is important to describe the length and drop of the net, mesh size (in differentparts of the nets) and mesh orientation. In the case of long lines, following data should be provided: hook size, number of the hook, total length of longline, kind of bait... For traps, it is necessary to describe the shape of the pot, the number of openings, pots, type of bait, etc. Also, a detailed description of fishing operation (fishing technique) should be described.

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 – a GIS map of regulation should be done and catch structure should be providing. 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. A special attention should be done to describe bycatch of endangered species in the catches including birds, turtles and mammals.

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

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. 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.

If there exist data on selectivity of fishing gear, they 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.

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.
It is necessary to investigate whether there are private databases of fishermen on fishing and the state ofresources. 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.

## • Collection of biological data

Collection of biological data on the local type of fishing is necessary to adapt as much as possible to the protocol for data collection prescribed by the provision of the DCF (EC 2017/1004 and EC 2016/1251).
It is necessary to try to collect data as much as possible on board on fishing vessels, if there are existing possibilities. If this is not possible, data are collected at landing places. Should be kept in mind that the landing, not the catch, is analyzed at the landing site. The catch consists of landing and discard, 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 survey, using a research or commercial vessel.
According to the EU DCF protocol collection of biological data 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.

When collecting data, special attention should be paid to the methodology of data collection andprocessing and harmonize it as much as possible with the methodology prescribed by DCF (length measurement method (TL, CL, ML), scale for determining maturity stages, gonadosomatic index, length weight relationship, otoliths reading methodology, length age relationship, von Bertalanffy growth parameters…).

- Collection of data on impact of fisheries on marine ecosystem

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.
According to the DCF, 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.

- Collection of 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. Depending on the type of local fishery, fishing effort can be described in different ways and it should be choosing the one that is most suitable for the tools used in local fishing. The following ways of describing fishing effort are most commonly used: day (hours) at sea; Fishing days; kW * Fishing days; GT * Fishing days; Number of trips; Number of fishingoperations; Number of nets / lengths; Number of hooks; Number of lines; Numbers of pots and traps. Landings can be described by the value of total landings and by commercial species; Live weight of landingstotal and by species and prices by commercial species.

- Collection of economic data

Economic data on the local type of fishing should be obtained through a national data collection framework. If this data is insufficient or accurate, local data collection can be approached. The best waysto collect are through interviews with fishermen or through questionnaires. If data are collected in this way, it would be good to discuss

the content of the questionnaire with the national scientific organization involved in the ARGOS project (CNR and IOF) before applying it. It should be kept in mind that some fishermen will not be able to provide the necessary data because their economic data is held by their accounting services (firms). Therefore, this information should be sought from them, in agreement with the fishermen.

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.

### • Collection of social data

Like economic data, social data is best to be collected through interviews with fishermen or through questionnaire. It is necessary to use official DCF data if they exist and if they are useful at the local level.

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

We should keep in mind that fisheries in local communities are not just a branch of the economy and 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 should be well described.

### • Additional data collection

Depending on the defined purpose for which data on local fisheries are collected, it is possible to collect additional information. This is important if we keep in mind that this type of fishing takes place in an extremely sensitive coastal ecosystem. This is particularly important if we keep in mind the planned shift in fishing policy from the assessment and management of single species approach to the ecosystem approach in fisheries. Possible additional data collection could be following: Ichthyoplankton research with the aim to determinate distribution the early developmental stages of fishes using 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 marine organisms. 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 the effect 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 onmarine 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.

In conclusion, when collecting data at the local level, it is necessary to keep in mind the goal to be achieved by such collection. Also, before starting to collect data, it is necessary to see which data already exists and
are already being collected through different sources in order not to duplicate activities. Whenever possible, it is necessary to apply the already existing methodology of collection and processing of biological and other data in accordance with the DCF protocols, so that the data are complementary and comparable with official national data. Special attention should be paid to the standardization of data. Whenever possible, data should be collected in the field on board fishing vessels. This will best describe the structure of catch, bycatch and discard. When collecting data using interviews and questionnaires, it is suggested that the questionnaires be coordinated with the National Scientific Organizations (CNR and IOF). Depending on the objectives of the research, it is possible to collect various additional data on exploited species, biodiversity of marine communities and changes in marine ecosystems.
All collected data must be stored in a database. If there are no official databases, it is possible to enter the data into Excel software, which allows storing and basic data processing and graphical display of results. In all stages of work on local data collection, processing, analysis and reporting, it is recommended to bein contact with the national scientific institution in order to coordinate and carry out the activities of different project partners in a complementary and standardized way.

**Table 1.** Summary of the parameters to be collected in fisheries pilot studies and the sources throughwhich the data will be collected (as presented in the Deliverable 4.2.1.

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

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

| | | |
|---|---|---|
| | 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). | |
| **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<br>Interview<br>Questionnaire |
| **Additional data** | ▪ Climate change<br>▪ Invasive and alien species<br>▪ Organic and inorganic pollution<br>▪ Microplastic<br>▪ Underwater noise<br>▪ Molecular investigation | Scientific data base<br>Scientific publication<br>Official statistical data<br>Private fishermen data<br>Interview<br>Questionnaire<br>Grey literature |

# 3. Agenda for the standardization of data on local level in field of aquaculture

## • Introduction

An overview of data collection in aquaculture is made as a part of work package WP 4.2 entitled "Common Management Scheme aquaculture activities at the local level'' within the ARGOS project. Aquaculture as a local activity inevitably has its imprint on the local community and the environment. Considering the local nature of aquaculture activities, the "Common Scheme for management of aquaculture activities at the local level" should serve to delimit governance at the global and local levels,and accordingly to delimit in data collection. The data collected through the ARGOS project will be available to the local community and decision-makers to use as guidance in developing a protocol for license holders on how to proceed in the event of changes. Therefore, here we present the groups of collected data, the purpose of the collection and the level of collection.

Data on aquaculture in the Republic of Croatia are collected in accordance with the provisions of the Regulation of the Parliament and the Council 762/2008, Parliament and Council Regulations 2017/1004, Commission Implementing Decision 2019/909 and Delegated Commission Decision 2019/910. The data collected are classified as economic, social and environmental. The basis for economic, social and environmental analyses in aquaculture is general production data. Part of the data is collected through the Fisheries Information System and part through annual collection of socio-economic data conducted by the competent ministry. Elementary records data in aquaculture are permits for aquaculture issued by the Ministry of Agriculture. The Ministry maintains a Register of Aquaculture Licenses, which is publicly available (https://ribarstvo.mps.hr/default.aspx?id=415). Licensing includes all others prerequisites from other regulations. This especially refers to obtaining a concession, location permit and meeting the requirements in the field of environmental and nature protection.

The Croatian aquaculture sector consists of both freshwater and marine aquaculture. Marine aquaculture production includes fish and shellfish farming. Fish farming includes: finfish (sea bass, sea bream, meagre and greater amberjack) farming which takes place in almost all coastal counties, but is mostly represented in the Zadar county; bluefin tuna farming located in Zadar, Split-Dalmatia and Šibenik-Knin county; and two licensed production units that started farming trout, located in Lika-Senj county. Oyster farming is mostly carried out in the area of Mali Ston Bay in Dubrovnik-Neretva county, while mussels are grown all along the cost, including Mali Ston bay, the western coast of Istria, the mouth of the river Krka and Novigrad Sea. Thus, considering the specifics of each type of farming, data collection should be tailored to each individual region or county and the type of farming represented.

## • Collection of statistics in aquaculture (production data)

The collection of statistics in aquaculture through the fisheries information system is regulated by Ordinance on

the collection of statistical data in aquaculture (N.N. 13/2019). These are general production data that license holders are obliged to record once a year through electronic register on the Ministry's website. Register on aquaculture licenses is publicly available at https://ribarstvo.mps.hr/default.aspx?id=415. The Marine Aquaculture Register is divided on the following forms: hatcheries, marine fish farms (without tuna), shellfish farms and tuna farms which have special statistical patterns. All forms contain the same basic information: number in the registry on aquaculture licenses; company data; name, size and location of the farm; species farmed; duration of the license and additional measures if necessary.

Further data on farming for each location include:

- **The form for the hatchery** contains data on planted eggs (origin and quantity), data on quantity and product values (juvenile, spawn).
- **The form for marine fish (except tuna)** is complex due to the overlap of species and generations on the same farm. Data are entered once a year for each species separately. They include breeding technology, breeding volume, number of breeding units (cages, pools), data on sales, data on losses (mortalities, escapes), data on transfer to the next production year (kg, pieces), data on plantations (kg, pieces), data on harvest and data on income from sold fish.
- **The form for shellfish** is also entered once a year. It refers to data on farming installations (length, volume and area), on the status at the beginning of the year, sales, losses (kg or pieces) and income.
- **The form for tuna** contains the ICCAT number of the farm, quantity and value of tuna in the farm, farming technology, farming volume ($m^3$), number of cages, losses and sales data (kg, pieces, value and country to which the tuna was sold).

## • The collection of economic data

Economic data on aquaculture are collected annually by the Ministry of Agriculture and processed by the Scientific, Technical and Economic Committee for Fisheries (STECF) resulting with the separate chapter in the report STECF (The EU Aquaculture Sector - Economic report 2020 (STECF-20-12)). Collected data include:

- 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 purchase of assets)
- 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 labor, unpaid labor, full-time equivalent (FTE)
- Number of enterprises

However, when collecting economic data particular attention should be paid to the economic impact of aquaculture on the local community. Thus, within Argos project we strongly recommend 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.

## • Social data collection

In accordance with Regulation (EU) 2017/1004, social data refer to employment data including (employment by gender, age, level of education, nationality, employment status and FTE by gender). 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 small and medium-sized businesses (veterinary services, maintenance services, transportation or repair services, local processing industry, retail, etc.). Finally, in order to create synergies between aquaculture and local communities, it is advisable to monitor and describe the impact of local farms on existing activities, such as local fisheries,tourism, shipping and nautical tourism.

## • Data on impact from local aquaculture on marine ecosystems

Fish farms

In Croatia, fish farms may only be established in zones recognized by the Ministry of Construction and Physical Planning as areas suitable for sea farming activities. Site selection is a critical factor in minimizingthe environmental impact of aquaculture 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 parameters, such as the current use of space (zones in the coastal area, economic activities, transport and transport infrastructure); oceanographic data (wind, waves, sea depth, temperatures, salinity); environmental data (protected areas, NATURA 2000 areas, data on marine and coastal habitats, toxicological data etc.). Once established, according to the Environmental Protection Act ("Official Gazette", No. 80/2013 and 153/2013) all farms are obligated to continuously monitor and record following environmental data:

- Dissolved oxygen, chlorophyll, ammonia (sea water)
- Redox potential, organic carbon, total nitrogen, total phosphorus (sediment)

- Visual census of the impact of fat in the mediolittoral and changes in habitats and living communities
- State of macroalgal communities (Carlit method)
- The state of benthic communities
- Presence of antibiotics residue in shellfish community overgrown on cages or nets

Report on the results of the monitoring program for each covered concession area is made once a year and submitted to the competent bodies, which includes the County in which the farming takes place.

In case of disease, the Veterinary Service prescribes treatment and the concentration of active substances of certain medicament following legal framework (Veterinary Act NN 82/13, 148/13, 115/18and bylaws for the implementation of aquatic animal health control measures) in order to minimize thepossible negative impact of excreted agents on other aquatic organisms or environmental microbiome.

In accordance with the regulations regarding the health of aquatic animals, in particular the Ordinance on the prevention and control of diseases of aquatic animals (Official Gazette, no 132/2014), every aquaculture facility (farms, processing facilities, shipping centers) is obliged to keep records on the deaths of aquaculture animals, movements of aquaculture animals and the results of monitoring programs (http://www.veterinarstvo.hr/default.aspx?id=226). Finally, when transporting aquatic animals, the transporter is obliged to keep records of:

- deaths during transport
- farms, production areas and processing facilities in which the transporting vehicle entered
- any exchange of the water during transport.

Shellfish farms

Croatian Ministry of Agriculture, Directorate for Veterinary and Food Safety, has adopted the Plan for monitoring the quality of the sea and shellfish on production areas and areas for relaying live bivalve molluscs. 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 to with following data collection protocol:

- Composition of phytoplankton communities in sea water (every two weeks during low production season and once a week during high production season)
- Determination of biotoxins (PSP, LT, ASP) in shellfish determination (once a week)
- Determination of microbiological quality (e.g., the presence of E. coli and norovirus) of shellfish (once a month)
- Determination of benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene and chrysene, in

bivalve molluscs (every 6 months)

- The presence of heavy metals (Cd, Hg, Pb) in shellfish (every 6 months).

- Additional (future) data collection

Given the importance of establishing environmentally sustainable aquaculture, it is advisable to collect additional data for which there is no current obligation. The data collected through the ARGOS project will be available to the local community and decision-makers to use as guidance in developing a protocolfor licence holders on how to proceed in the event of changes.

1. 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.

2. 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 ichthyo populations 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.

3. Additional data collection regarding the impact of aquaculture on the marine ecosystem through escaped fish should include:

- 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.

**Table 2.** Summary of the parameters to be collected in fisheries pilot studies and the sources through which the data will be collected (as presented in the Deliverable 4.2.1.

| Data for collection | | Source of data |
|---|---|---|
| **Production data** | ▪ Farming species<br>▪ Farming technology<br>▪ Farming volume<br>▪ Number of cages/recirculation tanks/other farming units<br>▪ Balance of 01.01. reporting year<br>▪ Sold fish<br>▪ Losses (mortality, escape, other)<br>▪ Transfer to other farms of the same holder<br>▪ Balance 31.12. reporting year<br>▪ Harvest<br>▪ Sale<br>▪ Additional info for tuna (min 100 fish per 100 tons of harvested fish): length/mass | DOF - MIPAAF<br>Questionnaire<br>On board sampling |

| | | |
|---|---|---|
| **Economic data** | ▪ Income: gross sales per species, operating subsides, subsides on investments and other income<br>▪ Operating costs: personal costs, value of unpaid labor, energy costs, livestock costs, feed costs and other operating costs<br>▪ Capital costs as consumption of fixed capital<br>▪ Investments in tangible assets (net purchaseof assets)<br>▪ Financial position: total value of assets and gross debt<br>▪ Financial results: income and expenditures<br>▪ Row material weight: livestock used and fish feed used<br>▪ Employment: paid labor, unpaid labor, full-time equivalent (FTE)<br>▪ Number of enterprises | DOF - MIPAAF |
| **Social data** | ▪ Employment by gender<br>▪ FTE by gender<br>▪ Unpaid labor by gender<br>▪ Employment by age<br>▪ Employment by education level<br>▪ Employment by nationality<br>▪ Employment by employment status | DOF - MIPAAF |

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| **Impact of aquaculture on marine ecosystem** | ▪ The amount of total organic carbon in the sediment<br>▪ The amount of total nitrogen in the sediment<br>▪ The amount of total phosphorus in the sediment<br>▪ Microalgal abundance and community structure<br>▪ The state of benthic communities<br>▪ The state of phytoplankton communities in shellfish production areas<br>▪ Determination of biotoxins in shellfish<br>▪ Determination of microbiological quality of shellfish<br>▪ Determination of benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene and chrysene in shellfish<br>▪ Determination of heavy metal profile in shellfish | DOF – Italian regions<br>On site sampling<br>Scientific surveys<br>Scientific publication |
| **Additional (future) data collection** | ▪ Fish immunization activities<br>▪ Feed ingredients and biochemical composition<br>▪ Feed conversion ratio<br>▪ Water quality parameters<br>▪ Impact of organic waste on Posidonia beds<br>▪ State of natural ichthyo populations<br>▪ Occurrence and frequencies of disease transmissions at farms<br>▪ Occurrence and frequencies of parasite transmissions at farms<br>▪ Shellfish production losses caused by fish predation | On site sampling<br>Scientific surveys<br>Scientific publication |

| | | |
|---|---|---|
| | ▪ Spatiotemporal distribution of farmed fish escapees<br>▪ Genetic traceability of both wild and farmed fish origins<br>▪ Detection of genetic introgression | |