



# **Fisheries Sampling and Data Collection**

Steven Mackinson Chief Scientific Officer, SPFA





Investing in Sustainable Fisheries



# Overview of this session

What information is needed and why How it's collected - understanding different approaches to data collection and the methods used

How it's used

What information is needed and why?



# Where does the information come from and how is it collected?

Data sources and the methods used to collect it

#### Sources of data

#### **Fisheries Dependent**

 meaning information collected from the industry during the course of their normal operations.

Conducted as a requirement under statutory sampling programmes such as the EU Data Collection Framework (DFC) or for specific research programmes.

Includes catch and effort data plus biological data from landings.



#### **Fisheries Independent**

 meaning information collected during scientific surveys, using sampling designs that provide the best estimate of stock density.

Conducted as a statutory requirement (DCF) or to address specific research questions.

Includes survey catch and effort data plus a variety of biological, oceanographic and environmental data.



# <section-header><complex-block><complex-block><complex-block><complex-block><complex-block><complex-block>

# Fisheries dependent

# **Fisheries dependent**

# Biological data

**Routine** - Length, weight, sex ratio, maturity stage.



Then age determination from ear bones (otoliths).





# **Fisheries dependent**

# Economic activity



# Fisheries independent - information

Survey catch



Environment



Biology



Oceanography



# Fisheries independent - methods

# Swept area surveys

#### Use

Change in the density of fish over time and space – an indicator of change in population size. Tuning stock assessment models, where surveys used to provide the patterns over time and catches are used to give size of population.

#### **Method principles**

- Not trying to count all the fish, but not trying to avoid them either!
- Uses statistical sampling methods to make a best guess (most accurate estimate) of the fish population in the area.
- Standardized methods so that the density 'signal' doesn't get muddled and multiple surveys are comparable and can be combined.
- Trade-offs: tools (gear) and species suitability, accuracy and precision

#### **The End Game**

Abundance of each age group - for use in stock assessment (the 'numbers-at-age matrix').

#### Numbers-at-age matrix

YEAR/RINGS	0	1	2	3	4	5	6	7	8	9+	TOTAL
2001	1025	58	678	473	279	319	92	39	18	2	2982
2002	319	490	513	913	294	136	164	47	34	7	2917
2003	347	172	1022	507	809	244	106	121	37	8	3375
2004	627	136	274	1333	517	721	170	100	70	22	3970
2005	919	408	203	487	1326	480	577	116	108	39	4664
2006	844	72	354	309	475	1017	257	252	65	44	3689
2007	553	46	142	413	284	307	628	147	133	23	2677
2008	713	148	260	183	199	137	118	215	74	43	2090
2009	533	98	253	108	96	88	40	58	112	34	1421
2010	526	84	243	234	124	84	63	34	59	56	1508
2011	575	124	306	271	218	130	63	52	60	66	1865
2012	627	110	412	671	403	306	151	104	89	109	2982
2013	461	327	239	482	571	422	327	145	153	160	3287
2014	1104	309	303	380	616	487	284	192	92	123	3890
2015	508	225	454	241	282	456	431	270	167	170	3204
2016	1450	86	578	813	293	280	368	307	186	173	4534

Numbers in millions (North Sea herring)



#### Numbers-at-age matrix

North Sea Herring. Time series of numbers-at-age proportion at ages 0-8+. Colours indicate year-classes. All ages are scaled independently and therefore the size of the bars can only be compared within an age.



#### Numbers-at-age matrix: surveys and catch

#### Common questions about swept area surveys

- Why do you fish in random locations when we know fish aren't random?
- Why use that old sock of a net? It couldn't catch squat.
- How can you tell us how many fish in the see when you don't see any in your survey?







# **Fisheries independent**

#### Use

Stock density in each functional unit

#### **Survey Principles**

 Swept area principle, where the sweeping is how many burrows per area of seabed

#### Tools

- · Sledge mounted TV cameras
- Different ground types and 'functional units' are surveyed because burrow density varies

#### Method

- The TV goes down and records over a swept area.
- Someone watches TV and counts the burrows.
- Catch samples used to determine mean weight and sex ratios
- Numbers are converted to stock biomass
- Other organisations do the same and compare and combine

Resource: How Nephrops surveys work

## Nephrops surveys





# Fisheries independent

## Acoustic surveys

#### Use

Stock size and distribution. Behaviour and migration.

#### **Survey Principles**

- · Not trying to count all the fish, but not trying to avoid them either
- Unbiased estimates of average density with the area surveyed

#### Tools

- The scientific sounder calibrated so quantifiable and comparable
- Operates at multiple frequencies (18, 38, 120, 200, 300kHz (same as fishermen)
- Frequency response helps determine species, but it's still largely reliant on expert knowledge
- Future is multibeam and broadband for greater discrimination near the bottom and more accurate sizing

#### Method

- The acoustic backscatter is assigned to species
- The backscatter (target strength) is known, so backscatter can be converted to numbers of fish.
- Trawl samples give the numbers and at size (age), so numbers can be partitioned to size (age) groups.





Resource: Why acoustic surveys go against the grain

# **Fisheries independent**

#### Use

Estimate population size and movement patterns

#### **Survey principles**

- Recaptured/Marked = Caught/ Population
- Geolocation to reconstruct migration

#### Methods

- Tag fish and put them back catch them again later
- Plastic, metal and RFID
- · Simple data storage and advanced satellite
- Rewards required

#### **Examples**

- Mackerel RFID and how it's being used in stock assessment
- Tracking behaviour tuna, plaice tidal stream transport, cod

Resource: How tagging programmes estimate fish abundance

# Tagging programmes





# Fisheries independent

# Tagging programmes



# How is the information used?

Where does it go?



#### **Fishery data flows**



12

Data needed	How it's collected	What it's used for
Landings (or	Logbooks, landing	How many fish of each age were removed from the
Catch)	slips	population – required in stock assessment.
Discards	Logbooks, observer	How many other fish were removed from the
	programmes, cameras	population (depending on survival)
Effort	Satellite monitoring (VMS), logbooks (fishing duration)	Fishing capacity and efficiency (catch per unit effort, CPUE). CPUE a proxy for changes in fish availability. Used to determine relative sources of mortality and sustainable harvest rates.
Biological data –	Market sampling and	Tracking the size and age composition of the
lengths, weight	Age reading from	population (cohorts), which is used in stock assessment
and age in each	otoliths in the	to estimate the numbers and biomass of each age
group	laboratory	group. Also reveals biological and ecological changes,
		such as changes in growth due to feeding conditions.
Economic	Economic surveys	Economic performance of fleets, sectoral contribution national and local economy. Development objectives

# Fisheries dependent – summary takeaway

# Fisheries independent – summary takeaway

Data type	How it's collected	What it's used for			
Survey trawl catches	Bottom trawl surveys (Q1 and Q3) (Demersal or beam trawl) - Swept area method	Density index, catchability, population composition, distribution. Used in tuning stock assessment models.			
Acoustic density (and trawl for ID/ samples)	Calibrated split-beam scientific echosounders (Simrad EK60 or EK80)	Acoustic density at age. Particularly for pelagic species – herring, sprat. Abundance index for stock assessment models. Also changes in distribution patterns.			
Burrow density for Nephrops	Underwater TV Cameras and image analysis processing	Relative abundance of Nephrops. Sex ratios.			
Biological data – lengths, weight, age in each group	Survey catch sampling followed by lab analyses	Changes in the size and age composition of the population, proportion mature, growth rates. All used in stock assessments.			
Tagging	Tagging – markers and trackers	Relative abundance estimates at age and estimating total mortality for use in stock assessment. Migration patterns and consequences for spatial management and zonal attachment.			
Larval and egg counts	Various nets and samplers	Estimate abundance of that parent population (spawning sock size), determine spawning locations from timing, forecast likely recruitment			
Environmental	Various physical and chemical sensors, water samplers and acoustic devices for seabed characteristics. Plus grabs and cores for sediments.	Relating patterns to environmental conditions. From population biology to ecological understanding necessary to make predictive models.			

**More resources** 

- Fish stocks: counting the uncountable
- Fisheries Dependent Information conference lots of presentations about science and industry working better together



# Swept area survey game



#### Swept area surveys: Tools

1. Density of the population in an area (the numbers per unit area). Often referred to as the Catch per unit effort (CPUE)

 $Density(CPUE) = \frac{Survey \ catch}{Area \ swept \ by \ trawl}$ 

2. Total abundance of species in the area

 $Abundance = Density \times Survey area$ 

Use the spreadsheet to design your survey and calculate the abundance

# **Fisheries independent**

# Swept area surveys: Methods

- Design ways to divide up the sampling of the survey area efficiently and to get the best estimate even when unexpected things happen.
- Sampling protocols reproducible so comparisons can be made
- Sampling the catch biological information
- Raising the sub-sample to the sample catch
- Raising the survey catch to the total area



Acknowledgement: Allan Hicks, MREP workshop