THE BIG PICTURE II

Benthic Imagery Workshop 2021

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Benthic imagery enumeration approaches

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Joint Nature Conservation Committee

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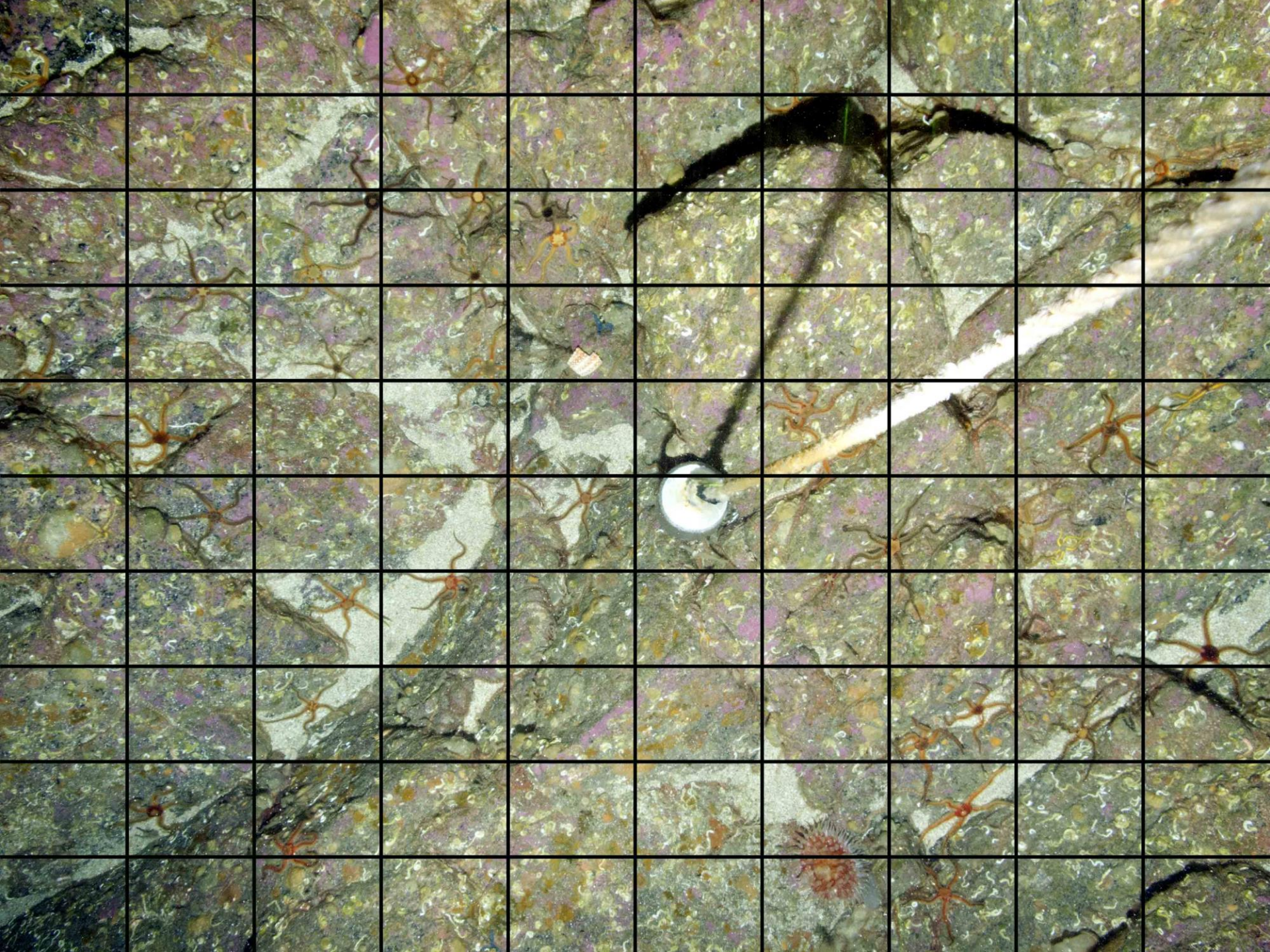
Cover			Counts				
	Growth form			Size of individuals/colonies			
Percentage cover	Crust/meadow	Massive/Turf	Density	<1cm	1-3 cm	3-15 cm	>15 cm
>80%	S	-	>10,000 / m^2	S	-	-	-
40-79%	A	S	1000-9999 / m^2	A	S	-	-
20-39%	C	A	100-999 / m^2	C	A	S	-
10-19%	F	C	10-99 / m^2	F	C	A	S
5-9%	O	F	1-9 / m^2	O	F	C	A
1-5% or density	R	O	1-9 / 10m^2	R	O	F	C
<1% or density	-	R	1-9 / 100 m^2	-	R	O	F
-	-	-	1-9 / 1000 m^2	-	-	R	O
-	-	-	<1 / 1000 m^2	-	-	-	R

The Marine Nature Conservation Review SACFOR scale for the estimation of littoral and sublittoral cover and abundance (1990 onwards). SACFOR codes are: S = Superabundant, A = Abundant, C = Common, F = Frequent, O = Occasional, and R = Rare

Connor, D.W., Allen, J.H., Golding, N., Howell, K.L., Lieberknecht, L.M., Northen, K.O., Reker, J.B. 2004. The Marine Habitat Classification for Britain and Ireland (version 04.05). Joint Nature Conservation Committee, Peterborough, 49pp.

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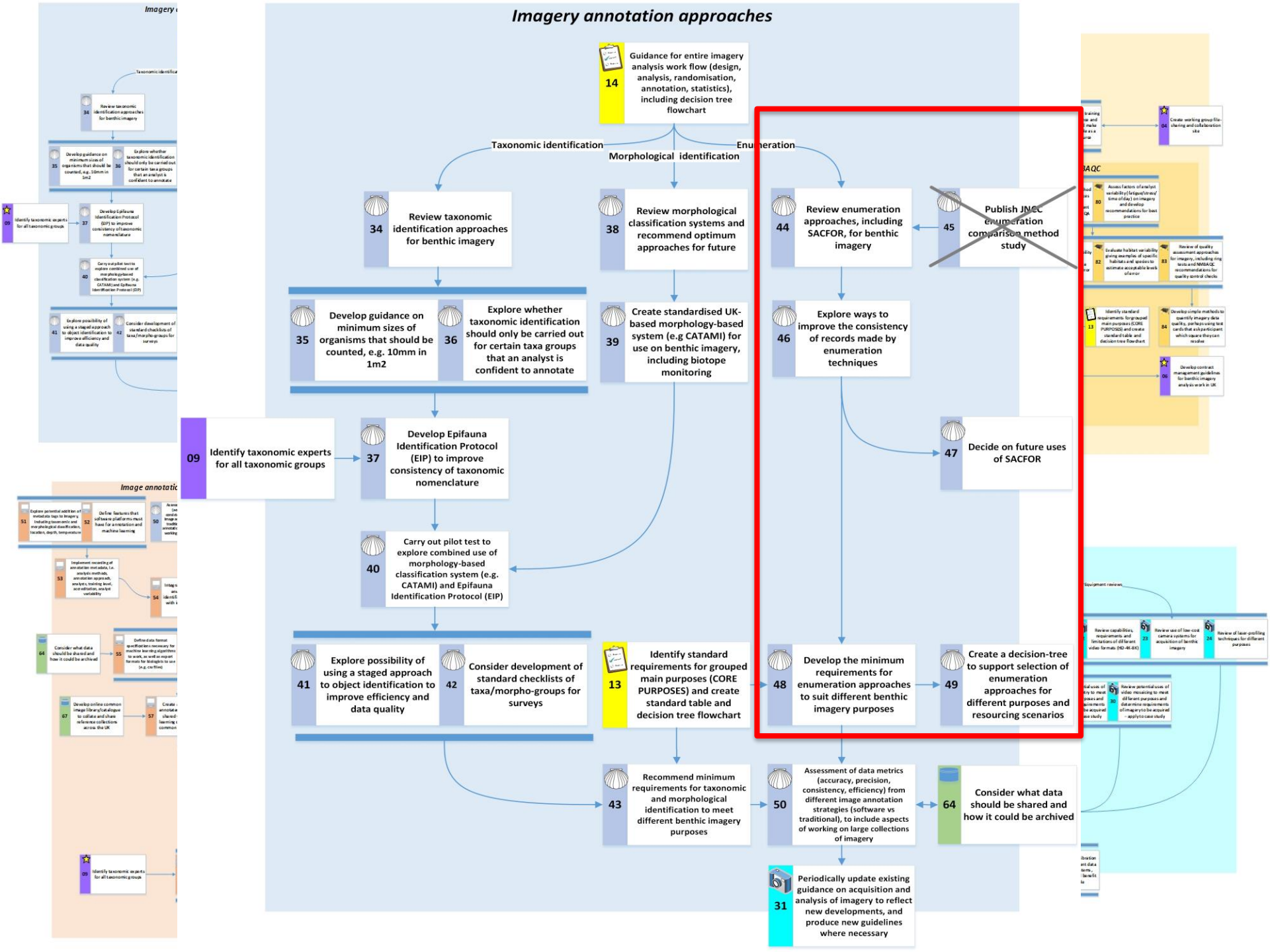
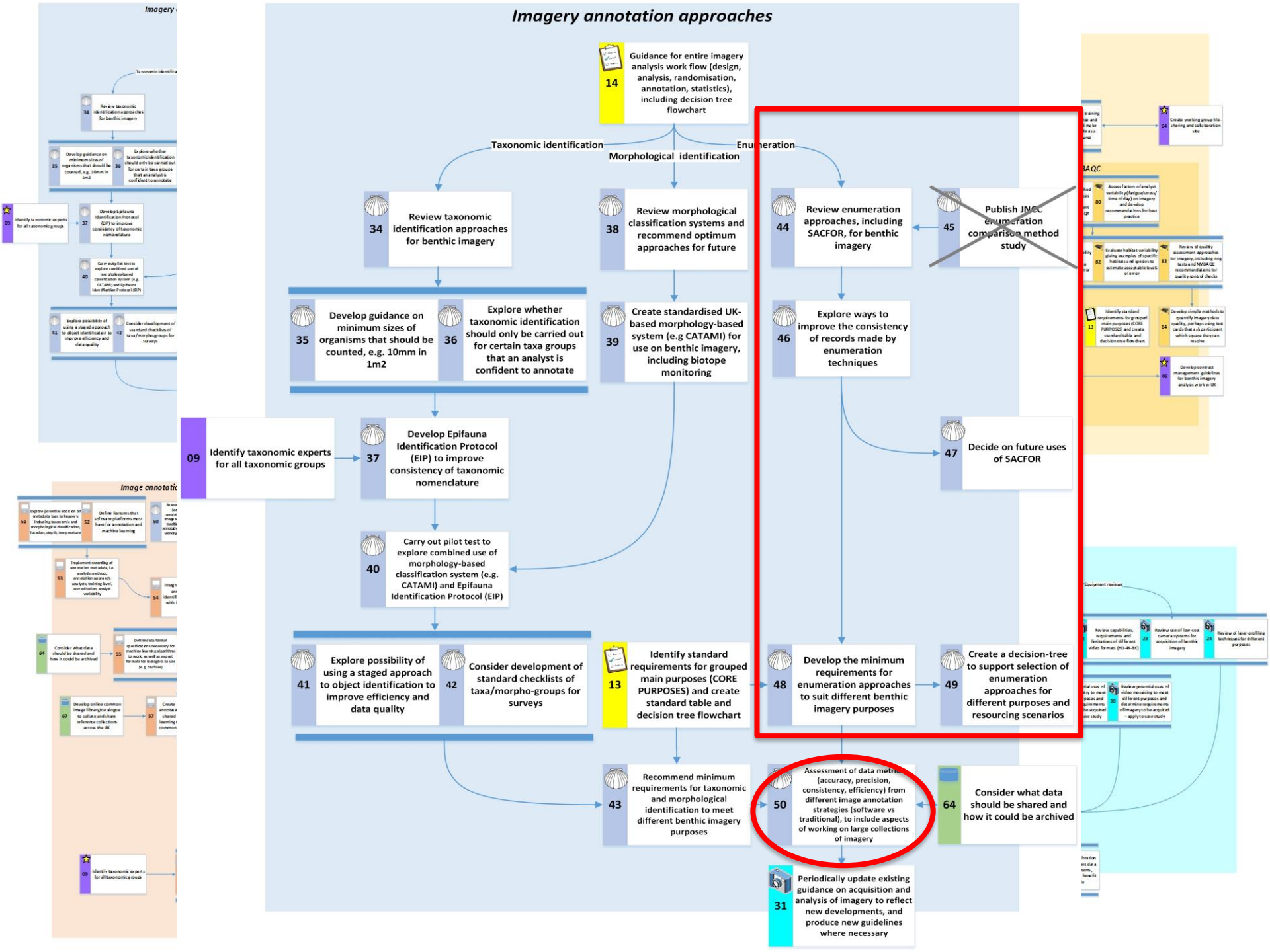
Benthic Imagery Analysis Workshop 2019


Imagery annotation approaches
14 Guidance for entire imagery analysis work flow (design, analysis, randomisation, annotation, statistics), including decision tree flowchart
Taxonomic identification
Morphological identification
Enumeration
34 Review taxonomic identification approaches for benthic imagery
38 Review morphological classification systems and recommend optimum approaches for future
44 Review enumeration approaches, including SACFOR, for benthic imagery
45 Publish JNCC enumeration comparison method study
35 Develop guidance on minimum sizes of organisms that should be counted, e.g. 10mm in 1m2
36 Explore whether taxonomic identification should only be carried out for certain taxa groups that an analyst is confident to annotate
39 Create standardised UK-based morphology-based system (e.g CATAMI) for use on benthic imagery, including biotope monitoring
46 Explore ways to improve the consistency of records made by enumeration techniques
09 Identify taxonomic experts for all taxonomic groups
37 Develop Epifauna Identification Protocol (EIP) to improve consistency of taxonomic nomenclature
47 Decide on future uses of SACFOR
40 Carry out pilot test to explore combined use of morphology-based classification system (e.g. CATAMI) and Epifauna Identification Protocol (EIP)
41 Explore possibility of using a staged approach to object identification to improve efficiency and data quality
42 Consider development of standard checklists of taxa/morpho-groups for surveys
13 Identify standard requirements for grouped main purposes (CORE PURPOSES) and create standard table and decision tree flowchart
48 Develop the minimum requirements for enumeration approaches to suit different benthic imagery purposes
49 Create a decision-tree to support selection of enumeration approaches for different purposes and resourcing scenarios
43 Recommend minimum requirements for taxonomic and morphological identification to meet different benthic imagery purposes
50 Assessment of data metrics (accuracy, precision, consistency, efficiency) from different image annotation strategies (software vs traditional), to include aspects of working on large collections of imagery
64 Consider what data should be shared and how it could be archived
31 Periodically update existing guidance on acquisition and analysis of imagery to reflect new developments, and produce new guidelines where necessary

Purpose	Feature verification	Habitat mapping	Habitat/Species monitoring
Summary	Imagery collected for use in verification of feature existance in particular area. Targets biological and abiotic features. Data standards and metadata rich. Limited acquisition standards, as only few replicates required to verify feature.	Imagery collected for use in habitat mapping. Targets biological and abiotic features. Data standards and metadata rich. Limited acquisition standards.	Imagery collected for use in habitat characterisation particularly assessment of trends & assessment of impacts. Targets biological and abiotic features. Uses quantitative approaches in analysis. Data standards and metadata rich. Limited acquisition standards.
Includes	- Ground truthing anecdotal information or data from multiple sources - Support marine licensing	- Mapping conservation features - Mapping of seabed, habitats and species - Ground truthing anecdotal information or data for inshore developments - Support marine licensing	- Detection of trends in conservation features (community extent, distribution, composition) - Assessing the effectiveness of management practices - Environmental Impact Assessment (including assessment of fishing impacts, offshore industrial impacts, impact assessment in MPAs) - Ground truthing anecdotal information or data for inshore developments - Support marine licensing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Previous work

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JNCC Report
No. 641

Optimisation of Benthic Image Analysis Approaches

Moore, J., van Rein, H., Benson, A., Sotheran, I., Mercer, T. & Ferguson, M.

ASML

ENVISION

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Aims

1. To explore the consequences of **multiple observers** using different **image annotation methods** on imagery collected from a temperate rocky reef community
2. To attempt a rank-based analysis of annotation results to consider the **optimum** method, in terms of several data metrics:
   - Power
   - Precision
   - Accuracy
   - Efficiency
   - Taxonomic richness
   - Consistency

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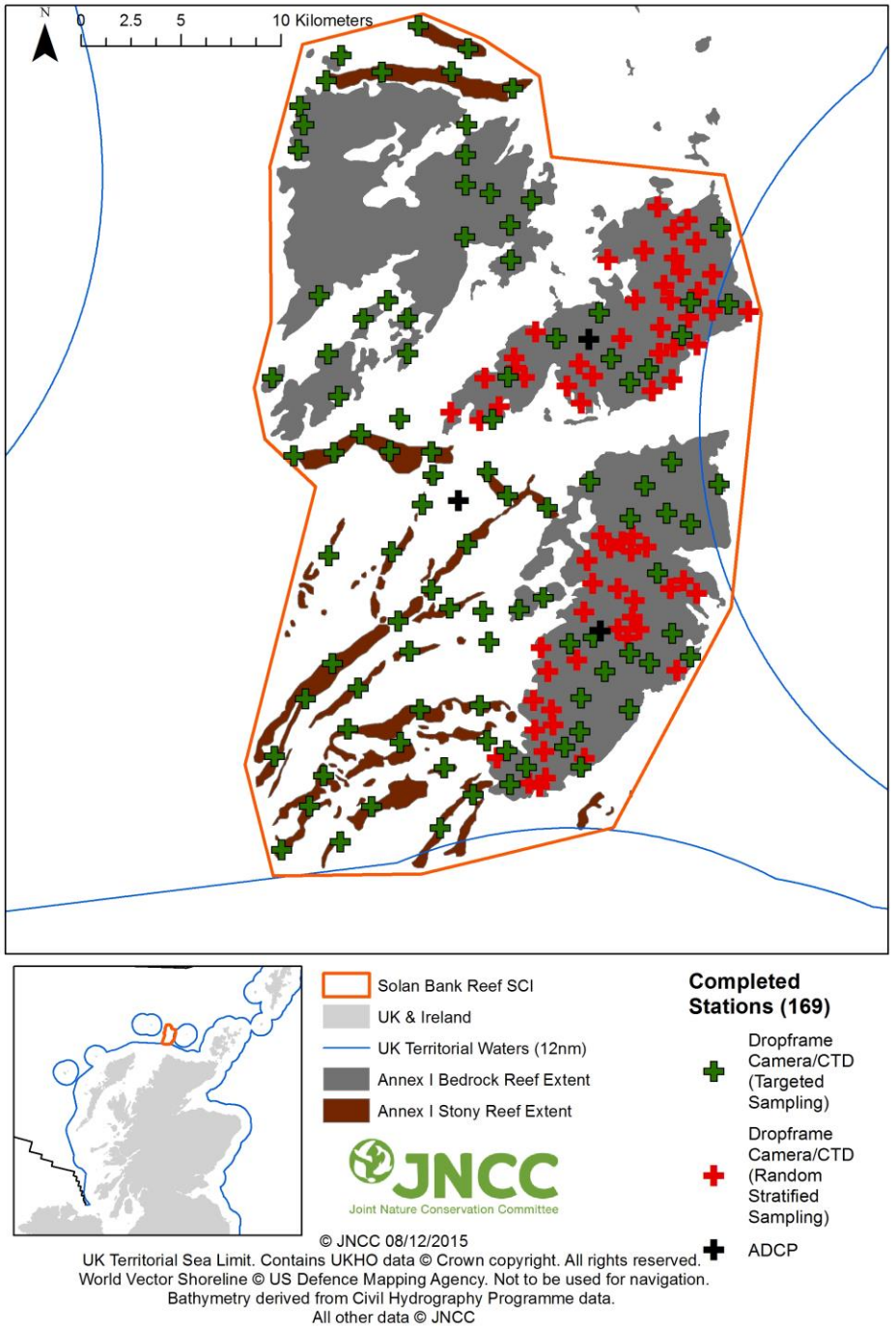
Methods

Imagery processing:

- 4630 raw stills
- Filtered by:
  - Image quality
  - Field of view (None >1m2)
  - Abiotic substratum
- Finally, only 100 images selected at random for this study

High density, high diversity temperate circalittoral bedrock reef community



Goudge, H., Morris-Webb, E., Stamp, T., Perry, F., Deamer-John, A. & O'Connor, J. 2016. Analysis of seabed video and stills data collected by drop down camera on the Solan Bank Reef SCI (1714S) (2014). JNCC Report No. 582. JNCC, Peterborough.

Methods

Imagery annotation:

- Image analyst consultants

Senior analysts x3	**Junior analysts x3**

- Annotation methods

Percentage cover	**Abundance count**
SACFOR scoring	**Point intercept**
Frequency of occurrence (10x10 grid)	**Frequency of occurrence (5x5 grid)**

Methods

Imagery annotation:

- Image analyst consultants

Senior analysts x3	Junior analysts x3

- Annotation methods x 6

- Order of images and methods randomised
- Current UK annotation protocols (no standardised taxa list – pre-EIP)
- Annotation time recorded

Analysis and results

Limitations of method comparisons

1. Data ranges
2. Taxonomic inconsistencies
3. Method truncation issues

Data ranges

- Percentage Cover: 0 to 98%
- Abundance Counts 0 to 344 individuals
- SACFOR: 0 to 6
- 5x5 Frequency 0 to 25 cells
- 10x10 Frequency 0 to 100 cells
- Point Intercept 0 to 90 points

Analysis and results

Analysis preparation (truncation)

- Many inconsistencies in taxonomic identification
- 'Truncation' of 417 taxa down to final 97 for analysis
  - Aggregation of same taxa to just one
  - Increasing and decreasing classification of taxa (i.e to species level)
  - Removal of spurious records

ID	Method	Ophiuroidea	Ophiothrix fragilis	Ophiocomina nigra
A	SACFOR	6	5	5
A	Abundance Counts	236	19	4
A	10x10	92	29	9
A	5x5	25	17	5
A	Point intercept	15	1	
B	SACFOR	6		
B	Abundance Counts	150		
B	10x10	95		
B	5x5		25	
B	Point intercept	8	19	1
C	SACFOR		6	5
C	Abundance Counts		220	11
C	10x10		97	17
C	5x5		25	5
C	Point intercept		29	3

- Truncation difficulties with SACFOR and Frequency grid data

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Analysis and results

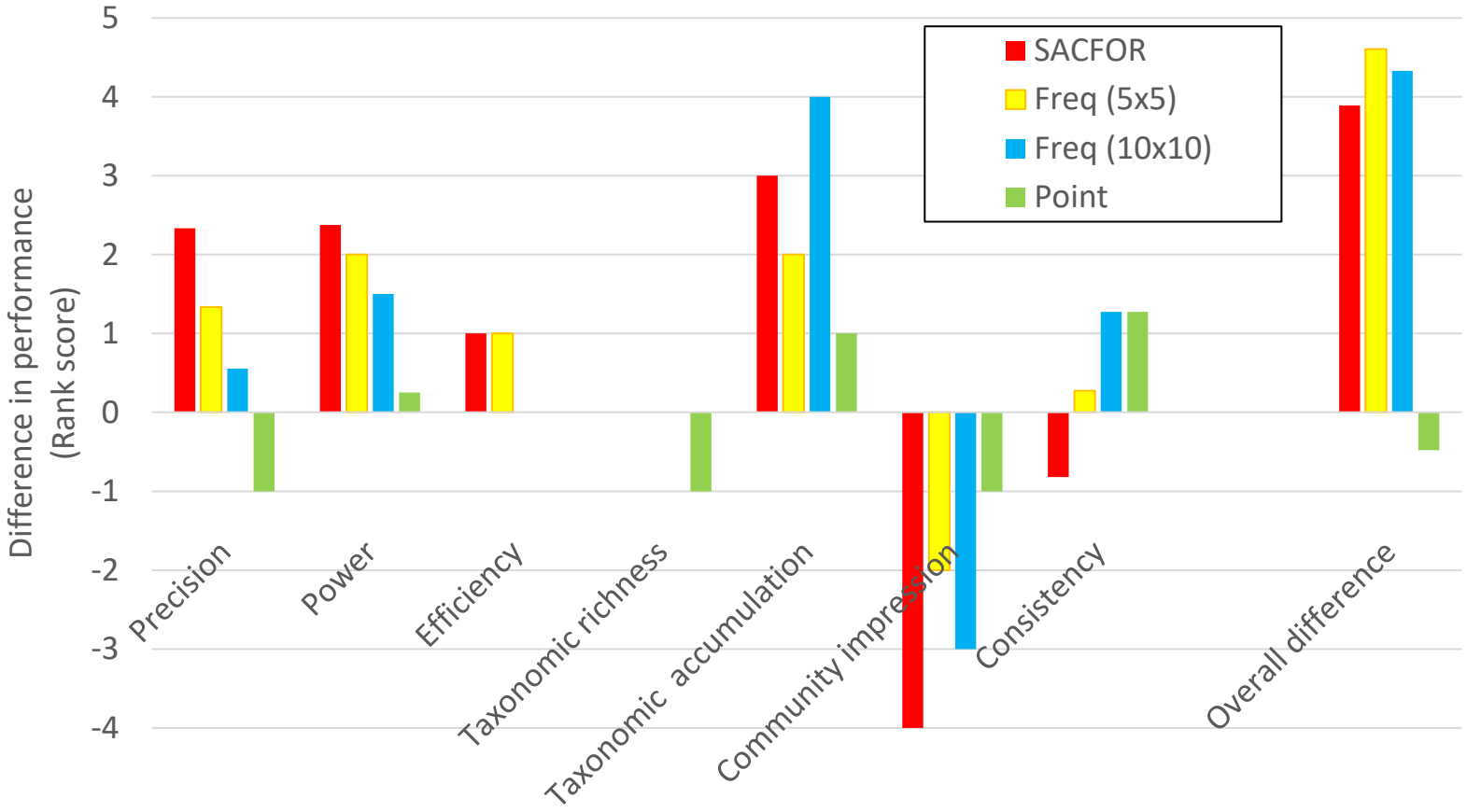

Figure 13. Relative performance of data extraction methods, as indicated by rank scores relative to combined scores of Abundance Count (erect/solitary taxa) and Percentage Cover (ground cover taxa) for all key data sets of every data metric in this study.

Conclusions

- Rank-scoring system suggests:
  - Frequency of occurrence with 5x5 grid is optimum method across all 7 metrics
  - Traditional annotation methods most accurate but poor levels of precision, power and consistency

Different people see the same things differently and that different methods create different impressions of the same community

Reflections

- *Inconsistencies in taxonomic identification and enumeration (Senior and Junior analysts)*
- *Truncation issues*

1. **Use of appropriate classification systems, image annotation software and machine learning**
   - Epifauna Identification Protocol
   - classification systems (SMarTaR-ID, CATAMI)
   - Annotation software (BIIGLE, Squiddle, VARS)
   - Machine-learning algorithms (physics-based vision; Deep Mind)

DeepMind

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Reflections

- *Methods that generate less data, reduce variability and enable higher levels of consistency*

2. **More precise targets/indicators needed**

3. **Appropriate sample sizes needed**

4. **Continued collaboration with marine imagery community**

Enumeration approaches

Project Working Group of the Big Picture Group

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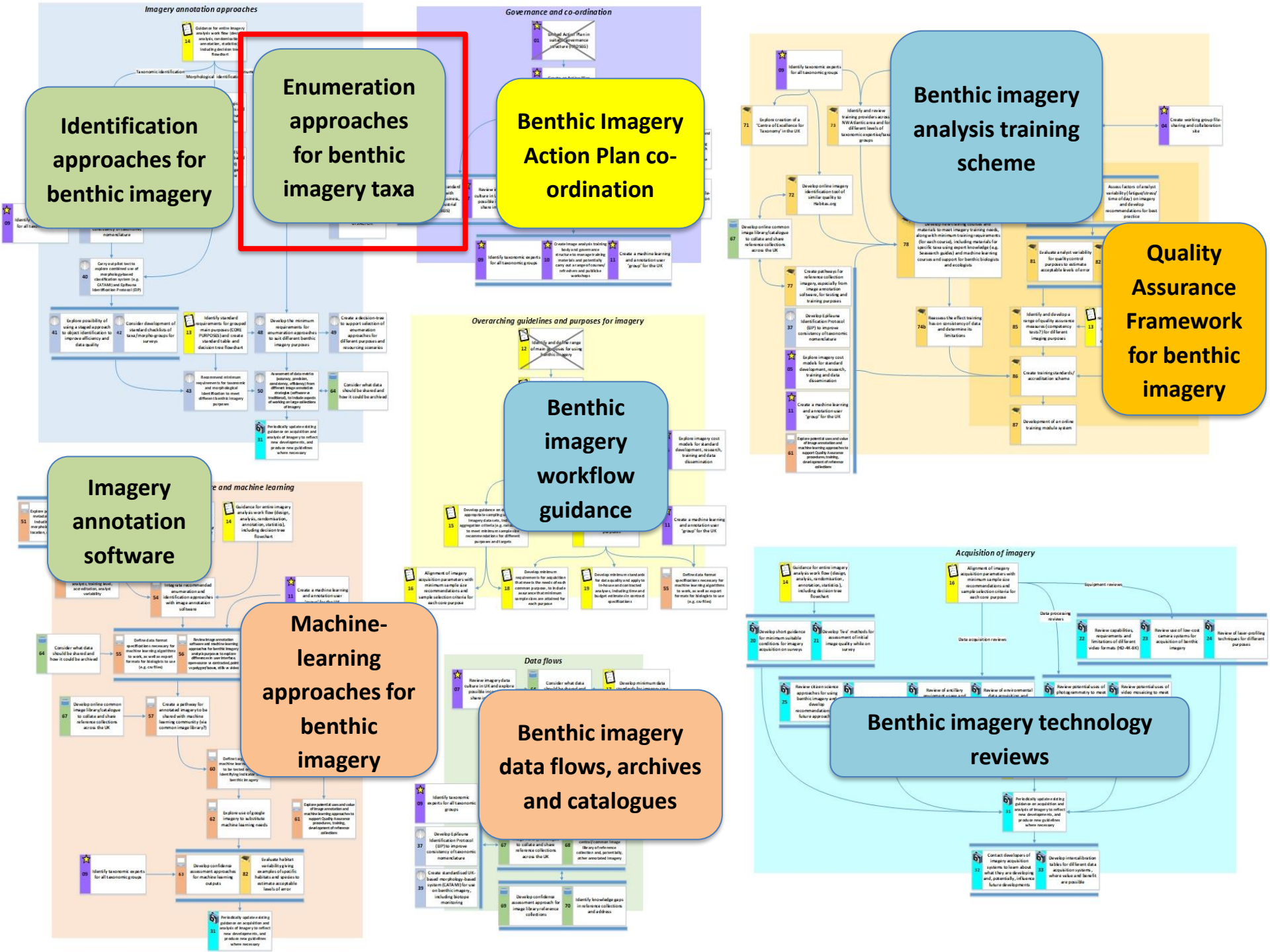
Identification approaches for benthic imagery
Enumeration approaches for benthic imagery taxa
Benthic Imagery Action Plan co-ordination
Benthic imagery analysis training scheme
Quality Assurance Framework for benthic imagery
Benthic imagery workflow guidance
Imagery annotation software
Machine-learning approaches for benthic imagery
Benthic imagery data flows, archives and catalogues
Benthic imagery technology reviews
Imagery annotation approaches
Governance and co-ordination
Overarching guidelines and purposes for imagery
Acquisition of imagery
Data flows

Future workflows

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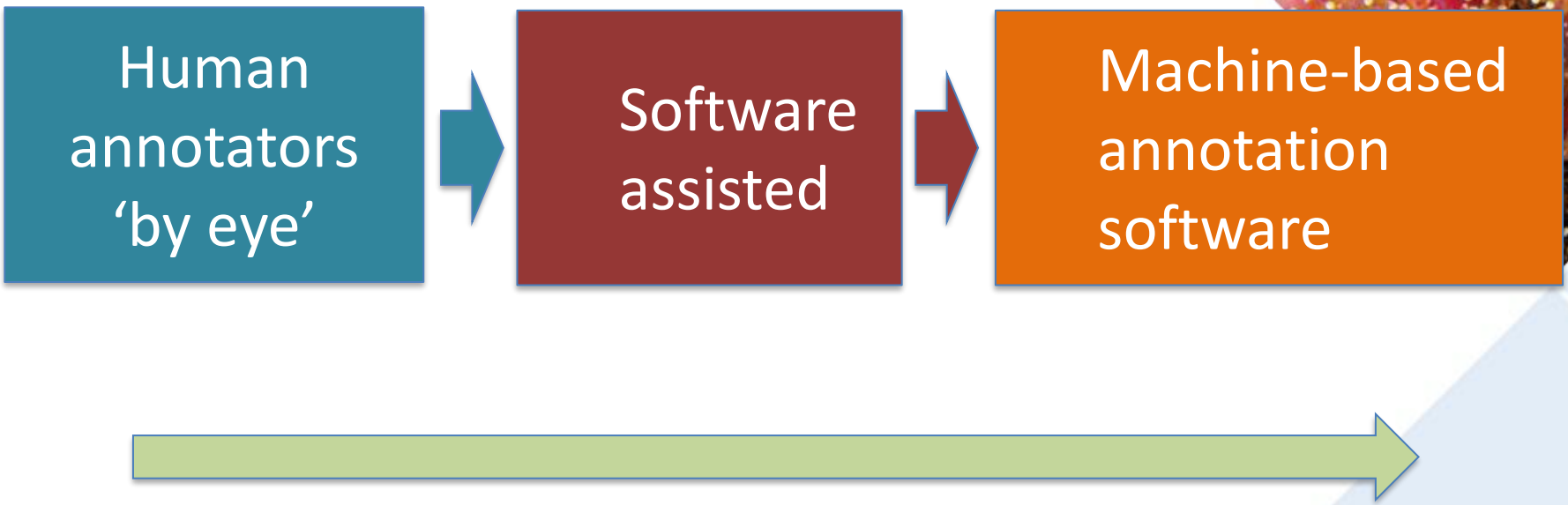
Who's doing the counting?



Future challenges

- Different methods for different taxa?
- Different methods for different purposes?
- Future proofing todays methods for tomorrows usage?
- Algorithms do the counting and humans check results?
- Standardising frequency grids to 10x10cm cells?
- Back compatibility of data?

Stay connected

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