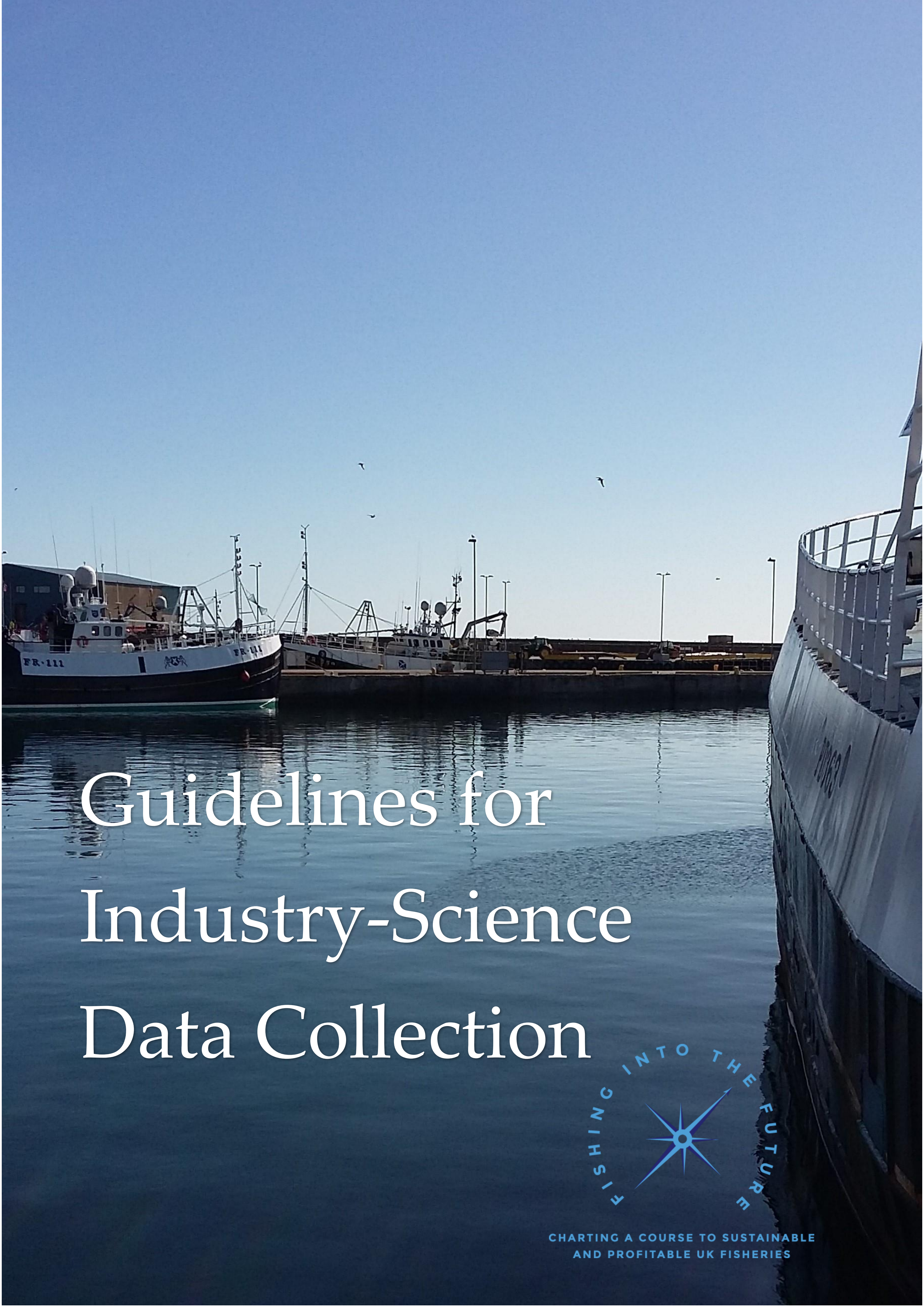

Guidelines for Industry-Science Data Collection

FISHING INTO THE FUTURE

CHARTING A COURSE TO SUSTAINABLE AND PROFITABLE UK FISHERIES

Guidelines for Industry-Science Data Collection

Step-by-step guidance to gathering useful and useable scientific information

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Report for SEAFISH

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These

Guidelines for Industry-Science Data Collection

provide a tool to help fishermen – in collaboration with scientists and managers – generate trusted, credible and relevant data which has the best chance of being applied as evidence in fisheries management.

They support the development of industry-led initiatives from the bottom-up, as well as top-down initiatives from managers and scientists, and everything in-between.

FISHING INTO THE FUTURE
CHARTING A COURSE TO SUSTAINABLE UK FISHERIES

SPFA
SCOTTISH PELAGIC FISHERMEN'S ASSOCIATION

Cefas

Executive Summary

Making the most of opportunities for engaging the fishing industry in scientific data collection is perhaps more important now than ever because, while available resources for state-funded evidence gathering has reduced in recent years, the demand for better data, improved stock-assessments and real-time fisheries management continues to grow.

These guidelines provide a reference tool to help fishermen – in collaboration with scientists and managers - generate trusted, credible and relevant data which has the best chance of success in being applied as evidence in fisheries management. They cover the practical and engagement processes that determine the success of industry-science data collection initiatives and sustaining them over the long term. The process should follow a logical sequence, and in these Guidelines, we make a distinction between two streams of activities - those related to the practical aspects, and those related to the engagement processes. In practice, these will occur in parallel and simultaneously (Figure 1.1).

Making the processes visibly explicit helps to emphasise that it's the engagement process that distinguishes industry-science schemes from ordinary scientific data collection schemes, and in many cases, determines if they are a success.

Knowing that each fishery is different - each with its own unique set of challenges - the guidelines are presented so that they can be universally applied to all fishery types. Several case studies are illustrated to help demonstrate how the guidelines can be applied to develop protocols for specific initiatives.

Figure 1.1. Framework for the *Guidelines for Industry-Science Data Collection.*

How this document is organised

This document offers guidance to address detailed questions relevant at each stage in the process. When the guidance is employed in a practical workshop setting we advise that just the main questions from each stage are used to help the group with their planning. This allows for more dynamic and freeform discussions on the problems at hand. The detailed questions in the guidance serve as a checklist of items to be reviewed and considered where relevant.

It is structured in three sections:

- Section 1 describes what the guidelines are about and why they are needed. It also describes how similar initiatives are occurring elsewhere.
- Section 2 delivers the step-by-step framework for designing and delivering effective industry-science data collection. It describes the planning, delivery and application of industry-science data collection initiatives. It describes 5 stages where attention to the details of how to collaborate effectively need to be considered in tandem with the practical aspects (Figure 1.1).
- Section 3 provides test-cases by retrospectively mapping on to a single page how the stages from the guidance were applied to each specific situation.

We have used some icons and text colouration to help orient you to different elements of the process, these are simply:

 = Science processes (black type)

 = Collaboration processes (blue type)

Contents

Section 1. Context and purpose

A global perspective

The demand for evermore information driven by an ecosystem approach to management requires new types of information and new ways of collecting it. The fishing industry has considerable and unique capacity to help meet these requirements. But, while their involvement in generating scientific evidence relevant to management is considered important for the future of fisheries, many people are unclear about what this may entail.

Some scientists and managers have legitimate concerns regarding the ability of the fishing industry to provide quality controlled data in a form that's accessible and useful for generating the scientific evidence for advice in management. There are concerns also about the governance of the scientific process and what partnerships with industry mean for the integrity of scientific institutions.

Fishermen also have their concerns, particularly if they perceive that management bodies are not committed to make use of their data, or they are concerned that management does not react quickly enough on their information. If they don't understand clearly how science is generated and used in management, it can exacerbate their frustration with management, potentially leading to poor compliance.

Working in partnership, benefits both industry and science because the value of science to management is better understood and accepted when the scientific knowledge is co-created. It's important more now than ever because, while the scientific information requirements continue to grow to meet the ever more complex needs of the ecosystem approach, the capacity of the scientific infrastructure is not increasing. On the contrary, in many areas, financial pressures have led to reductions in capacity and overstretched limited resources. As a consequence, science is more frequently turning to industry for help with monitoring and research. At the same time, industry is turning to science for help - for several reasons. One, because as a profession it is becoming increasingly more scientific and technical. Two, because it needs to operate effectively in management systems underpinned by science, and three, because it needs to demonstrate its sustainability credentials to assure environmentally aware markets.

The net result of this is that we see more examples of integration heading toward the right-hand side of the spectrum of industry involvement in science (Stephenson et al. 2016, Figure 1.2).

Degree of Integration →

↓ **Degree of Integration**

	Sampled by others	**Provided by Fishermen**	**Collaborative Arrangements**	**Participatory governance regime**
Fishery Observations	*Basic fishery data gathered by others without fishermen's direct input (e.g. catch sampling and port monitoring)*	Fishermen provide fishery information that could be sampled by others, such as length - frequency, catch sampling	Fishermen collaborate in enhanced sampling	Governance regimes accepts and expects the use of fishermen's observations and sampling
Fishermen's 'Experiential Knowledge'	Fishermen's unique 'Experiential Knowledge' is sampled by researchers	Fishermen's unique knowledge is summarised /presented by fishermen	Fishermen and researchers/managers collaborate in research generation and use of unique knowledge	Governance regime is built to accept and expect fishermen's unique experiential knowledge as part of 'best available' information.

Figure 1.2. *Spectrum of the types of contribution and degree of integration of fishermen's knowledge in assessment and management. All but the italicized cell are examples of 'Fishermen's Knowledge Research' (from* Stephenson et al 2016*, with permission).*

Recent projects on science-industry partnerships such as GAP2 and CFRN have promoted active engagement in the planning and execution of research, and explored the conditions that determine how successful projects are. Good collaboration is a process that requires care. Arrangements are most successful when there is common purpose, a co-constructed process, agreement on how information will be used, and a supportive and receptive institutional structure.

In Europe, the recent emergence of the principles for Responsible Research and Innovation (RRI) [1], provides compelling reasons to actively involve relevant stakeholders in developing and delivering fit-for-purpose science research projects. The foundation for RRI is the understanding that challenges such as food security that lie before us will have a far better chance of being tackled if all societal actors are fully engaged in the co-construction of innovative solutions, products and services.

[1] *Responsible Research and Innovation means that societal actors work together during the whole research and innovation process to better align both the process and its outcomes, with the values, needs and expectations of European society. It is adopted as a cross-cutting theme and policy for research in the EU H2020 programme.*

In addition to the step-by-step guidelines presented here, there are numerous examples around the world that endorse the value of establishing industry-science initiatives and provide guidance on how to do it (Box 1).

Box 1. Selected international examples on guidance for establishing effective industry-science initiatives.

Guidelines and codes on involving fishers in research

GAP2 Good Practice Guide (Mackinson et al. 2015)
Canadian Fisheries Research Network (Thompson and Stephenson 2016)
Fishermen and Scientist Research Society: Code of ethics and Data sharing policies
EU regulation on fisheries data collection (1543/2000)
FAO Code of Conduct for responsible fisheries and related documents
New Zealand's Research Science and Information Standard (NZ MPI 2011)
Gulf of Maine Research Institute - Marine Resource Education Programme for fishermen
Australian guidelines for engaging fisheries stakeholders

Responsible Research and Innovation

Principles of RRI
Public Engagement in research and innovation
Rigor Respect Responsibility: and ethical code

Specific examples

- Acoustic research with industry (Melvin et al.2016)
- Understanding stakeholder interactions (Röckmann et al. 2015)
- Co-creating knowledge on fisheries (Holm et al. 2017)
- The optimal process of self-sampling (Kraan et al 2013),
- Co-construction of collaborative research on lobster (Rochette et al in press)
- Benefits and organisation of cooperative research (Johnson and van Denson 2007)
- Fishermen's knowledge in modelling (Bevilacqa et al. 2016)
- Conference on fisheries dependent information

The UK scene

Many fishermen in the UK have expressed a desire to contribute data from their fisheries as scientific evidence to help improve management and stock assessments. Individual motives for this may be complex, but most fishermen agree on the long-term goal of securing access to good fishing opportunities for this and future generations. Their interest in science is also deeply rooted in a genuine curiosity to know and understand more about what is happening underwater, and this alone provides a good basis for industry-science initiatives. Unfortunately, the efforts of fishermen to collect useful and useable scientific data are often undermined by a lack of suitable guidance on how to plan and execute robust data collection.

While the specific details will vary for each fishery, the common features for successful Industry-Science data collection initiative can be defined, and this is where this document comes in.

Purpose and audience

The purpose of these guidelines is to:

- Provide a reference tool for collaborations to initiate and execute industry-science data collection initiatives which have the highest chances of success,
- Help scientists understand how to work with industry to enhance scientific knowledge and data,
- Help fishermen understand and contribute to the scientific evidence base for management, and
- Support manager's need for salient evidence upon which to develop management measures that benefit the sustainability of fisheries.
- Demonstrate to those responsible for commissioning scientific research that defined methods exist where working closely with the fishing industry is required or desirable.

To achieve this, the guidelines will show you how to work collaboratively to:

1. Align your initiative with actual needs and evidence gaps so that it is fit-for-purpose.
2. Define the evidence and determine how and where it needs to be presented for it to be applied.
3. Design a statistically-robust research programme.
4. Deliver the initiative with a team that is fully trained and incentivised to contribute.
5. Prepare and present the findings in a format for peer and quality review.
6. Assess how well the process has gone.

A central feature of these guidelines is the attention given on how to work together effectively and respectfully. It describes the essentials of what it takes to co-design and co-deliver industry-science initiatives, helping you to:

a) Identify those people and institutions that should be involved, and the roles they need to play.
b) Consider how to motivate people's participation by identifying the drivers and incentives that resonate with them.
c) Plan for joint learning and training activities that develop shared understanding.
d) Get the support of managers and other stakeholders, and communicate effectively with a wider audience.
e) Look critically at the results and the process, and use this learning when planning new initiatives.

The guidance is not restricted to the process of gathering scientific information required for stock assessment. It's equally relevant to research on understanding the biology and ecology of species and behaviour of fisheries.

Knowing that each fishery is different - and that each location around the UK coast presents its own unique set of challenges - the guidelines will need to be adapted to provide specific protocols on a needs basis. There will never be a one-size fits all cook-book. To help demonstrate how the guidelines can be made in to specific protocols, several case studies are illustrated.

Section 2. How to design and deliver effective industry-science data collections initiatives

Process Overview

Consideration needs to be given to the collaboration process *at the same time* as the practical aspects, since the roles that people play and the way they interact with one another are key to determining success in Industry-Science initiatives.

The twin processes of developing the scientific rigour and content are inseparable (Figure 1.1) and it is this which makes this approach to data collection unique, and where these Guidelines provide their real impact.

In summary, the stages can be viewed like this:

1. **Stage 1:** (INITIATE) Initiates the process; convening people to analyse the task*
2. **Stage 2:** (PLAN) Practical planning through co-design
3. **Stage 3:** (SURVEY) Collecting data on the water and considering issues
4. **Stage 4:** (APPLY) Getting the knowledge applied
5. **Stage 5:** (REVIEW) Critical evaluation; drawing out lessons for the future

*Stage 1 might take several meetings to address before starting stage 2.

Step-by-Step breakdown

The planning and delivery cycle above can be broken down into its constituent parts. It is advisable to consider planning your own process as a series of steps with a focus on initiation, as all subsequent steps will be greatly informed by Stage 1. A summary of these separate steps can be found in Figure 2.1

INITIATE

STAGE 1: Initiation by Co-Creation

What do we want to achieve?

Science: Initiation	**Collaboration:** Co-Creation
- What is the problem and why does it need to be solved? - Who wants to solve it and what outcomes do they expect? - What are the aims for the project? - Who are the gatekeepers that will influence how the evidence will be applied? - What is the scope, scale and timing of the project? - Are the outcomes achievable?	- *Who are the end-users and knowledge providers who need to be involved?* - *What understanding and expectations do people have?* - *Is the aim agreed and understood?* - *What core values are needed to make the collaboration work?* - *Who needs to be on the project team?*

PLAN

STAGE 2: Practical Planning by Co-Design

What evidence is needed and how do we get it?

Science: Practical Planning	**Collaboration:** Co-Design
- What objectives are needed to ensure the aims are achieved? - What information is needed to make it fit-for-purpose? - Are there any critical needs or constraints that must be addressed? - What's required to make the data collection scientifically robust? - What skills and training are required? - What are the costs and resource requirements? - Who owns the data and what access arrangements are needed?	- *What are the conditions needed to motivate industry's participation & the commitment to sustain it?* - *Who needs to be involved and in what role?* - *What feedback mechanisms are needed to ensure quality participation that's valued by individuals?* - *What working practices can meet the operational needs of scientists and fishermen?* - *What research tools might help co-delivery?* - *What communications will help promote and strengthen the collaborative effort?*

COLLECT

STAGE 3: Survey and Analysis

Gathering evidence and making the most of it

Science: Data Collection and Analysis	**Collaboration:** Co-Delivery
- What on-board procedures are needed to make the data collection work? - How will the work be managed to ensure a quality job gets done? - How will the team and others be kept up to date with progress? - How will the data be analysed, interpreted and reported?	- *How can we build shared knowledge and skills?* - *Why is it a good idea for scientists to be on board fishing vessels whenever possible?* - *How do we keep a focus on getting the job done to the required standard?*

APPLY

STAGE 4: Applying the Knowledge

How do we make the knowledge count?

Science: Application	**Collaboration:** Knowledge Management
- What routes lead to getting the data used as scientific evidence, and who takes it? - What format do the data need to be in for quality review? - What's required to justify any proposal based on the findings?	- *How do we gain the support of relevant managers and other stakeholders?* - *What needs to be communicated about the process and outcomes?* - *Why is it important to give visibility to fishermen's contributions and how they have been used?*

REVIEW

STAGE 5: Evaluation

Did it achieve what was expected?

Science: Objective Evaluation	**Collaboration:** Process Evaluation
- Has the aim been achieved? - Do the benefits outweigh the costs? - What worked well and what could be improved? - What strategic actions need to occur to ensure continued relevance?	- *How did the collaboration process go?* - *What was the value and benefit of knowledge co-construction?* - *Why should you give credit where it's due?* - *What should the group do next?*

	1. INITIATION BY CO-CREATION	2. PLANNING BY CO-DESIGN	3. SURVEY AND ANALYSIS	4. APPLYING THE KNOWLEDGE	5. EVALUATION
	What do we want to achieve?	The evidence we need and how to get it	Gathering evidence and making the most of it.	How do we make the knowledge count?	Did it achieve what was expected?
SCIENCE questions to consider	- What is the problem and why does it need to be solved? - Who wants to solve it and what outcomes do they expect? - What are the aims for the project? - Who are the gatekeepers that will influence how the evidence will be applied? - What is the scope, scale and timing of the project? - Are the outcomes achievable?	- What objectives are needed? - What information is needed for it to be fit for purpose? - Critical needs and constraints to address? - What is needed to make the data robust scientifically? - What skills and training are required? - What are the resource implications? - Who owns the data and what access will they require?	- What on-board procedures are needed to make the data collection work? - How will the work be managed to ensure quality control? - How will the team and others be kept up to date with progress? - How will data be analysed and interpreted?	- What routes lead scientific data to being used as evidence and how takes it? - What format does the data need to be in for a quality review? - What's required to justify any proposal based on the findings?	- Has the aim been achieved? - Do the benefits outweigh the costs? - What worked well and what can be improved? - What strategic actions need to occur for this to continue?
COLLABORATION questions to consider	- *Who are the end-users and knowledge providers who ned to be involved?* - *What understanding and expectations do people have?* - *Is the aim agreed and understood?* - *What core values are needed to make the collaboration work?* - *Who needs to be on the project team?*	- *How to motivate industry's participation?* - *Who needs to be involved and how?* - *What feedback mechanisms are needed?* - *What working practices can meet the needs of the science?* - *What research tools might help co-delivery?* - *What communications will strengthen collaboration?*	- *How can we build shared knowledge and skills?* - *Why is it a good idea for scientists to be on board fishing vessels whenever possible?* - *How do we keep a focus on getting the job done to the required standard?*	- *How do we gain the support of relevant managers and other stakeholders?* - *What needs to be communicated about the process and outcomes?* - *Why is it important to give visibility to fishermen's contributions and how they have been used?*	- *How did the collaboration process go?* - *What was the value and benefit of co-construction?* - *Why should we give credit where it is due?* - *What should the group do next?*

Detailed process Description

1a. Initiation

What is the problem and why does it need to be solved?

Start by identifying what the problem is and why it needs to be solved. Think about the drivers that influence this because it will help you to identify the specific evidence needs necessary to design a fit-for-purpose data collection initiative. Example drivers are:

- Failings or risks resulting from current management approaches (Examples: zero TAC species, choke species issues, fishermen's response to discard ban/ other management measures)
- Politically important/ controversial issue (Examples: discard ban, inconsistency/ conflict between science and industry knowledge, charismatic species of environmental concern).
- Lack of data or knowledge required for assessment and future management (examples: Non-commercial species catch and bycatch, basic biology, data to support MSFD)
- Need to improve quality
- Changes in resource availability or efficiency demand doing things differently.
- A quick answer is needed
- Cost saving or efficiency
- Profits
- Innovation opportunity (e.g. technical advances mean thing can be done better)
- Market access depends on information to demonstrate sustainability
- Social licence to fish is threatened
- Institutional momentum
- De-regulation

Don't start out with a plan to collect data in the hope that it might be useful or someone else will be able to 'do something with it'. Collecting data intended to be used as evidence for management requires you to think precisely about what information is needed and how it will be used.

The problem (or enhancement) needs to be clearly stated in general terms so that it can be translated in to the scientific objectives or hypotheses that can be evaluated using relevant scientific methods (e.g. Table 2.1).

Table 2.1. *Examples of problems translated to scientific objectives (see Section 3 for more detail on the examples used here)*

Management questions (Problems)	Scientific evidence needs	Scientific objectives
How can managers determine whether setting a zero TAC for a combined 6a,7bc herring is a good decision?	Reliable evidence to be able to separate the assement of herring stocks in to their 6aN and 6sS, 7bc components and decide appropriate management for each.	Distinguish whether herring in 6aN and different from those in the south and collect information necessary to estimate their abundance.
What species might be elligible for an exemption from the discard ban, helping fishermen can continue to operate?	How well different species survive fishing and what can be done to improve survival rates?	Measure the survival rates of species to different gear types and evaluate at sea measures to enhance survival. Focus on priorities such as those that might be choke species.

Who wants to solve it and what outcomes do they expect?

Identify the people and institutions that need or want to solve the problem. It might be that the key people who most need to solve it are not the people paying for the work, so it's not always clear.

Different participants and end users may have different expectations of what they want to achieve. The involvement of decision makers is particularly important here so that the details of what information needs to be collected, and when it needs to be available, matches with how they can apply it.

What exactly is the aim?

The aim of the work should be precisely defined and reflect the problem to be solved, and not the methods to solve it. This means people's attention is focussed on why it matters, not what is being done. This will then align with what outcomes are expected.

For example, it's common to see aims like '*to conduct an acoustic survey of herring*'. It says nothing about why this is important or needed. It just says something about the method. If the problem was that we didn't know how many herring there are in the sea, a better aim would be '*to determine the abundance of herring*'.

(see section 2a on Objectives)

Who are the gatekeepers that influence whether the evidence will be applied?

Having an awareness of both the institutes and people that act as gatekeepers to how information flows through the science and management system is essential if the information has achieved its intended use. Navigating these institutional and social pathways can be convoluted because the structures evolve, and the people and power dynamics change. Depending on whether the information is intended principally as either evidence to inform management, or as evidence for buyers looking for reassurance on sustainability (but noting that one does not exclude the other), will determine the pathways to follow.

The case studies in Section 3 identify case-specific pathways, and Figure 2.2. provides a generalised example for the UK that provides insight into what kind of pathways need to be considered.

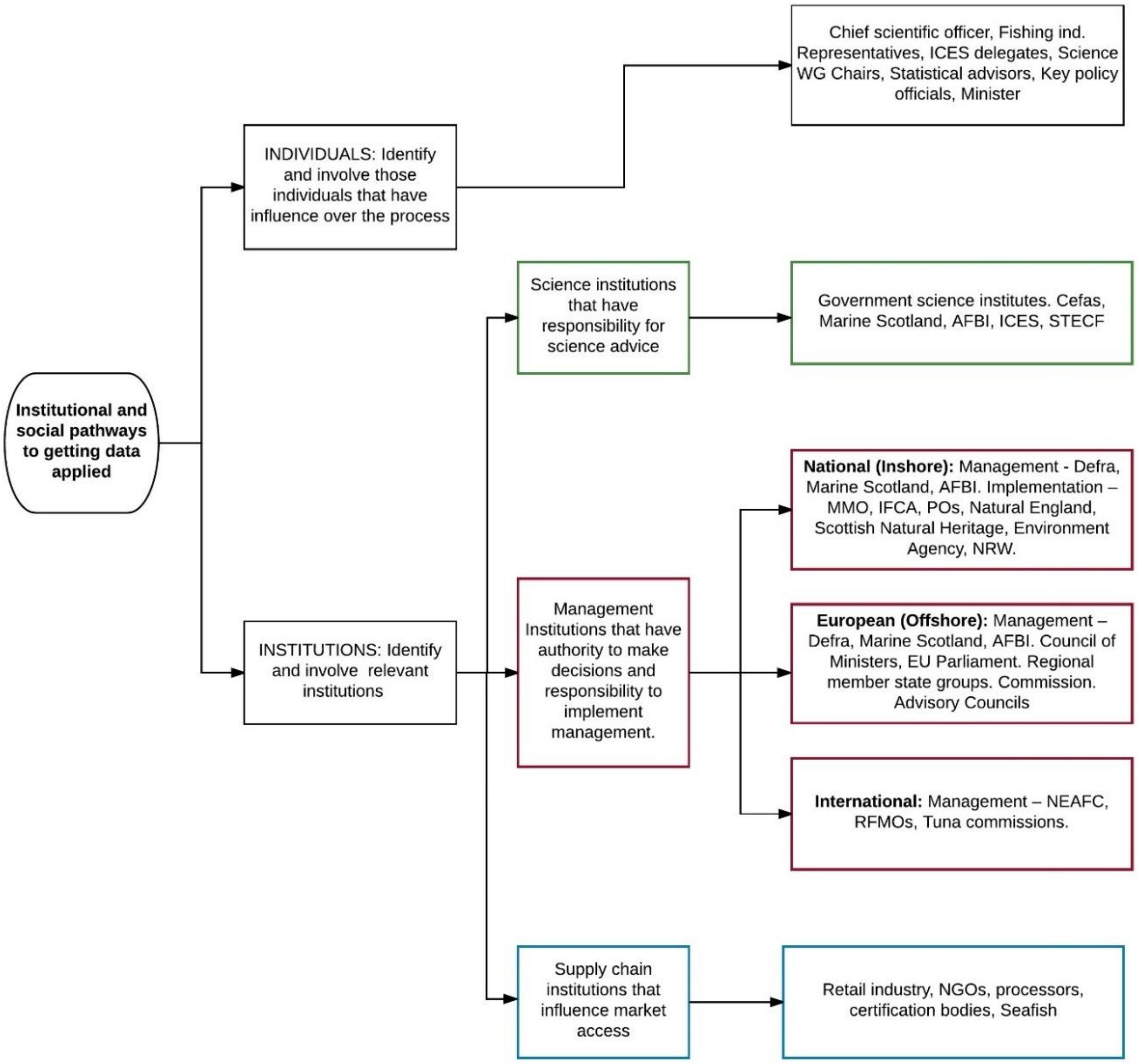


Figure 2.2. Structures in the social and institutional pathways to application

What is the scope, scale, timing and likely costs and benefits that need to be considered?

In deciding whether to pursue the work, a rough scope and cost is required to understand if the science is achievable and affordable. This rough specification needs to be squared with funding sources and the conditions of any funding programme that is being applied to. For example, some funding sources will only support specific actions, such as technical innovation or capacity building.

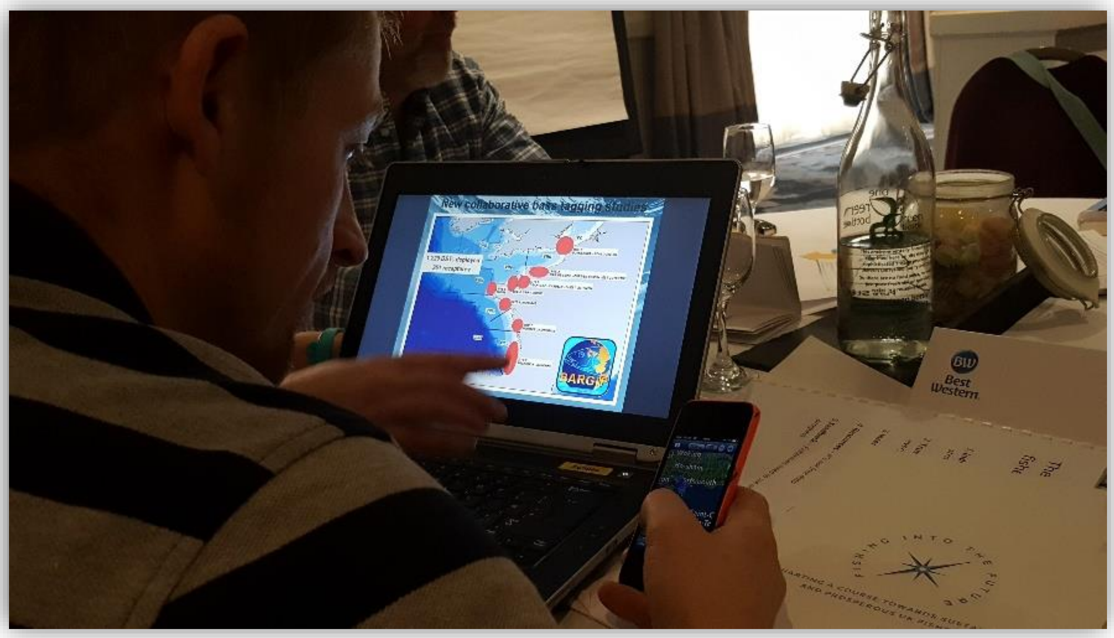
If funding has not yet been identified, a concept note will be needed to attract the attention of funders, and should cover (i) the problem and specific aim, (ii) how the data will be used and what it will achieve, (iii) who benefits and how, (iv) how the data will be collected, (v) resources and timing.

ICES scientists are currently considering evaluating the cost and benefits of data sets used in stock assessments and fisheries advice, so this group (and its report) would be essential to be aware of if the goal is to generate evidence to support management. http://www.ices.dk/community/groups/Pages/WKCOSTBEN.aspx.

Are the anticipated outcomes achievable?

It should be possible now to decide if it's likely that pursuing a programme of work will 'deliver the goods'. If not, then it's prudent to stop and reflect, with the aim of coming up with a good plan rather than muddling on in the hope that something good might come of it.

Be mindful that while scientific information generated through fishing industry surveys and research can be useful for assessing the state of fish stocks and understanding changes in the marine environment, not all scientific needs can be met by enlisting industry support, and some might be better addressed without it.



1b. Co-creation

Who are the end users and knowledge providers that need to be involved?

Identifying the end users of the data goes hand-in-hand with defining how the information is intended to be used. If the end users are the same people who need to solve the problem and have commissioned the work, then it's clear that they should be involved.

When the end user is an institution, such as ICES (in the case of giving scientific advice), or the UK Government, European Commission, or Defra (in the case of prescribing management measures), it can be difficult to identify the individuals that need to be involved, not least because of the frequent turnover of people in such institutions. In this case, the best chance of success is to start by connecting the aims of the industry-science initiative with the aims and priorities or relevant institutions. For example, the ICES strategic plan, the UK Government fisheries objectives, or objectives defined in articles of the Common Fisheries Policy.

Identifying and involving people that have relevant knowledge to ensure that any data collection is fit-for-purpose needs to start at the beginning of the initiation phase so that they can help in the feasibility assessment and discuss alternative options before any detailed plans are made.

What understanding and expectations do people have?

The problem may have several dimensions, and be perceived differently depending on people's personal and professional motivations and the factors that influence them (Appendix 2). Being directly involved in the scoping of the work provides opportunities to speak openly about expectations, concerns and alternatives necessary to define an agreed aim (Section 1a). It provides opportunities to address lingering suspicions and develop understanding of each other's knowledge. It requires face-to-face interactions that actively engage people through brainstorming ideas, prioritising and defining objectives. This is the process of co-creation and the result should be a shared understanding of the nature of the problem and how to address it.

Experience indicates that an important part of managing expectations related to fisheries science is ensuring from the outset that all participants understand and respect that the results and their level of certainty might not meet their individual expectations or desires. Unrealistic expectations or fears for how the knowledge and data arising will be used need to be tackled head on.

Is the aim agreed and understood?

The main aim and any additional aims should be mutually agreed based on a clear understanding of the problem, the needs of the end users and the individuals involved. Communication and engagement at this planning stage should be used to manage expectations by making clear what can and cannot be achieved

What core values are needed to make the collaboration work?

Establishing productive and lasting working collaborations is a process that requires care; the foundations of which are mutual respect and trust at an individual level. Agreeing to operate with some core values, such as openness, honesty and shared learning will help to achieve this. Suitable opportunities to help promote this can be / should be factored in at the design stage.

There are numerous personal attributes and skills that help facilitate the development of effective working relationships. An ability to listen and ask appropriate questions helps achieve understanding and respect for the knowledge and views of others. An awareness of the social and cultural context of different ways of working (Figure 2.4) will help prevent and overcome many small but potentially significant issues.

About Fishermen	About Scientists
Way of life	
Love of the sea Way of life Livelihood – money is important, but not all financially motivated Want to be involved, feel useful/important Not just short-term vision (but some do)	Love of the sea Driven by curiosity and academic motivation Not all motivated by academic 'fame' Want to be involved, feel useful/important Try to provide knowledge produced for better stewardship
Education and authority	
Educational levels variable Authority of knowledge: scientists can be perceived as the 'authority' because of links to government and policy	May lack skills for collaborative work May need endorsement of other 'authority'
Ways of working	
Time rhythms (tide and seasons) guide work patterns but unpredictable weather can lead changes in plans at short notice Need to fish efficiently as possible to maximise income	Constrained by available time of research vessels and weather Need to design surveys that provide robust scientific information

Figure 2.4. *What needs to be understood and taken into account when working with each other? (adapted from GAP1 Good practice guide)*

Who needs to be on the project team?

The project team have the responsibility for getting the job done, planning the work, reviewing the progress and making decisions to adapt work as necessary. The team does not need to include everyone with an interest or involvement in the work, but it does need to work for them.

Having an appropriately balanced project team comprised of scientists, fishermen, policy end users and other relevant stakeholders is important because it leads to better informed decisions that lead to fit-for-purpose results. Having a team also demonstrates the shared responsibility and ownership of those involved.

Experience shows that because people adapt their behaviour to the situational and social context, fostering a no-blame and no-surprises culture as well as being modest, tends to promote greater openness and confidence in one another. These behaviours within the team will be reflected outwards to others involved in the work.

Consistency of people involved is critical to success.

2a. Practical Planning

What objectives are needed to ensure the aims are achieved?

The aims of data collection actions will now be clearly defined, achievable, agreed and communicated to all relevant stakeholders.

The specific objectives should now be formulated which focus on components of the problem, not the methods to solve them. This means that when all the objectives are met, the aim is fulfilled. Following the example where the aim is to 'determine the abundance of herring', an objective might be '*assess the spatial distribution of herring*', which would be a necessary component of determining the abundance.

What information is needed to make it fit-for-purpose?

Figure 2.5 provides an overview of the components of technical and practical considerations required to make data collection fit-for-purpose.

The specific data requirements will depend on the drivers (and associated evidence requirements) of the data collection. For example, if the data are collected to enhance evidence supporting delivery of EU fisheries management goals e.g. fishing at MSY (CFP), Good Environmental Status (MSFD), and national implementation then they need to fit in the mandatory data collection programme under the EU Data Collection Framework (DCF). If the data are collected using the required protocols, then they should also be useful to provide evidence towards improving management of stocks to e.g. increase quota and economic return to fishing industry. The key variables here will include fisheries data (catch composition), biological sampling, surveys, and economic data.

Similarly, if the drivers are to improve sustainability and environmental credentials of the fishing industry (e.g. for MSC accreditation, RASS profiles) then accurate catch and fishing activity data will be needed. Other drivers of data collection such as the development and demonstration of selective fishing gears and methods to reduce discards and reduce environmental footprint would also require specific technical and practical considerations.

Issue	Process	Primary considerations	Secondary considerations	Tertiary considerations
TECHNICAL AND PRACTICAL ASPECTS	DESIGN	Location, timing and duration		
		Scientific platform: RV; FV?	Number of vessels	Whose vessel is available?
				Is it suitable (specification?)
				Cost of vessel hire and making it operational for the task
		Tools	e.g. catch sampling, remote monitoring	
		Statistical Design to ensure quality	Number of trips and samples	Scientific protocols and statistical guidance, Cefas, MSS, ICES
		Cost – estimated based on specification – consider against quote and revise		
		Staff resources	Experience; done it before?	
			Training requirements (industry and scientists) necessary to be effective	
		Innovation opportunities	Technology innovation: using tech to improve data capture, quality and efficiency	
		Technical Scope – new or existing equipment	Procure equipment or borrow it	
		Data **requirements**	Data products; ways to distribute mobilise information in relevant forms	
			Metadata	
			Access and ownership	Transparency
			Standards and formats	ICES guidance
				MEDIN – what is the relationship with ICES?
				ISO – international Standards Organisation
				Organisation's standards: - relates to the use of the data e.g. MMO / JNCC / MESHards and formats
				DCF / DCMAP (under STECF)
				How to future proof it?
			Quality assurance procedures	
			Design for multi-purpose use	
			Storage	
		Add value to existing schemes? Weigh up the cost-benefits		
		Experience – done it before?	NO: what else is required?	

Figure 2.5. *Components of the technical and practical considerations in the design stage*

To assess and manage marine resources, biological, technical, environmental and economic data are required. Thus, the minimum information includes biological characteristics, such as age and length distributions of the commercial catch; total catch (landings plus discards) as well as information about fishing effort, fishing efficiency and fleet behaviour. Indices for stock status such as fish size, age, sex ratio, size at maturity, and reproductive status are therefore all important. Further, the biological data are needed with sufficient coverage to be representative of the stock.

Environmental data are also required to provide an understanding of the environmental effects on stocks. Data are needed on target species, incidental catches, spatial patterns of fishing effort, sensitivity of the habitat to the fishing gear, the impact of the gear on the habitat and the rate of habitat recovery. The environmental data need to be presented relative to fleet activity i.e. spatial patterns of fishing intensity.

Social and economic data are also needed to understand the size, nature and location of the fishing fleet. These include value of landings to different ports by different types of vessel/gear; economic contribution of fisheries in terms of value added and employment; relative social, economic and environmental performance of different subsectors (gears; metier) exploiting common resources and quota allocations between fleet segments.

Are there any critical needs or constraints that need to be addressed?

Early on the team should consider any foreseeable critical issues that would prevent the work from achieving its aims. The means to overcome them need to be identified and built in to the planning.

Where the data is intended to support stock assessments, critical needs might be ensuring that established standard sampling protocols are followed and that the level of accuracy (precision and bias) in the data is determined. The usefulness of any data collection programme will also depend upon a rigorous statistical design and validation to ensure that the data are robust. For EU fisheries, ICES has established a range of expert groups whose primary role is to coordinate and promote the collection of high-quality data with sound scientific and statistical procedures. These expert groups include i) Regional Coordination Groups (EC groups) that coordinate and optimise regional DCF data collection schemes according to end user needs, and identify data deficiencies and how to address them; ii) Working Group on catch (WG Catch) which focuses on the technical and methodological aspects of data collection; and iii) PG Data – planning groups on data needs for assessment. Data proposed for use by ICES for its advisory role would need to be reviewed through the ICES benchmarking process where data quality is assessed (unless considered part of an existing data collection programme).

What's required to make the data collection scientifically robust?

Designing a data collection initiative that yields high quality, scientifically defensible data requires detailed consideration of the survey design, quality control procedures, methods for data collection, capture, storage and analysis, and making sure people have appropriate skills and training. And finally, the financial resources to do the job.

Sampling design

The scientific objectives provide the starting point in designing a robust sampling design. Key questions to consider include:

- Will data be collected from the fishing industry e.g. logbooks for fully documented catch?
- Will data be collected from a representative sample of vessels or fishing trips taken at random e.g. for estimating catches and fishing activity from a random sample, then raising to total fleet?
- Will data be checked for collector bias? Data collectors will require training, and differences in data due to collection methods will need to be identified.
- Will data be collected from one or more vessels for specific purposes, e.g. in localised studies for testing new gear designs, exploring potential new fisheries?
- What measurements should be taken?
- What should the duration of the programme be?
- What strata are within the fishery under investigation (gear, target species, spatial units, temporal units)?
- What is the number of samples required (statistical power analyses)?
- Are samples taken and processed on-board the vessels or do we use port sampling?
- How can the results from samples be scaled up to the total fleet?
- How are data registered and processed (software on-board and in fishing laboratories)?
- How to deal with legal issues: e.g. keeping undersized fish on-board?
- How to arrange these kinds of issues with the authorities?

The most common data collected in fishery-dependant surveys through science-industry collaborations is the catch. Some basic features of catch sampling design include:

- Incorporating randomness into sampling increases the probability that samples will reflect the population accurately i.e. each and every individual should have an equal chance of being in the sample.
- Maximizing sample size to account for variation and rarity in the population.
- Taking multiple samples to account for any systematic differences in the distribution of fish on the ground, within the gear, and the way it is handled. It is better to take multiple samples rather than take one big one!
- Take care for sources of bias. For example, inconsistent sorting, day and night variations in catch composition due to fish behaviour or chosen fishing ground, tendency for fish of different sizes to be unevenly mixed in a pound, hopper or on a conveyor.

The sample size and frequency of sampling will be determined by factors such as:

- Time available between hauls
- Conditions on deck

- Volume and composition of catch
- Catch handling system chosen by the skipper/crew

It is very important that data collectors record as accurately as possible the total volume of each catch component (retained and discarded), and the corresponding volume of samples and subsampling rates. This is to enable numbers and size distributions of fish to be raised to the total caught in each unit of fishing operation. All calculations also will need to be clearly shown.

Other data that might be collected may include: environmental data (e.g. seawater samples), substrate data (e.g. grab sample of the seabed) and acoustic data.

No matter how good or bad a sampling design might be, sampling may not go according to plan, and there may be quality issues related to implementation, e.g. inadequate coverage of strata due to uptake or other issues. These factors may lead to bias, or to poor precision due to small numbers of sampling units. Diagnostics will therefore be needed to show where and how these problems affect the data and the likely impact on overall quality.

Several ICES expert groups (EGs) provide guidelines for good practice in collection of data from fisheries (Box 2).

Box 2. ICES guidance on scientific sampling programmes.

- Workshop on practical implementation of statistically sound catch sampling programmes (WKPICS: 2011 – 2013; 2012 has guidelines for good practice).
- Study group on practical, implementation of discard sampling plans (SGPIDS: 2011 – 2013);
- Working group on commercial catches (WGCATCH: 2015 onwards);
- Working group on recreational fisheries surveys (WGRFS: 2012 onwards)

Quality control procedures

The sampling design should have ensured that the data were collected in a way that minimized any bias and allowed for the reliability of the data to be assessed at the required level (national, regional).

Quality control procedures should include:

(i) Cross-checking the data with other sources of information from the same area, fleet, time-period etc., such as VMS, logbooks, observers, correlation with year class strength, comparison with surveys from other countries, check with fishermen.

(ii) Monitoring the internal consistency of the data series e.g. comparing the variation between participants fishing in the same period, area and fleet; checking if biological measures are within acceptable limits.

(iii) Independent validation/quality assurance of data collection by independent collectors e.g. observers.

Where the data is intended for use in fish stock assessment, they would need to be introduced during an ICES benchmark meeting. Particular attention would be given to verifying that the sampling scheme followed good practice in terms of statistical design, its execution, the analysis methods and the interpretation of results.

Tools and technologies for effective data collection

A wide range of tools and approaches are available and have been applied to monitor and collect catch data that fishermen could use. These are summarised in Table 2.2. Each technology and approach has its own logistical requirements, coverage, data it can provide and its quality, precision and confidence (including issues around the data validation), and potential cost of implementing the approach. In general, data collection is not limited by the tools / approaches to use rather by the design that makes the most practical and commercial sense at a vessel level.

Table 2.2. List of approaches and technologies that fishermen could use to collect data.

Approach	Description
Remote electronic monitoring	Monitoring of catch on fishing vessels through integration of video cameras, gear sensors and GPS to record and log fishing activity for monitoring and review onshore
Observers	Scientific observers on board fishing vessels to collect data on quantities of retained and discarded species, including biological data and information on fishing activity
Onshore sampling	Onshore observers vising ports to collect data on age, length, catch composition and area fished
Self-sampling	Can be classified as the: • self-collection of discard sample material for analysis by laboratories • self-collection of data by fishermen • self-reporting of catch and activity
Reference fleet	A group of vessels that serves an enhanced data collection role, with the vessels considered sufficiently representative of the activity of that fishery for the data to be raised to the level of the fishery as a whole.
Automated species identification and measurement	System for automatic species identification, length measurement and weight estimation from a calibrated camera system
At-sea weighing equipment (scales, codend weigher)	Platform-mounted scales which can quickly measure bulk weights (including boxes, baskets) of fish or crane codend weighers (load bearing scales attached to net)
Catch documentation tools	Wheelhouse tools for effective recording of activity, environmental conditions and catch information including e-logs
Onshore grading equipment	Shore based equipment for grading and sorting fish, including the possibility to measure lengths and weights.
Ships echosounders	Many ships echosounders are able to record raw echodata and thus provide information on the distribution and relative abundance of fish. To be used to quantify the abundance and biomass they need to calibrated using existing scientific protocols.
Ships plotters	Spatial and temporal information on the distribution of fish marks and fishing activity can be recorded directly in the ships plotter. The data is typically held in a databased file that can be downloaded from the ships computer.

Data storage and access

If the fishing industry actively participates in data collection then this has the potential of generating a considerable amount of data, and therefore mechanisms for data ownership, storage, privacy and access need to be developed during the planning stage. A variety of databases are available to store the data generated that the industry could use or could follow their example. Data hubs such as the Marine Environmental Data and Information

Network (MEDIN) promotes open sharing of, and improved access to the wide array of marine data that is collected and used by many different organizations. The Cefas held Fisheries Data Archive Centre (FishDAC) is also another example where data collected by fishermen could be stored. Whichever data hub is used, it should be assured that the data are kept confidential, where necessary, and a data share agreement is in place with the project partners and stakeholders.

Since 2000, an EU framework (Data Collection Framework (DCF)) for the collection and management of fisheries data is in place. Under this framework, EU Member States (MS) collect, manage and make available a wide range of fisheries data needed for scientific advice. The data are collected by national programmes in which the MS indicate which data are collected, the resources they allocate for the collection and how data is collected. MS must report annually on the implementation of their national programmes and the Scientific, Technical and Economic Committee for Fisheries (STECF) evaluates these annual reports.

Part of the data collected by the MS is uploaded in databases managed by the Joint Research Centre (JRC) which is assembling the data, storing it in databases, analysing its quality and coverage and making it available to the STECF working groups. Once the STECF reports are finalised the data is disseminated in aggregated form for a target audience of experts for further use in scientific analyses and policy.

The EU has agreed to provide a greater flexibility for end-users to define the details of data collection from 2017. This provides a route through which data collected directly by fishermen could be included in assessments and policy advice. Understanding currently available data is an important perquisite in the planning of future data collection initiatives.

What skills and training are required?

Training needs should be discussed in advance of data collection and specific plans made as needed. While not always practical, training in data collection is best done on-board the vessel so that any practical constraints can be identified and resolved. Shore-based theoretical training can be done beforehand, these can be less effective but enable larger numbers of individuals to be trained more quickly. There may also be a requirement for training in data management.

While the skipper should be fully aware of the scientific data collection activities, its most effective to invest time training one or two crew members to a high degree of competence and encouraging them to share their knowledge and skills with other crew. Normally, these individuals will have some seniority and respect from their peers, and enthusiasm for the additional scientific sampling and data collection tasks required.

Training should be adapted to each particular situation based on the objectives of the data collection programme. Some of the key considerations are:

- It should be clear what kind of data are required (and why) and what kind of format is required in order to make data collection and processing more efficient.

- The goal should be to instruct fishermen how to collect data not to educate them to become fisheries scientists.
- Individual training and procedures are important to increase understanding and commitment. This can be easily achieved when scientist are on-board the fishing vessel.
- It also needs to include how validation trips will be selected and executed and how data will be checked data for quality.

If the data are for stock assessment, training for data collection could include aspects on

- How to execute data collection
- Ability to sub-sample when appropriate
- Agility with raising factors
- Knowledge of different measuring protocols for different species
- Coverage of catch
- Log sheet completion
- Accuracy of measurements
- Ability to sample randomly and representatively.

What are the costs and resource requirements?

Estimating the costs and resources required to undertake the work goes hand in hand with the survey planning, since resources are rarely unlimited. The direct and indirect costs associated with the collection, archiving and analysis of data should be considered / estimated. Direct costs of equipment, chartering, staff time and fuel etc. are relatively easy to estimate. Indirect costs such as lost fishing time, extra burden on crew, and time for checking data quality, less so. In some cases, additional crew may be required or sorting practices may need to change to accommodate data collection. Limitations on deck and sorting space as well as accommodation for additional crew would also add to the cost of data collection.

Apart from the cost of collecting the data, sufficient finances will also be required to fund quality control methods (e.g. observers time), storing the data (IT costs), analysis and interpretation, manipulation to necessary formats and project management. Funds are also required for meetings (with partners, and with end users), exchange between data collectors and data stewards, training, day to day management and coordination. It is important that these associated costs are not underestimated as going ahead with insufficient funds may lead to failure of the data collection initiative.

Who owns the data and what access arrangement are needed?

A decision needs to be made about who owns the data. Fishermen's organisations, scientific institutes or other organisations could host IT systems (servers, databases etc.) to enable the data collected to be stored, maintained and accessed with appropriate security to ensure against improper access. If the data are to be used by ICES and STECF, then there are pre-agreed channels that need to be followed e.g. in the UK, data to ICES and STECF are usually submitted by the Marine Management Organisation (MMO) or Cefas.

2b. Co-design

What are the conditions needed to motivate industry's participation and the commitment to sustain it?

The reasons why participation in the design and delivery of scientific data collection are important to fishermen are intimately connected with the things that motivate them to want to get involved. These reasons will be different for each specific case, but key ones are:

- **Empowering industry leadership** – establishing a bottom-up approach that empowers industry responsibility for the data used in generating scientific advice for management.
- **Promoting a sense of stewardship** – equipping the industry to be monitors of the marine environment.
- **Demonstrating industry's sustainability credentials** – averting the all-too-common narrative that the fishing industry are the bad guys.
- **Doing things that you couldn't otherwise do** – fishing vessels (and factories) providing platforms to collect relevant data at a level of intensity, coverage, and duration that isn't possible with traditional scientific surveys. Thus, filling knowledge gaps and adding new complementary data to existing scientific data.
- **Providing opportunity to innovate** - applying industry innovations to provide an alternative 'window' on the marine environment and make data collection efficient and cost effective.

Depending on the nature of the work, specific incentives for the involvement of fishermen might need to be considered. Ideally, the need and problems should be sufficiently compelling to get industry involved, but they need to resonate with the priorities of fishing as a business.

Lasting commitment to partnership working emerges from two things, a trusting, respectful working relationship, and sustained value (impact) to the issue(s) that matter. Experience shows that projects that are co-constructed and have strong feedback channels and/ high and visible impact outlast those where the science becomes invisible or intractable once the data collection is done (Johnson and van Densen 2007, Mackinson et al. 2015). A recent example of this the European Commission's amendment to the spurdog TAC that provides a derogation from the zero TAC for vessels engaged in a spurdog By-catch avoidance programme, the evidence for which relied heavily upon the successful engagement of industry (Hetherington et al. 2015, 2016) (See Case study 1).

Who needs to be involved and in what role?

Finding the right level of participation and defining roles is essential to be able to utilise appropriate skills and knowledge where it's needed. There's no need to involve everyone in everything, because it runs the risk of poor engagement when people are asked to participate in things that seem irrelevant to them. However, not being involved does not mean being unaware (see more on this in the following sections).

Some roles will be obvious, others not, so the best approach is to ask people how they can (and want to) contribute to the objectives in a meaningful way. The need for inclusivity should be constrained by the practical aspects of getting the job done.

Three roles are particularly important:

- **Leaders** able to motivate and inspire others toward a common goal. This role is often assumed by individuals that have a have broad expert knowledge of a subject because of the respect that others give them.
- **Bridge builders** that act as knowledge-brokers in helping others to overcome seemingly insurmountable barriers and building effective working relationships based on a shared understanding.
- **Linkers** able to connect the data from industry-science initiatives with the institutions and end users that put it to work.

What feedback mechanisms are needed to ensure quality participation that's valued by individuals?

Making sure there is sustained value to individuals is equally as important as the focus on the science objectives, and this comes about when people feel and see that the work is worthwhile to them personally as well as collectively. This is why establishing effective feedback mechanisms is one of the core design principles in planning and delivery industry-science initiatives.

Examples of types of feedback mechanisms include: using industry observations to formulate scientific hypotheses, survey briefings and debriefings, bespoke data reports, fishermen getting involved in data exploration and validation – particularly mapping, training activities, using fishermen's observations to create scientific hypotheses, meetings, chat groups, social media, newsletters, specific science briefings… and more.

During the work, effective feedback means keeping people in touch about significant and relevant findings. Face-to-face conversations are best, but social media are effective too. As an example, the fleet of commercial vessels and scientists involved in a recent industry led survey of Western British Isles herring (see Case study 2) created a Facebook page and Whatsapp group. The live commentary on Whatsapp was used during the survey to adapt the survey design based on what the vessels were seeing. It continues to be used to keep the those involved informed during the analysis of the data. The Facebook page was influential in reaching a wider interested audience.

The key thing about using social media for this purpose is keeping it relevant as and when needed.

What working practices can meet the operational needs of scientists and fishermen?

Fishermen should not automatically be expected to undertake tasks that interfere with their priorities on board during commercial fishing operations. However, the commitments established in coming to an agreed set of objectives will provide the basis for technical discussions on plans of what is and is not achievable on board fishing vessels. Considerations of the scientific methods, tools and the need for quality controlled data are paramount in this discussion since this will determine whether the data will be fit-for-purpose and the aims achieved.

What research tools might help co-delivery?

Collaboration processes are mainly common sense, finding what works best given the situation at hand. There's also quite a lot of methodological tools that can help to facilitate the co-delivery of work by providing specific ideas on how to work together. The GAP2 Toolbox is a great resource for guidance. The toolbox includes tried and tested methods to assist in delivering collaborative industry-science initiatives (Fig. 2.6 and Appendix 3). Details at: http://gap2.eu/methodological-toolbox/

Figure 2.6. *The GAP2 Methodological toolbox overview*

What communications will help promote and strengthen the collaboration?

In addition to ensuring access to data (See section 3a) and establishing feedback mechanisms among the delivery teams (See section 3b), other more outward looking channels are needed to make sure the value is communicated to relevant people, such as skippers, owners, teams, associations, institutions, policy makers, scientists. The point of these communications should be to inform and educate about progress, scientific results and their significance. Whatsapp, Facebook, YouTube are all good channels for dissemination to the fishing industry as well as government organisations, science institutions and the public.

A communication strategy identifying the audience(s) and tactics to deliver coherent and continuous efforts is required. Initiatives should consider using some dedicated communications specialist to ensure this is done effectively.

3a. Data collection

What on-board procedures are needed to make the data collection programme work?

On-board data and sample collection procedures must be designed specifically to meet the aims and objectives of the survey. That's to say, there is not a standard set of off-the-shelf data collection procedures for fishery dependant surveys. The procedures need to be tailor-made to achieve the objectives.

The level of participation from the fishermen will determine the procedures required on-board. If the surveys are scientist-lead, such as the UK Fisheries Science Partnership, a scientist or observer is likely to be aboard throughout the survey(s), requiring little additional input from the fishermen other than their usual duties. At the other end of the scale are self-sampling surveys, such as the Cefas lead Shark By-Watch UK and NEPTUNE Scientific By-catch Fishery, involving numerous vessels at sea simultaneously, typically with a scientist or observer absent. The fishermen aboard collect catch data, biological data, tagging and landing samples.

For either approach, a written plan of the survey should be produced by the lead scientist with input from fishermen taking account of operational and local knowledge needed that will determine the feasibility of the plan. This should contain concise information on the aims, objectives, sampling methods, sailing logistics, key personnel, health and safety, and so on. This should be written in plain English so its accessible for everyone who needs and wants to read it. For self-collection, self-recording or self-sampling surveys, for the fishermen to buy-in to the additional work being asked of them, the on-board procedures must not be overly burdensome so that they can efficiently be incorporated into the day to day vessel routine. To do this, regardless of the survey approach undertaken, it's best practice for a scientist to go aboard for the first trip for each participating vessel, or if numerous vessels are taking part, sufficient vessels that represent the group, to understand how the skipper and crew interact (during fishing operations if possible), how typical fishing operations are conducted, and which fishermen are likely to be the most competent and engaged in the data collection process. These observations are vital in determining how the fishing vessel & crew work to gather good quality scientific data and what specific training requirements and approaches will need to be tailored to the situation, taking special account of health and safety risks and existing procedures.

Where a scientist is aboard the vessel providing training, once the fishermen are successfully trained in the scientific sampling and data collection required, the scientist should take on more of a support role in both training and data collection, overseeing and helping fishermen train their peers. Typically, the skipper will be trained to record the information of the fishing location (position, depth, fishing gear etc.) known as the station details. The scientist or trained fishermen on deck will record information on the catch composition, species identification, length, sex etc., depending on the specific survey.

The means to record the data must be provided to data collectors, this maybe on paper to be later transcribed, or using digital formats (e.g. phone apps, e-logs, photos). The scientific sampling and data collection asked of the fishing crew should be the minimum required to collect the necessary catch data to meet the aim of the survey.

How will the work be managed to make sure that a quality job gets done?

As well as having agreed aims and survey objectives, milestones (points in time) and deliverables (specific tasks) also need to be defined at the outset so that the progress of the survey and its output can be evaluated and measured. This will help identity issues to adjust the data collection where necessary. Clearly defined deliverables will also help manage the expectation of the survey's outcomes in the longer-term. To ensure the data collected is of the highest possible quality, the lead scientist must remain engaged in the process, a scientist or observer should go back on-board at regular intervals to quality assess the data being collected, and provide refresher training where required.

How will the team and others be kept up to date with progress?

The self-sampling field-data should be inputted into an electronic format and quality assessed for errors as soon as feasibly possible. A brief, short report should be produced and supplied to the skipper and crew, outlining useful information, points of interest, trends and data errors. This feed-back loop is a way of communicating to the participating fishermen that their data is being looked at, maintaining their engagement and buy-in, whilst highlighting any data issues to maintain data quality.

Regular one-to-one contact between the scientists and fishermen is essential and its effect on success should not be underestimated (see section 2b). On a one-to-one basis, two-way communication on the results from the scientist, and on-board procedures from the fishermen should be provided and discussed, allowing for modification and development of the survey where necessary. Meetings or workshops near the port of operation should be convened, bringing together all the relevant stakeholders at the beginning and end of the programme, and as required in the intervening period.

How will the data be analysed, interpreted and reported?

Before analysing, interpreting and reporting the survey data, first the audience for which it is intended should be identified. For example, the audience may be for a fishing industry body (e.g. a producer's organisation), government (e.g. Defra) or scientists (e.g. STECF). The target audience will determine what is needed and the format for the end user. It is likely that the data analysis and interpretation will be conducted by scientists, hence presented in scientific language. However, for the lay person this style and can be impenetrable, so thought must be given to presentation.

A variety of accepted statistical methods might be used to estimate parameters and determine the uncertainty associated with any estimates.

Box 3. Example of how catch data is analysed

The analysis procedure needs to follow methods appropriate for stratified random, multi-stage sampling. As the primary sampling units are the vessels within strata, the sampled trips represent all the trips of that vessel in the stratum. The weight for a species would therefore be estimated through:

- Raising from the sampled hauls to all hauls in a trip
- Combining over trips of the same vessel if two or more trips have been selected for that vessel in the sampling stratum, and raising from the sampled trips to all trips of that vessel in the stratum using appropriate raising factors.
- Combining the estimates for all sampled vessels in the stratum and raising to all vessels in the list frame for that stratum.
- Combining estimates over all strata for which a combined estimate is required.

The fishermen's self-sampling data should only be analysed, interpreted and reported upon for the purpose or aim for which it was collected. If it is used for another purpose, consent from the fishermen who collected the data must be sought first to prevent mistrust.

3b. Co-Delivery and knowledge Co-construction

How can we build shared knowledge and skills?

During delivery, specific training actions will need to take place to ensure that the team have the skills and understanding necessary to do the job. These are perfect opportunities for building strong working relations based on shared knowledge and understanding of each other's skills. Providing rapid feedback on the results and findings during the work is an effective way to share knowledge and promote good team working.

Why is it a good idea for scientists to be on board fishing vessels whenever possible?

Experience from collaborative research projects around the world confirms that there's a lot of value in scientists going on board commercial vessels. The main benefits are:

- you get to know one another (according to scientists interviewed during GAP2 project, fishermen develop a higher opinion of those who join them on the vessels!)

- it allows fishermen to show scientists what is practically possible for them to do in terms of scientific work
- it creates the right environment for scientists to provide face-to-face feedback and jointly resolve issues
- it's a perfect training /education opportunity for both fishermen and scientists

But not all fishermen and scientists think it's a good idea, mainly because of fishermen's lingering suspicions about scientist's intentions or because or scientists worries that the science may be corrupted in some way. Good plans and good relations mitigate these issues.

How do we keep a focus on getting the job done to required standard?

The efforts of everyone will be worth nothing if the job is not done to the standards that are required for its application. This means following agreed scientific protocols for the collection and analysis of the data. It does not however mean that surveys and methods cannot be adapted to circumstance, so long as the methods and data still hold up to the necessary standards.

4a. Application

What routes lead to getting the data used as scientific evidence, and who takes it?

The collection of data is not an end in itself. To be made useable and useful, the data and results of analyses need to be presented in an acceptable scientific format (e.g. Box 4) to the relevant institutions that (i) serve to verify and give credibility to the data through their quality control processes, (ii) apply the data in making decisions. (see section 1a, Figure 2.2), and (iii) end users. To ensure that the information arrives at a time that it can be used, the schedules of the work groups need to be considered.

To 'carry' the data on its journey through the system, someone acting as the data steward will need to be involved in various international scientific working groups to present the information and address any questions relating to methods, interpretation and data quality assurance.

Box 4. Example of standard processing of data for ICES stock assessment Expert Groups.

- Database extraction and evaluation of survey data quality and correction of detected errors
- Estimation of quarterly discard weights, and length compositions of retained and discarded catch for each assessed stock
- Estimation of age compositions of retained and discarded fish for stocks with catch-at-age assessments, together with associated weights at age
- Calculation of other biological parameter estimates such as proportion mature at age, when requested by the Working Groups.
- Preparation of archived national Annual Data Files for each stock.
- Uploading of national data sets on InterCatch.
- Compilation of international data sets by ICES stock coordinators (acting as data steward) located in the UK labs.
- Stock coordinator attends international meeting on stock assessment where data from all sources and countries is compiled, documented and (subject to quality) included in stock assessment model(s).

What format do the data need to be in for a quality review?

The data and any results from analyses will be evaluated by relevant scientific working groups. They will need to be supplied in the right format to these groups, the level of detail and form being prescribed by the application. Knowing this in advance is important since it may also influence the design of data capture and storage needs.

For instance, to ensure quality review, data to be used for stock assessment purposes will need to include variables formatted along the lines of:
a) Data acquisition. This should include aspects of

- Selection of stocks sampled – indication / list of which stocks are going to be included in the data collection scheme
- Types of data collected – species, age, length, sex ratio, volume caught etc
- Target and frame population - Target populations are the stocks within their geographic boundaries. For example, when samples are collected from fishery catches, the sampling frames are the vessel lists and areas used for sampling fishery length compositions.
- Sampling stratification and allocation scheme - An overview of the long-term sampling strategy indicating for each parameter (age, weight, sex ratio, maturity and fecundity) the year that data collection has taken place or is planned.

b) Estimation procedures
c) Data quality evaluation

What's required to justify any proposal based on the findings?

Fisheries management requires consideration of a variety of issues, all of which need to be addressed using evidence based on data collected from biological, economic and socio-cultural sources. Over time, many different management issues emerge in every fishery which managers and decision makers need to consider. For instance, are current catches in the fishery sustainable and making good use of the resource? Is the fishery being conducted in an economically responsible and efficient manner consistent with the economic goals and priorities of the country or local area? Addressing such questions will therefore invariably require deciding on suitable trade-offs between these conflicting requirements. If the decisions are to be good, they need to be informed by the best available data. A proposal therefore needs to be developed to demonstrate, based on the evidence, what alternative management options could be considered appropriate.

4b. Knowledge management

How do we gain the support of relevant managers and other stakeholders?

To have the best chance of success, dissemination is not enough. Seek personal direct support and advice of managers and stakeholders that are connected within the institutional network necessary to get to results applied.

What needs to be communicated about the process and outcomes?

The various stages required in trying to get the data applied should be communicated so that those involved see their efforts rewarded and understand how their data is being used.

Any outcomes and benefits should also be disseminated more widely so that other relevant stakeholders and institutions become aware of the achievements and their utility. A key benefit of this engagement is helping to make the end users receptive to future initiatives based on the promise of similar success.

Dissemination tools include social media (Facebook, twitter, YouTube), a website, and printed articles in the fishing industry press, amongst others.

Why is it important to give visibility to fishermen's contributions and how they have been used?

Efforts should be made to make positive news of the role that the industry played in initiating, planning, delivery and impact of the work, as well as the collaborative process itself. This helps develop a shared knowledge-based, and more importantly, a few good words will go a long way to sustain existing initiatives and build new ones.

5a. Objective evaluation

Has the aim been achieved?

If the work has been carried out to achieve the objectives, then the aim will have been fulfilled. Throughout the work, it's likely that the experience of practical implementation and the results may have affected the aim. Such changes should have been understood and documented on the way accordingly, but a subtler effect of this learning process can be changes to people's expectations for the outcomes. A reflection on the original expectations and what has been achieved is worthwhile to understand how things have changed, why and what impact they had.

Do the benefits outweigh the costs?

Whether or not the benefits of the work outweigh the costs should be evaluated both in quantitative and qualitative terms. The criteria for measuring the performance will need to reflect different aspects of cost and benefits depending on what matters to the people involved. This critical assessment is necessary to determine the value and utility of the work so that decisions can be made whether to support continued investment of money and effort. It's also of value in planning future work.

What worked well and what could be improved?

From a practical point of view, the project team should consider any feedback received during implementation and how this can be used to inform how the work could have been carried out in more efficient, cost-effective ways that would maintain or enhance the quality of the work. Possible innovations and relevance to other problems should be identified.

What strategic planning actions need to occur to ensure continued relevance?

Depending on whether the work is a one-off or intended for continuous development, (e.g. establish a quality controlled time series of data from and industry sampling programme) will inform the decision that needs to be made. A critical cost-benefit analysis is of great value here to be able to demonstrate value and utility and identify areas for improvement. At this point the institutional and social pathways need to be considered again so that any work has continued relevance to those that need it and can use it.

5b. Evaluation

How did the collaboration process go?

Beyond the easily measurable aspects of whether a project met its aims, people will have a feeling about how things went and the degree of success. It's possible that all the objectives were met but people were not happy with the way the project was conducted. If the distribution of benefits is seen to be unfair, or there are concerns over inclusivity and conduct of those involved, then the price for achieving the objectives might be any future collaboration.

What worked and what didn't should be discussed in open meetings but with opportunity for anonymous input to the project team too. Throughout the course of the work, it's common to find that expectations change as people learn. The evaluation should be aware of this and look to assess the success against the original expectations.

Taking the time to reflect together on how things might be improved will help cement the commitment to core values of openness and transparency and prove useful in future plans.

The outcome of this assessment can be influenced a lot by the success of the feedback and dissemination activities designed to provide both value and meaning to those involved, as well as a wider audience.

What was the value and benefits of knowledge co-construction?

Being self-critical can be difficult, but an honest evaluation of how things went means questioning the value of the process of knowledge co-construction. Was knowledge co-constructed, what sort of knowledge and how is it useful? Did people value the knowledge they gained? Would some other approach work better?

Why should you give credit where it is due?

Following scientifically accepted norms and doing what's right and proper means shining the light on the those that did the work. Champion other people's ideas, but never take the credit for them.

What should the group do next?

Success breeds success. The momentum and enthusiasm that comes from a successful collaboration can be taken and applied to new challenges. It serves as a stimulus for people's confidence and as a source for innovative idea. So what's next?

Section 3. Case Studies

Case Study 1: An industry-managed trial to monitor, avoid and reduce spurdog by-catch, preventing a 'choke' to UK fisheries under the Common Fisheries Policy (CFP) landing obligation.

© S. Hetherington

Problem: Although spurdog are a prohibited species, they are caught in demersal trawl and gillnet fisheries within European waters. Due to their status, current catches of spurdog are discarded, although the extent of this problem is unknown. The new CFP introduced a Landing Obligation with a phased implementation from 2015. Previously, spurdog was a zero TAC species meaning they had the potential to become 'choke' species in mixed fisheries, whereby it forces fishermen to stop fishing altogether and tie-up their vessels in areas where spurdog is caught as by-catch. The recent (2017) addition of spurdog to the Prohibited Species list has helped to prevent it from becoming a 'choke' species, in effect opting out of fisheries legislation, ensuring that discarding can continue. However, this is not in the spirit of the Landings Obligation, as it does not contribute to the reduction in fishing pressure of the stock and does not address wasteful dead discarding.

Enabling mechanism: Undertaken with UK Government funds, fishery-dependant scientific evidence (Bendall *et al.*, 2014, Hetherington *et al.*, 2015) underpinned a UK proposal, and initial trial of a pilot project to develop a real-time Spurdog By-catch Avoidance Programme. A positive, but cautious review by STECF in November 2014 (STECF report 2014) and again in November 2015 (STECF report 2015), with a strong UK Government policy lead, led in July 2016 to an amendment to Council Regulation (EU) 2016/72 for fishing opportunities in Union waters recognized that spurdog "*… present a real choke species on full implementation of the Landing Obligation…...*" and that "*….in order to facilitate the implementation of the Landing Obligation, a programme to introduce real-time avoidance of spurdog has been developed …*"). The amended Council Regulation allows fishing vessels participating in the project to land limited quantities of dead spurdog, thereby incentivising industry participation in the programme. Requested and driven by UK government, the UK has an exemption to the prohibited species listing of spurdog, allowing landings, whilst evaluating the programme.

Aim and objectives: To develop, trial and evaluate an alternative option to the prohibition of spurdog; a UK pilot project to develop a real-time Spurdog By-catch Avoidance Programme, with the purpose of;

1. A strong science-industry collaboration to rapidly collect suitable, viable data on discard rates, survivorship, and abundance;
2. Reduce the number of significant spurdog by-catch events and promote the return of live spurdog to reduce wasteful dead discarding and overall fishing induced mortality;
3. Account for unpredictable and unavoidable bycatches within the future landing obligation;
4. Not incentivising any targeting of the stock.

Partners:

Department for Environment Food & Rural Affairs | CFPO | SHARK TRUST | NFFO | Cefas

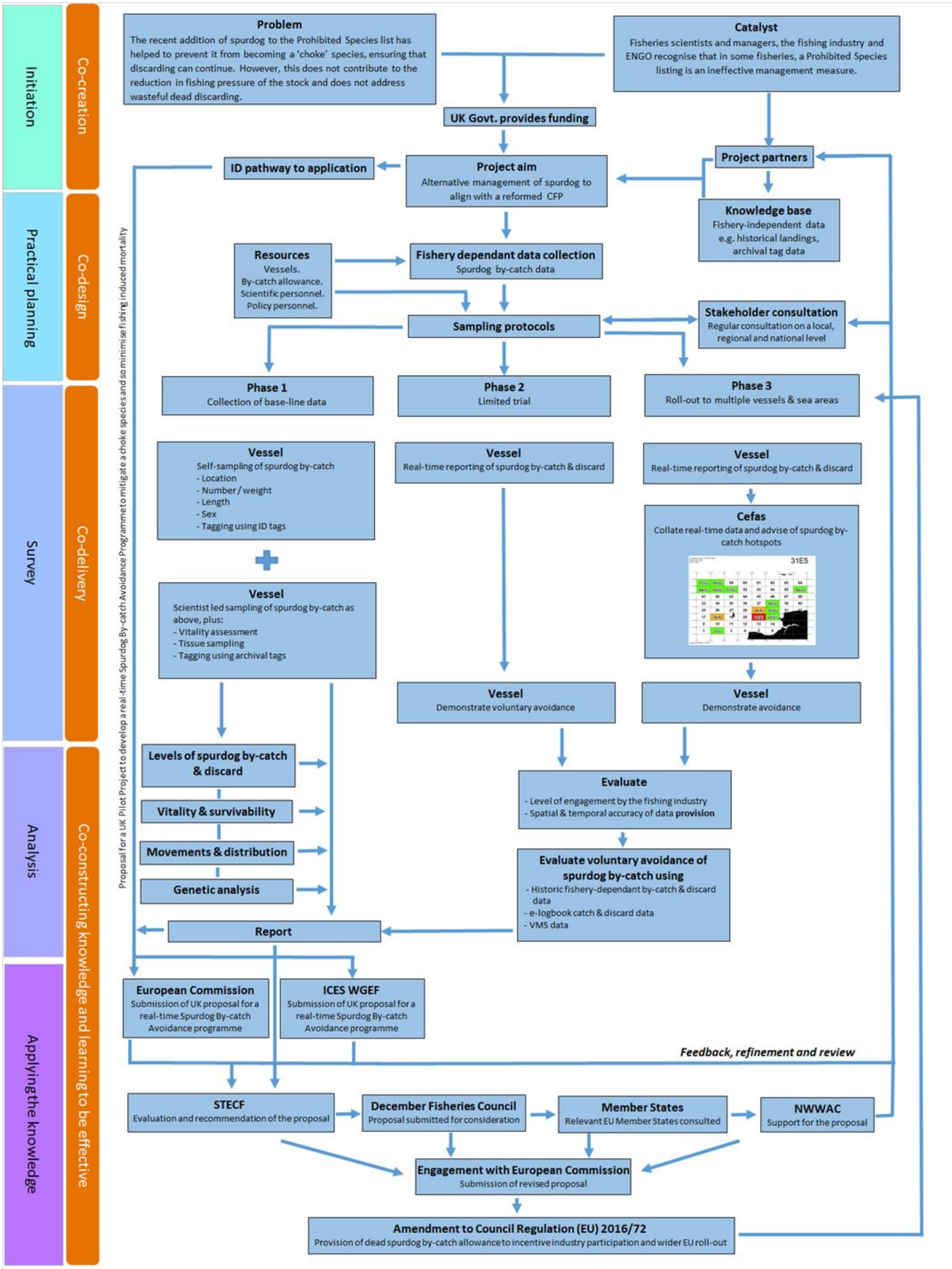


Figure 3.1. *Architecture of the development, trail and evaluation of the real-time Spurdog By-catch Avoidance Programme.*

Case study 2: Western British Isles herring industry-science cooperative survey

Problem: During the ICES benchmark workshop on herring west of the British Isles (ICES 2015a), the stock assessments of 6a North herring and 6a South-7b,c herring were merged into one combined assessment. The consequence of this was that ICES advised a zero TAC in 2015 and 2016, and recommended that a rebuilding plan be developed. Prior to this assessment, the 6aN stock provided an MSC certified fishery.

Enabling mechanism: Following a special request (to ICES) by the European Commission, in April 2016 ICES provided advice on methods for undertaking a scientific monitoring fishery for obtaining relevant data for assessment (ICES 2016). EU Council regulation (EU 2016/0203) made provision for a scientific monitoring TAC, providing the basis for the industry-led survey to take place.

Aim and objectives: To improve the knowledge base for the spawning components of herring in VIa North and 6a South-7b,c, and submit relevant data to ICES to assist in assessing the herring stocks and contribute to establishing a rebuilding plan.

1. Abundance estimation: Generate an age age-disaggregated acoustic estimate of the biomass of pre-spawning/ spawning components of herring in 6a North and 6aS, 7bc ('Western herring') by collecting acoustic data and information on the size and age of herring.
2. Stock identity separation: Distinguish whether the 6aN stocks are different from the stocks in 6aS, 7bc using morphometric and genetic samples collected during the industry-led survey.
3. Age composition of the commercial catch: Provide continuous fishery-dependent time series required for assessment from catch-at-age data collected during the industry-led survey and subsequent monitoring fishery.
4. Evidence for a rebuilding plan: Use the results of the surveys to contribute to the scientific basis for development of a rebuilding plan for Western herring.

Partners:

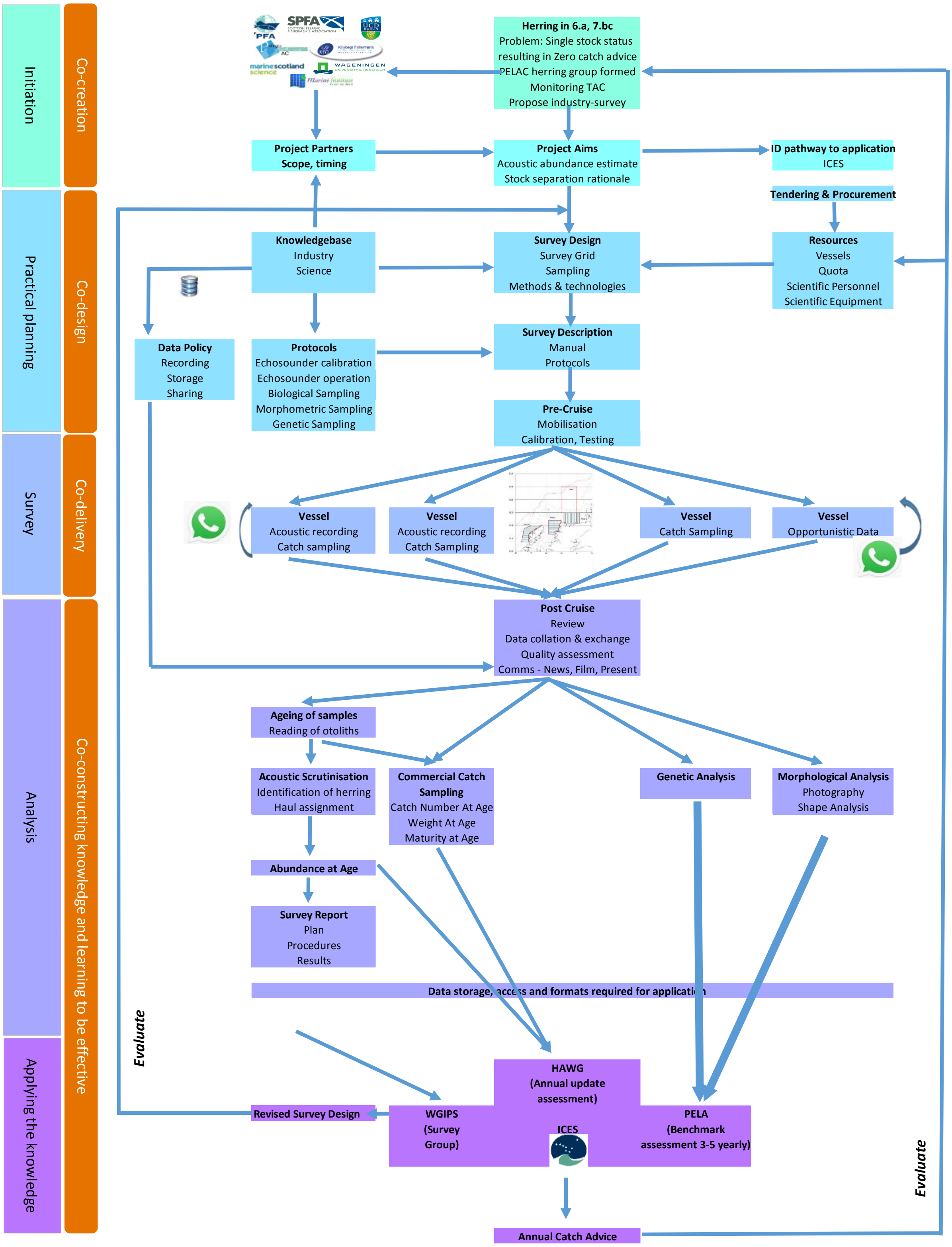


Figure 3.2. *Architecture of the planning, implementation and analysis stages in the Western herring surveys.*

Case study 3: Securing discard survival exemptions



Problem: In January 2014, the reformed CFP came into force with a ban on discarding. Exemptions can be granted for species demonstrating high survival rates, and this created an immediate demand for scientific evidence on fishery specific discard survival rates.

Enabling mechanism: Following a special request (to ICES) by the European Commission and STECF, ICES initiated a new group to provide guidance on Methods to Estimate Discard Survival (WKMEDS). At the same time, the UK Government allocated funds to conduct science to estimate survival levels for priority species and invited tenders to bid for this work.

Aim and objectives: To generate discard survival evidence that could be used to support exemptions from the Landing Obligation for priority UK species and fisheries.

1. assess the potential survival rates of quota species in different English fisheries and areas and complete a prioritisation process to select four case study species and fisheries;
2. deliver four case studies to quantify discard survival for prioritised fisheries under normal commercial fishing operations; and
3. identify the factors that most influence discard survival rates with the aim to identify mechanisms to improve survivability.

Partners:

- Skippers and crew of fishing vessels Guiding Light III, Halcyon, Luc, Admiral Grenville (Interfish)
- Cefas
- ICES (Workshop on Methods to Estimate Discard Survival)
- NFFO
- Defra
- Regional Management Groups
- STECF

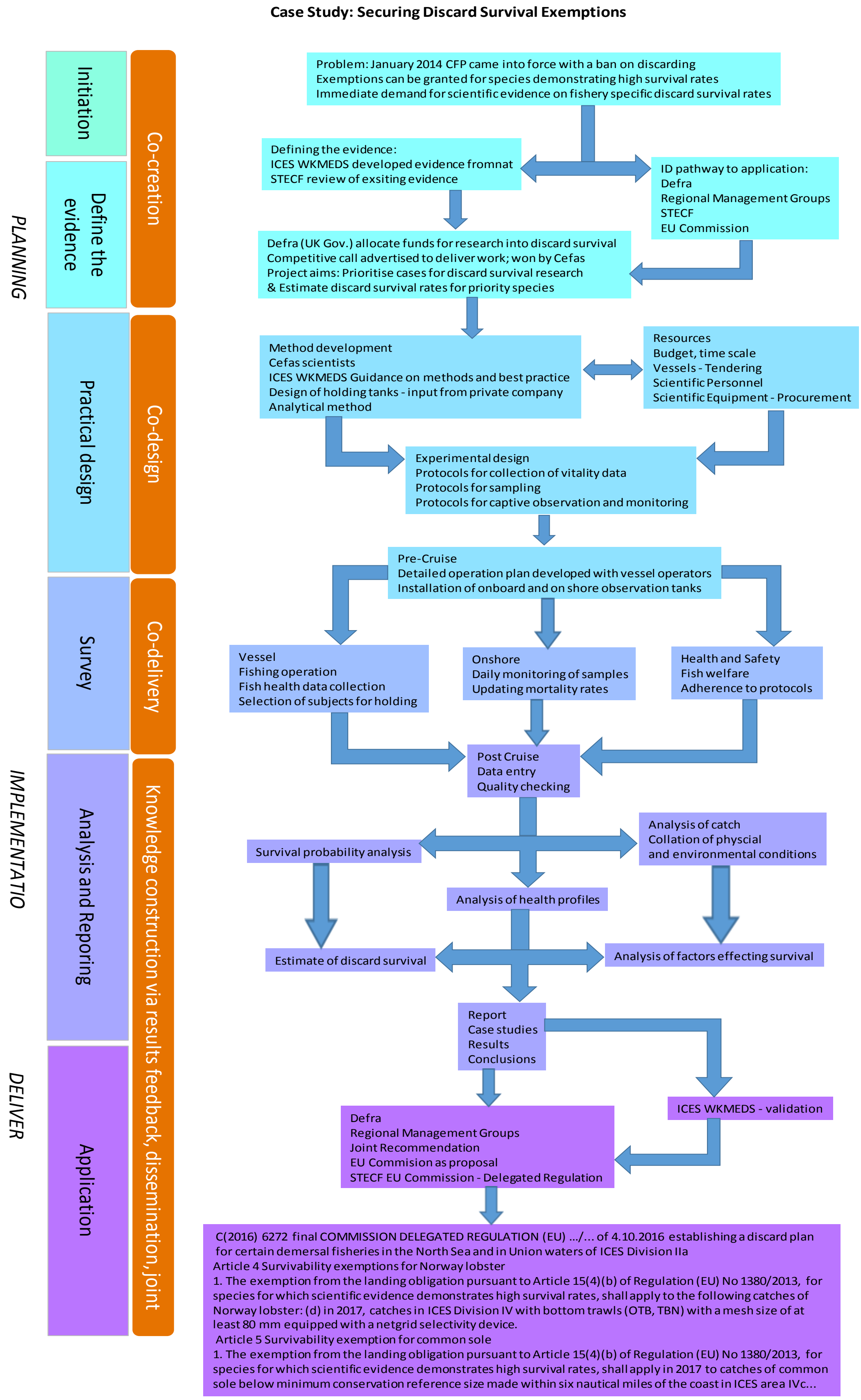


Figure 3.3. *Architecture of the planning, implementation and analysis stages in the Discard survival study.*

Appendices

A1. Definitions

In this document, we use the term *Industry-Science Data Collection* to refer to activities where scientific data is collected with and by fishermen for the purposes of providing evidence for management or for research.

We refer to the *participation or collaboration* process as active engagement in planning and delivery of scientific work. It goes beyond *cooperation* because it signals a commitment to a common aim rather than performing a function to achieve aims set externally.

Because this document is about participation in the collection of scientific data relevant to management and research, it is necessary to clarify what is meant and understood by participation in science and participation management decision-making (Figure 4.1). While there are common features of the two processes, and the persons involved may be the same, the key distinguishing feature is the absence of a political agenda associated with scientific process. Science aims at improving the knowledge and evidence for informed management decision-making.

Science	Common to both	Decision making
Having a stake/interest	**Having a stake/interest**	**Having a stake/interest**
– Science should be unbiased. – Fishermen's participation in science can be controversial when self-interests compromise the validity of their input.	– Research should provide the scientific information, whereas the stakes in the outcomes influences decision-making.	– Decision making needs to balance interests of industry, environment, social economics, and national interests
Political and economic influence and accountability	**Political and economic influence and accountability**	**Political and economic influence and accountability**
– As far as possible, science must be independent of political decisions	– Reasons for participation may appear to politically neutral when they are not.	– Political and economic influence aspects play a strong role because decisions influences economics. – Responsibility and accountability for management decisions must be clear
Role of science	**Social dynamic of participation**	**Role of science**
– Good science does not equal good management – Scientific research should give the best science that is possible, based on both fishermen's and scientist's knowledge.	– Social dynamics of multi-stakeholder process are similar – respect/collaboration – Participation of professional associations in research facilitates better participation in decision-making.	– Sometimes decision-making doesn't is based on incomplete or inadequate scientific information – Seeks simple answers from science – Decision-making takes a broader view that links the health of exploitable resources with sustaining social systems.
Level of detail	**Clarity**	**Level of detail**
– Scientific research often focussed on specific things in detail - microscopic – Benefits in learning about complexities of interactions in the ecological-economic systems	– For effective participation, there should be understanding from the initial start-up of the project	– Decision-making is often broad brush - macroscopic.
Costs of participating	**Adaptive**	**Remuneration for participating**
– Fishermen should be recompensed for their contribution to science when specific activities are outside their business objectives. Considered on a case-by-case basis.	– Learning by doing	– Fishermen are not paid to participate in public consultations.
Long term view		**Long term view**
– Plans should facilitate collaboration over the long term		– Decision-making should be pro-active rather than reactive.

Figure 4.1. *Differences between participation in science and participation in decision-making (adapted from GAP1 Good practice guide with permission).*

A2. Similarities and differences for scientists and fishermen in collaborative research (from GAP1 Good practice guide)

Fishermen	Common to both	Researchers
Attitudes and behaviour	**Attitudes and behaviour**	**Attitudes and behaviour**
– Fishermen's typical behaviour is to catch the maximum possible in a single day of work – Fishermen dislike added rules – Fishermen think that scientists are wrong and that they are right – there are a lot of fish in the sea – Fishermen may believe that scientists use some scientific hypotheses as if they were already proven true. As a consequence, fishermen think they are victims of this hypothesis and precautionary approach – Fishermen may not know if they are going to be available in 2 days because it depends on the weather – Fishermen may act as a single entity – Individuals and organisations behave differently – Will ask for scientific help only in extreme circumstances – Fishermen feel that scientists modelling fish stocks don't listen to fishermen if it disagrees with the model	– Both work in complex organisations – Always see your own side as taking the initiative – Only start to work together when there is a crisis – Willing to cooperate and explore new ideas and opportunities – Can be adaptable to rapid change – Selectivity issues are often a good ground for co-operation	– Scientists may think that they are always right – Dismissive of non-scientific knowledge (even if not overtly) – Would like to collaborate so that data quality can be improved. – Want to work as a 'team' with fishermen, but don't know how.
Motivation	**Motivation**	**Motivation**
– Knowledge as a tool for other objectives – More catches mean better income	– Both share an interest/curiosity concerning the biology/ecology of fish,	– Scientists enjoy learning why things happen – Interested in the ecosystem interactions – not just fish stocks

Fishermen	Common to both	Researchers
– Fishermen seek and enjoy finding patterns in what happens – Want a sustainable fishery	habitat and understanding of the marine environment – Both want the resource to be exploited sustainably – They both want good management –	– Want sustainable fish stocks
The job and its focus	**The job and its focus**	**The job and its focus**
– Job is fishing not science – Fishermen have economic objectives – Fishermen focus on stocks – Fishermen are cautious on the outcome of scientific reports	– Both have seasonal activity variation – Fisheries science should help to achieve sustainable fisheries	– Job is science not fishing – Scientists have objectives to learn and share knowledge with wider community. They might produce scientific papers on any topic – Scientists are interested in fundamental issues e.g. what are the general features of exploited systems? – Scientists often combine fishermen's benefits and environmental conservation
Timeframes	**Timeframes**	**Timeframes**
– Fishermen work in the real world and have to deal immediately with consequences. – Fishermen may need the data/answer on a short timescale e.g. in time for December Council.	– Long-term engagement in work is beneficial to both because it allows time to reap the rewards.	– Scientific research often planned over the long-term. Short-term benefits may be less clear. – Work for scientists is determined by multiple very long-term projects and may already be scheduled 6 months ahead – Science has a longer time span in relation to a research question
Source of knowledge	**Source of knowledge**	**Source of knowledge**

Fishermen	Common to both	Researchers
– Fishermen are scientists in their own way (practical scientists). They see a problem, ask the questions, and change the method of fishing accordingly. – Fishermen education is observation and experience-based including learning through communication with others – Fishermen are less formal in their acquisition of knowledge – Fishermen might have a different understanding of what 'data' are required – Great respect for practical knowledge – Fishermen 'sample' and learn through catching fish, so they go where the fish are.	– Understanding behaviour of fish. – What? And Why? – Look for patterns in the ocean – Scientists and fishermen do observations in similar ways: – Sampling catches, catch data, echo sounders – Both want to achieve a good knowledge of the size of fish stocks	– Scientists apply a rigorous and robust approach to achieving their understanding – Knowledge from classroom education and research studies – Scientists ask why. – Scientists take 'samples' in places that allow them to get an impression of the overall stock. They don't just go where the fish are which can cause concern among fishermen. – Scientists need to know the real data of catches – Scientists can get day-by-day knowledge from the fisherman – Scientists sometimes assume they own the results of the research process
Payment for research	**Economic Costs**	**Payment for research**
– Time spent on research activities might impact on fishermen's income – Fishermen often volunteer to do research and may lose money as a result	– Economic costs are impacting both fishermen and scientists – Increasing fuel cost affects how much work can be accomplished – Same economic interests	– Scientists paid to do research
Risks are different	**Risks are different**	**Risks are different**
– Fishermen may have financial risk of doing research that does not contribute positively to income.	– Risks can be highly biased with stronger direct consequences to fishermen: e.g. a scientific paper on an incidental catch can promote a scientist whereas at the same time it can ruin a fishing sector.	– Scientists risk their integrity and credibility over the long-term so thoroughness is essential.

A3. Tool box for collaborative research (reproduced from GAP2 with permission)

Step by Step Guide: THE METHODS

Methodological Toolbox

In collaboration with social scientists, the GAP2 project has produced a researchers 'toolbox' of tried and tested methods to assist participatory research. The toolbox has been designed to be an easily accessible, practical guide and can be used by anyone, from scientists, to policy makers, to fishers.

The full Methodological Toolbox can be found on the project's website at: www.gap2.eu/methodological-toolbox

Participatory Mapping

Participatory mapping is the most widespread visual participatory method. In marine studies and social research it has been used for many different purposes, especially for natural resource management and for the collection of indigenous and cultural knowledge.

Using this tool is quite simple: individuals or groups of people are asked by a facilitator to draw on a map their (qualitative or quantitative) knowledge about a spatial issue. Subsequently researchers can integrate information from different informants, also identifying categories, typologies, and concepts, and map them.

Further steps in participatory mapping may include the independent validation of maps from another group of informants, or the establishment of focus groups to discuss/refine maps that synthesize knowledge layers and, where needed, reconcile possible disagreements.

Participatory Modelling

Models are simplified, but not simplistic, representations of complex systems that allow us to summarize the relationships between systems' components and predict systems' behaviour. They are intensively used in fisheries and

Participatory mapping in action - an example from GAP2's case study in Galicia.

natural resource management to describe stock status and (socio) ecological processes, according to a set of input data and scenarios.

Participatory modelling relies on the integration of stakeholder knowledge into the process of model construction and hypothesis testing. In this sense participatory modelling differs from modelling itself in that stakeholders may play a role in both the model definition (e.g. select relevant variables, provide qualitative/ quantitative information on variables, set the relationships among them, set the general conditions) and in the selection of scenarios to be investigated (e.g defining possible management options to be compared).

Moreover, stakeholders contribute to the evaluation and interpretation of the models' outputs.

Participatory Planning

Participatory planning is a process aimed at jointly defining, proposing and preparing the work necessary to tackle an issue of shared interest.

Typically, participatory planning may also include the opportunity to tailor management rules at local/regional scale according to stakeholders needs. With the aim of contributing to the establishment of a bottom-up approach, one can also integrate experience based and research based knowledge.

In order to succeed, participatory planning activities should ensure the legitimacy, saliency, credibility and transparency of the process.

Participatory Sampling

Participatory sampling is a form of direct collaboration between scientists and fishers in the joint collection of data and samples.

True participatory sampling should include a shared approach to the design of the sampling activity, as well as participation in the field activity and discussion of results. Participatory sampling facilitates meaningful dialogue, the exchange of different types of knowledge (eg. experience based knowledge and academic, scientific knowledge) and the building of mutual trust. This is particularly true during collaborative field activities, where working jointly together fosters the co-operative relationship between fisher and scientist.

Participatory sampling increases the credibility of research outcomes, as it provides data collected with the direct involvement of fishers.

Self-Sampling

In self-sampling, full responsibility for data and sample collection is given to fishers joining the participatory research activity.

With this in mind, the foundation of the self-sampling approach is usually a preparatory activity where scientists and stakeholders work together to define the research goals. This includes determining the methods to be applied for data/sample collection, and how to use the information acquired through the process.

The idea is that fishers not only learn how to apply a standard protocol (e.g. how to measure a fish, how many fish to measure), but that they also understand the rationale behind the scientific methodology. For example, they need to have data that is comparable and potentially replicable, and therefore collected with consistent, standard methods. More importantly, self-sampling allows the fishing industry and stakeholders to play a primary role in data collection on a mutual trust basis, since the quality of the data collected with this approach is directly linked to the stakeholders' responsibility.

Semi-Structured Interviews

Semi-structured interviews are topical, information-rich conversations conducted with an open framework, which allows for two-way communication. They are used both to give and receive information. Where possible, interviews should be conducted face-to-face and in informal settings.

The semi-structured interview is modeled more closely on a conversation between equals than a formal question-answer exchange. The role of the interviewer involves not merely obtaining answers, but learning which questions to ask and how to ask them.

Oral Histories

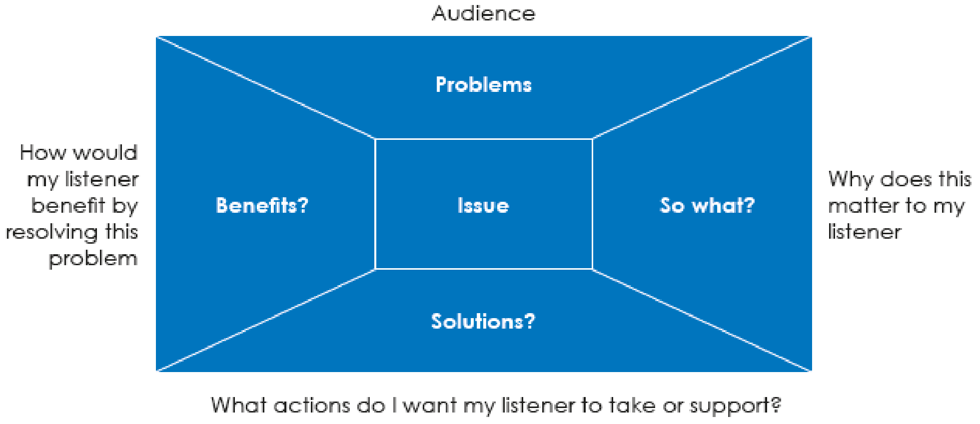
Oral history is the systematic collection and study of historical information about past events through interviews conducted with people who participated in or observed those events. Oral history is not folklore, gossip, hearsay or rumour. Oral historians attempt to verify their findings, analyze them, and place them in accurate historical context. In oral history projects, an informant or narrator recalls an event for an interviewer who records the recollections and creates a historical record.

Focus Groups

Focus groups are moderated discussions between five to ten participants. Focus groups are a form of qualitative research, a method for exploring people's attitudes, beliefs, desires, and reactions related to a specific topic. A focus group is a kind of group interview, usually conducted by a moderator in an unstructured and natural way where respondents are free to give views from any perspective. They are typically conducted face-to-face, but may also be organised via telephone conference or the internet.

GAP2 researchers & fishers practice interview techniques at a social science workshop.

Message Box



The Message Box

The outcomes of research can be complicated, caveated and difficult to explain to those from a non-academic background. Yet engaging people within industry, government and beyond is often crucial to the research method, and always essential to the uptake of findings in wider society.
Successful communication of research is crucial in participatory research.

The Message Box can be used to distil essential information from both ongoing and completed research, to engage individuals whose contribution is vital, yet hail from a different backgrounds, science-based or otherwise.

The tool works by encouraging researchers to clarify their thinking about the main issue that their work addresses, and importantly, the relevance of their work to their main 'audience'.

Researchers can then use the Message Box to condense the crux of their work into five sentences, explaining the problem, potential solutions and how their work relates to their audience.

The resulting set of concise messages can be disseminated using channels appropriate for the end user, ranging from social media, to newspapers, to policy briefings and events.

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Partners Page

These guidelines have been developed in partnership by 3 organisations who all have a stake in this work. Their common goal is to see an enhancement in the information that is used to assess fish stocks and to evidence appropriate management measures.

The partner organisations are:

Centre for Environment Fisheries and Aquaculture Science (Cefas)

The basis for setting fish quotas and responsive management, relies on understanding fishing operations. As the formal assessor of English fisheries, there is an obligation on Cefas, with other national government institutes, to deliver the best assessments of fish stocks using the available evidence and techniques. This evidence could be enhanced with additional data collected by fishermen. Cefas understands that the better the information used in making decisions, the higher the confidence we all have in those decisions.

Scottish Pelagic Fishermen's Association (SPFA)

The SPFA is concerned with establishing its members as stewards of the sea, and supporting them to optimise returns on their business investments. The SPFA Science vision is: *Scottish pelagic fishermen, respected providers of scientifically credible data that's used to assess the status of fish stocks and monitor changes in the pelagic ecosystem*. The SPFA understands the importance of sound science in management and they are investing heavily in improving available data to underpin fishery assessments.

Fishing into the Future (FitF)

Fishing into the Future has a mission to 'chart a course towards sustainable and prosperous UK fisheries'. A key part of its work programme is to provide fishermen with the tools they need to improve contributions to fisheries science and management, and engage fully in fisheries governance. Building bridges of trust between fishermen, scientists and regulators is a central theme for the charity.

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