NATIONAL MARINE BIOLOGICAL AQC SCHEME / BEQUALM
Minutes - Draft
02/07/2013 teleconference, 10:00-15:00

Attending: David Johns (DJ, Chair, SAHFOS), Mandy Prior (MP, Finance Manager, EA), Myles O'Reilly (MoR, SEPA), Claire Mason (CM, CEFAS representative), Richard Arnold (RA, Contractor), Ruth Barnich (RB, Contractor) Carol Milner (CMi, Contractor representative), Keith Cooper (KC, CEFAS), Clare Scanlan (CS, SEPA), Astrid Fischer (AF, Technical Secretary SAHFOS), Jim Ellis (JE, CEFAS), Joe Silke (JS, MI), Rafael Salas (RS, MI), Keith Cooper (KC, CEFAS).
Apologies: Tim Mackie (TM, NI EA) , Matthew Green (MG, Natural Resouces Wales), Gavin McNeill (GM, AFBI).

Actions in RED

Last Meeting Actions
Astrid:

- Identify the people involved in saltmarsh mapping. *JNCC are doing this, and more information can be downloaded from their web site.*
- Create a participants area on the web site. *Done, this is protected by a password. However, no information yet uploaded on the page.*
- Forward JNCC email to TM with the people working on epibiota. *Done.*
- Send the Zooplankton questionnaire to NMBAQC participants. *Done.*
- Send out Year 17 and draft Year 18 report, and to make a separate section on the web site. *Done, and the annual reports are now linked to from our homepage. Also, with lots of help from Myles all of the very early NMBAQC annual reports are now up on the site.*

Myles:

- Chase up agencies to see if they agree with the fail/pass on the audit reports for invertebrates. *Outstanding.*
- Send taxonomic database to TM by email to see if this is an option to send it to participants. *No longer required as this will be uploaded on the NMBAQC Web site. AF has been contacted by Nigel Grift who informed her he is working on a newer version, and that this is compatible only with Internet Explorer. Nigel asked AF if she could develop a version for Android or other platforms but AF is unfamiliar with this. Action RA to contact Nigel Grist to see how the new version is coming along. Action AF to put the most recent version up on the web with a note that this is a version working with Internet Explorer only.*

Carol:

- Send TM some videos and supporting assessment. *Outstanding, still awaiting permission.*

Mandy

- Let Astrid know which BS are available. *Done, referred to Prue Addison's document.*
- Speak to RA about QA flag needed for Merman upload sheet by CMA's. *Essentially is a table showing which labs (Competent monitoring*

authorities) and CSEMP sites have passed/failed the own sample exercise.
The web link to the NMBAQC site - http://www.nmbaqcs.org/scheme-components/invertebrates/reports.aspx, will take you to the document called – "Summary of CSEMP Own Sample Audits 1999-2008" shows the format of the table required (see table 4 onwards). Action Myles to contact all CMA's to to see if they agree with their fail/pass rates is still outstanding. MoR to send corrections to Richard so that updates can be sent out to participants.

Clare Scanlan:

- Look into the reference list and send one with definite approval to AF for inclusion on web site. *Will do this shortly. Outstanding.*

Richard:

- Investigate alternative transport suppliers. *Done. We have been discussing this internally and are of the view that we should continue with TNT for Year 20. We will of course keep their performance under review. The difficulties we experienced this year have actually strengthened our relationship with this supplier and they have a better understanding of what we are doing.*
- Investigate Fugro contested ID's – from RT39. *RTB39 states 'Specimens circulated intermediate forms with thoracic hooded hooks present and Leitoscoloplos-like body-form, unfortunately these specimens could not be externally verified; for the purpose of this exercise all entries of L. mammosus and S armiger are deemed as correct.'*

All:

- Send photos of sediment types to TM. *Outstanding?*
- Send further comments on Year 20 Application note to AF by 23 April. *Done.*

Priorities from HBDSEG

DJ attended the HBDSEG meeting in London and presented the update paper (Appendix 1). There were no questions/ comments from the HBDSEG group on the information below, but there were two main points (actions) discussed.

1. Indicator datasets

DJ and AF have been asked by the HBDSEG group to obtain a list of all the datasets that the HBDSEG sub-groups are intending to use to produce their Indicators. The purpose of this is to ensure that all the datasets satisfy NMBAQC criteria, namely Prue's paper from a few years back. The sub-group leaders were under the impression that this had been done quite recently anyway, so this hopefully won't be too onerous a task. HBDSEG will require an update on this at the next meeting in October, ideally with recommendations if there are shortfalls found.

2. Zooplankton.

There were discussions on zooplankton, both during the group meeting and afterwards. There are a couple of issues here. Firstly, it was recognised that there are currently no standards on zooplankton analysis, and DJ has been in discussions with Sarah Peaty (EA) concerning this. A draft document relating to CPR zooplankton analysis had been prepared according to British Standards, but we feel that a better approach would be to produce a standard based on multiple analysis techniques. Sarah would be very interested in having talks with the NMBAQC group, unfortunately she is away for this meeting but hopefully will be around for the next.

Carrying on from this discussion, the HBDSEG Pelagic sub-group had identified coastal zooplankton monitoring as an area that was lacking (although Scotland has just started this? Trial Zooplankton monitoring being undertaken by SEPA), and data from this would be required for their Indicator development (this is part of the sub-groups tasks to look at 'operationalizing' their Indicators for MSFD). The sub-group have been asked to provide an outline of what would be required, and costs involved (it was felt that this was something that might be possible to tag onto the EA phytoplankton monitoring, but at a reduced number of stations). Clearly, a zooplankton standard would be required for any work carried out along these lines.

HBDSEG wants to operationalize their indictors; and all datasets must comply with NMBAQC QA/QC standards. DJ/AF to contact leads of HBDSEG subgroups to find out where there are gaps and update HBDSEG for their October meeting.

HBDSEG are really interested in a zooplankton standard as there is currently no standard currently available. Sarah Peaty from the Pelagic subgroup is particularly interested and may join us in our next meeting.

CMi: We are working on methods for zooplankton sampling so I will keep in touch. DJ: We are trying to set a standard for various methods of sampling, including CPR but also other types of zooplankton sampling. DJ to keep CMi informed of progress.

Phytoplankton update

JS: The 2013 phytoplankton exercise is underway. We have an increased number of analysts participating, up from 32 to 50. We send out three tests: two samples and one paper test. The first sample is a homogenisation test, and the second one is an enumeration and identification test. The third test is a paper test to determine taxonomic skills. This test is prepared using the Ocean Teacher Platform from Oostende, Belgium, and Rafael is going there next week for preparations. This platform was used successfully last year. The third test will be sent out at the end of July. And a workshop is in preparation, probably for October/November, to be held in Galway.

DJ: where do the new participants come from? JS: Some labs do the test once every two years. There are 3-4 new labs from France, some from Australia, Israel, Singapore and one new lab from the USA. DJ: do you tailor your samples to the participant's local areas, as we were considering this for a possible zooplankton test? JS: No, it is a test in the analyst skills in taxonomy, so they should be able to follow a taxonomic key. Most phyto species are cosmopolitan

anyway but we do include some challenging material- they just have to work through the keys. It is a training exercise and they should be able to spot the features outlined in the keys. MP: For the WFD all the phyto samples need to be identified against a standard list, and ideally we would have an 'own sample' type of quality assurance. We were thinking of taking photos of the sedimentation chamber as the sample gets processed to build up a full analysis for external QA. JS: We have gone through this progress for our accreditation and traceability, we originally came up with a 2nd analyst to reconfirm the results of the 1st; however, this was going to be expensive and time-consuming. In the end we settled for the analysts to be confronted with a new species that they haven't seen before in that month, to be confirmed by a second analyst, and if they pass that identification test they are OK to analyse for another month. Action JS to send their quality protocol to MP.
DJ: The contractor who is doing the EA phyto samples, what kind of mechanism do they use? MP: They are currently gathering information to understand the variability in measurements. We have asked them to do a variety of tasks, including redo their own sample, and have a 2nd analyst do the same sample.

PSA update
RA commented on his report (Appendix 2). The PSA component is up-to-date, the only matter outstanding is the Annual report. MoR: we've received an unusual sample with more gravel/pebbles than usual. I've also had some enquiries about PSA assessments where Aquaculture monitoring contractors are using the British Standards guidance instead of our NMBAQC Best Practise guide and as a result are not using laser sizing. This may need some discussion, as there will be a different outcome to PSA analysis if laser sizing is not included and this could throw the IQI assessment. CM: When we set up the original standard, we mentioned that contractors could still participate in the scheme if they didn't have a laser for sizing; however, this was a few years ago and maybe we should now reconsider this. MoR: if they don't have the laser sizing, they will fail some of the test. CM: They should pass on the gravel/ sieve tests, as there would be nothing to laser. MoR: They should be able to do a broad range of samples, everything we sent out, and anything below 1 mm will be inaccurate for these contractors. CM: we are working on pass/fail criteria, especially in relation to the new IQI tool. We have our own reference data, but the reference data seems to be locked in the IQI tool. I have to speak to Graham about this. MP: it is best if you go and see Graham at the EA. Action CM to set up a meeting with Graham. CM: I am also working on sending in some photos for video analysis, this is work in progress. Action CM to sent photos for video analysis to TM.

Benthic Invertebrates update
RB: RT44 has gone fairly well, just waiting for one more return. We estimate to complete this by the end of July. LR17 is in an advanced stage, waiting to hear from two labs. We do individual reports for this exercise so it doesn't create a hold-up for the other participants. Nine reports are due to go out this week and this component should be finished by the end of the year. OS50-52: twenty of the thirty-six samples have been received. It is mainly the EA samples that have not been received. We will process and analyse the samples when they come in. We have received some year 18 samples very late, and we will focus on these samples first. MoR: I have tried to find out the cause of the delays so the

same shouldn't happen again for year 19 samples. If you can try to get the samples quicker to us, that would help. It has been a series of communication failures that have caused the delay in this case. RA: We will try to report on year 19 more speedily. RB: The MB20 component is completed with the report up on the web site. MoR: I have some small corrections on this report. Action MoR to send corrections to MB20 report to RB.
CMi: One of our contractors got marked down on a polychaete fragment that had not been identified. This is something for the NMBAQC Committee to decide on. RB: I have spoken to her, and learn how to rate matters. Some labs do not identify fragments, and just say 'fragment', even though they could be easily sorted to the corresponding pots. We are not going to rate this- if the contractor does not have a procedure to analyse fragments, we will not rate these. Action RB and CMi to forward the correspondence about this matter to MoR. RB: This is why we sent out interim reports, participants have the right to contest the results and we can then amend this. This is why we would like to receive the samples back on time, so we have time to investigate these matters. MoR: It is still a training exercise. Action MoR to investigate the ID issues. RB: how has the component been received? MP: it is along the lines we wanted, as specifically requested by participants.

Macroalgae
CS: The exercises went well, we have had limited feedback, but all positive. Emma and I have been discussing standards and certificates. We could probably do with organising a workshop to cover a variety of issues. MP: there is no money in the macroalgae component for a workshop, so the finances should be sourced elsewhere. Action DJ to discuss with Roger Proudfoot in October the possibility for financing a macroalgae workshop. CS: there are some common mapping issues, which will probably also arise in saltmarsh mapping. DJ: HBDSEG are very keen for data to be QA/QC-ed. CS: for saltmarsh mapping there are fewer participants, unless external extractors for countryside agencies would also join. Action CS to find out who would be interested to join saltmarsh QA/QC scheme.
MP: in the last couple of meetings we have talked about standardising the mapping method of aerial images of saltmarsh habitats. I have just circulated a draft report on this for comment (Appendix). It is drafted by Crispin Hambidge from the Environment Agency (same group as MP). Crispin does a lot of mapping for the WFD. Other Conservation agencies are also interested in mapping, in the past these surveys have not been consistent so one method of mapping would be a great advantage. Action all to give their feedback on Aerial mapping report within the next 3-4 weeks to MP. DJ: Is there an overlap between seagrasses and saltmarshes? MP: at the moment this is not an area that we have looked at. CS: Seagrass mapping overlaps with macroalgal blooming. With any of the methods there may be slight differences due to the way we collect data in the field, partly as a result of the resources available to each agency. I will look into this. DJ: Do you have a better idea now on the costs of updating the seaweed guide? CS: I will see Emma in a couple of weeks and talk to her about the guide and about a possible workshop. This year's report is on the web site and I will send the literature list to AF soon.
MP: how many passes would you normally have? I have had some comments about the gridded squares; do some options always lead to an overestimation of biodata? CS: yes, one option is failry consistently overestimating. You still

need to do the reality check on quadrats and use common sense, but this is not always done. Some in-house quality sensitivity testing for classification checks showed no significant issues with the classifications, given the scale of variation between the quadrat types, but it is something that would be good if we could standardise. However, people rarely want to change what they do. But you still need to do the reality check on it- and use common sense. MP: If we do decide to run a workshop this is an issue that needs to be addressed. Action CS to discuss the gridded square issues with Emma and others. CS: The original idea was that all participants should do all the options to give us a big dataset to analyse, but they won't all do all options. I had hoped to look at the variation from the tests but haven't had the time to do so. It would be worthwhile to look at these issues before the workshop. I've had some feedback from the seagrass exercise saying it was more difficult than the macroalgae component. MP: I have had no feedback from the EA on this. CS: we haven't looked at the identification of seagrasses either. Do your staff have a standard ID guide? MP: We have an ID sheet for three foliage types, it is A4 sized. CS: does it include *Ruppia*? MP: no. Action MP to send seagrass ID sheet to CS. Action CS to collate some ID guidance on seagrass to draft a standard for the NMBAQC web site. We could produce an angiosperm section on the web site and include saltmarsh mapping in it.

RT07 Rocky shore algae identification

The exercise went well, with most participants happy with the level of difficulty, which was greater than in the previous exercise. There was a query over the correct identification of one taxon, with two very closely related species within the same genus both being a possible identification. After much discussion and some consultation with an external expert, it was agreed to accept either name. Lessons were learned for future exercises about the level of information that should be provided with each specimen. In mitigation it should be said that there is a great deal of overlap in the species descriptions, and the revision of that particular key is long overdue. Unfortunately there is no chance of it happening soon.

OMC RT04 Macroalgal blooming and seagrass % cover

The exercise went well. There was more variation with seagrass than with macroalgae, and we may need a workshop to look into the causes of this. If we can find a site that would cover macroalgal blooms and seagrass, that would be ideal. This will be discussed with the contractor, and approximate costs sought.

OMB RT04 Biomass

The exercise went well. There is still considerable variability, and again, this is something that could be addressed via a workshop.

Reverse ring tests (rocky shore)

This component hasn't really been developed yet. A trial with the previous contractor was unsatisfactory, being only partially successful. At present there are external experts who will look at e.g. photographs, specimens on an occasional basis and do not charge for this. However, if it is done through a formal scheme like NMBAQC, it would have to be on a formal basis.

Reports

The recent reports have gone on the website. Previous ones still to be checked.

Certificates/ Pass rates

Certificates of participation have been drafted, and are submitted to this meeting for discussion (Appendix 3), e.g. on the appropriateness of pass/fail criteria.

MoR: I've had a quick look at the certificate, and you need to clarify they cover only one component on the first page, not the complete scheme, which means I may need to adjust the benthic certificate as well. Also, the certificate should state NMBAQC committee are the final arbiters.

Seaweed Identification literature

A draft list has been compiled. This will be sent to Astrid shortly for inclusion on the website.

Marine Angiosperms

- Seagrass: So far we have not covered seagrass identification, but this needs to be addressed. This could be done partly through a workshop.
- Saltmarsh: I've had responses from the NRA and DoE(NI). There is a mixture of this work being done by environment and nature conservation agencies, or consultants on their behalf. The general opinion is that if there is a QC scheme, agencies would expect themselves or their contractors to be involved. However, we are all at different stages of knowledge and expertise with saltmarsh, and the frequency of surveys is likely to vary markedly among agencies – potentially from annual to once in six years. There is no scheme for QCing mapping using e.g. aerial photography, so one would be useful. The EA has done most work in this regard, so it would be useful to look at their criteria for ensuring quality of analysis. However, I haven't had a response from the EA yet, and will need to follow this up (after discussion with Mandy at the meeting). SEPA also has procedures, but we do need to develop the QA aspects further.

Workshop

There are several areas which could benefit from a workshop. These are some preliminary thoughts on what one or more workshops might cover:

- Mapping – this cuts across macroalgal blooming, seagrass and saltmarsh, but comprises three main aspects.
  - Use of remote imagery – what is the most useful type for different quality elements; how do you geo-reference and analyse data in a consistent fashion across organisations and methods?
  - Definition of "available intertidal habitat" for OMB.
  - *In situ* definition of patches (macroalgae and seagrass);
  - Assessment of unsurveyed areas ("no-go" areas on H&S grounds)
- Field/Lab work
  - Survey techniques – e.g. hovercraft v. foot sampling

- Macroalgal blooming – assessment of % cover; biomass sample collection; definition of entrainment; treatment of biomass samples (washing).
- Seagrass - assessment of % cover; identification of seagrass species
- Saltmarsh – species and community (NVC) identification; definition of zones; WB definition

Epibiota update

AF: the last teleconference meeting we have had was just before our previous NMBAQC meeting. I have now received some of the Standard Operating Procedures (SOPS) and am collating these in a document. The SOPs can then be used to produce a Best Practise Guidance document. Also, I have been approached by Chris Pirie from Natural England who are organising an Epibiota workshop but mainly focussed on monitoring environmental change. This was originally planned for the second week of July but should now be happening early September. I have not heard anything recently but I know that Chris has been away.

DJ: We still have no epibiota lead. I have heard from TM that Gavin has left. Tim did have some ideas for a lead, but does anyone else have some? MP: Conservation agencies are the most likely candidates. CM: Matt Green may know of someone. AF: The person working with Matt Green on epibiota is Rohan Holt, I have his contact details.

Fish update

RA: Both exercises have now been completed. MoR: I am happy for the reports to go up on the web site. I do have some comments on the dragonet identifications, but these can go into the annual reports. RA: The annual report will be the next item we will work on. MoR: one question, the fish samples were sent frozen this year, not in alcohol, as was done in previous year. Why the change? RA: This was due to the person who organised the ring test. MoR: Did you find out how the participants felt about this change? RA: there have been some delays in transport, and some samples were left in the in-trays of participants, but we have had no feedback from the participants. CMi: We do not have a freezer in our lab, so I had to take the samples home, and I live ½ hour away from work, so it was not an ideal situation. RA: I will make some notes about this in the annual report. MoR: Just to say to JE to stay in contact with RA and I am happy to give feedback and help when required. JE: I am relatively new to this, and would appreciate it if I could hang back this year and start next year. MoR: The only thing outstanding this year is the annual report, but I will keep you cc-ed in all communication. We also have to discuss the fish workshop next year. Action MoR/RA to cc JE in all fish communications. MP: We will also need to write the specification for the Fish/PSA/invertebrates tender. Especially for the FRRT training exercise, we need to ensure that not only common species are sent in this test, so maybe we should ask for a larger number of fish to be sent out? JE: you could keep the same number of fish, but specify a maximum/minimum. E.g. no more than 8 flat fish, at least 1 rockling and 1 goby. DJ: when is it due out for tender? MP: it is due to go out in September, so ideally it should be ready by the end of August. Action MP to set up a meeting in 2-3 weeks time to discuss the tender.

Zooplankton update

AF: I have sent out the questionnaire to NMBAQC participants and have collated the results into a draft document (this still has to go through internal audit at SAHFOS) and this report has been given to the committee for review (Appendix 4). Any comments welcome. MoR: it looks good. DJ: it is something that HBDSEG are very keen to set up, but we don't know how to progress from here. MoR: Our previous standards have been set up by performing a series of exercises and use the comments of those involved to set up standards. The taxonomy is internationally based but we tend to focus at UK coastal species. DJ: the ICES plankton group were a bit upset about this first exercise and we do need to get the international community involved. MoR: We had the same experience when we set up the invertebrate component before. A starting exercise may be the best way forward. DJ: the support from HBDSEG in this matter will certainly help. Action DJ/AF to discuss way forward.

AOB

MP: There is a deadline of 3 weeks for commenting on the saltmarsh document. CS: There are some identification issues that need to be addressed for the next meeting. MP: there is no ringtest for saltmarshes but a tender specification will be coming out in September and we could include it in that, if we flag it now. CS: there are not very many people interested in saltmarshes, we need to know how to make this financially viable. There are a number of contractors that do this type of work but I am unsure of the costs. Action CS to send comments to MP by 23 July.

CMi: I had a question regarding our policy about using WORMS, as some of the species on WORMS are incorrect, could we have a list on the NMBAQC web site when not to use WORMS? AF: You should contact WORMS and they will update. MoR: It is a tremendous resource, we do not want to say anything negative about WORMS. We should speak to the WORMS people instead. MP: we use WORMS as a standard list. DJ: We should definitely support WORMS. MoR: There is also the European Register of Marine Species (ERMS). RB: The way that scale worms are set up in ERMS is better than in WORMS. It depends on the editors who work on it, for example the polychaetes are not well presented on WORMS. We hold workshops were we invite specialists to get updated keys, and they use the names that have not yet been included in WORMS? AF: Could you be the editor for WORMS? RB: I used to do this for ERMS but when it was taken over by WORMS all our hard work was disregarded by the IT specialist who set up WORMS. The Polychaetes are very diverse. The current editor is a volunteer and does not have the time to do all the updates. AF: Is the ERMS site still correct? RB: no, that is out-of-date by 10 years now. MoR: Can you write a guide about the problem? RB: for polychaetes we have to be careful, we have had the workshops and we would like to use this information. It uses updated keys and we can point out where the information comes from. Action RB/MoR to produce a draft document that outlines the problems using WORMS or ERMS using scaleworms and other polychaetes to highlight issues.

CMi: I've received a few complaints from the public sector, saying that some of the tendered work is going to people who only participate in NMBAQC as 'information only'. MoR: the minimum level is 'own sample' for participation in NMBAQC. CMi: I was told that one lab was awarded work by Cefas but that their

participation was ‘information only’. Is there any way to check this? KC: We are setting up a framework now where people have to give this level of information. MP: I can help and tell you who has signed up. There are very few organisations who are ‘information only’. Action CMi to send details to MP and KC so that this issue can be addressed. MoR: I am aware that some invertebrate analysis has been subcontracted by agencies in Scotland to labs who are not participating in the scheme. CMi: Some countryside agencies are not always cued in to NMBAQC. MoR: It is certainly an issue where we should try to raise awareness among CMAs letting contracts about the requirements for proper QA, but we have to be careful not to interfere directly in confidential matters especially where we have heard information (or rumours) from unconfirmed or confidential sources. .

Papers for *27th* HBDSEG Meeting

Paper Type: Information and Discussion
HBDSEG are asked to:

- Provide input on priorities for NMBAQC scheme.
- Identify further areas for NMBAQC to investigate
- Ensure QA requirements are considered in the development of MFSD tools.

1. Priorities for HBDSEG

David Johns (SAHFOS) has now taken over from Tim Mackie as chair. NMBAQC is currently working on a Best Practise Guide for Epibiota and on the development of a Zooplankton component.

2. Phytoplankton update

The registration for the phytoplankton exercise in 2013 is now closed. There are similar numbers of laboratories participating to last year. There are 28 laboratories and over 40 analysts registered. New laboratories from France, Italy, Singapore, USA and Australia taking part this year. As a new addition to the scheme an advisory group has been formed and it is overseeing the design of the exercise. The Marine Institute is setting up a homogeneity and stability test for the method following the guidelines of ISO13528 on statistical methods for proficiency testing schemes to test the homogeneity of the materials sent to the participants and the Marine Institute is looking at the technical requirements needed in order to accredit the Bequalm scheme under ISO17043 in the future.

3. PSA

The PS44 and PS45 reports have been completed and are up on the web site. The circulations of tests sent out in February have just been returned. We are making progress with the outstanding year 19 tasks.
There has been some discussion on the latest iteration of the WFD benthic biology classification tool, IQI (Infaunal Quality Index) tool. One of the issues that needs addressing is how to set the quality limits or pass/fail for PSA to provide robust input data.

4. Benthic Invertebrates

The year 19 Ring Test (RT) 43 report is on the web site and has been sent to participants. RT44 is on track. There are 8 out of 23 returns to date and the deadline is approaching soon. For the Laboratory Reference 5 out of 12 sets are returned to date. Own Sample tests for year 18 and 19: we have 20 sets of samples received and are working through these. This is all on track.

5. Macroalgae

There are 8 laboratories participating in the ring test. For the Macroalgae Seagrass test 12 laboratories have signed up versus 13 last year. All the samples have been sent out. For the biomass component 11 laboratories have signed up, these samples are about to be sent out. We will issue certificates this year and will be using the template for the invertebrate component. We are going to add a fail/pass, with +/- 2 z-scores as acceptable. For rocky shore you can only be right/wrong, so it will be classed as a percentage from the 5 samples. It will be used as a guideline only.

6. Epibiota

We have had a teleconference discussion about epibiota on 17 April. Part of the issue is assessing PSA and sediment type from video, which is difficult to judge. The issue we are trying to raise is where forcing of an assessment may cause misidentification or a difference with the PSA analysis. We want to show that his potential source of misidentification exists. The biggest issue from the meeting is that some of the guidelines in the British Standards are very coarse. There were quite a few contributions to the discussions, including from Cefas, National Oceanography Centre Southampton, JNCC, Natural Resources Wales.

Natural England are looking at the feasibility of holding workshop looking at Best Practise in using video data to monitor epibiota communities, possibly in the week beginning 8 July 2013. This is mainly focused on the needs of MPA monitoring, and in particular trend monitoring: detecting changes in communities over time. The workshop would be used to consider issues such as: approaches to determining the number and distribution of tows, the minimum length of a tow, the number of still images required, how the video material is analysed and subsequent statistical analysis on the data.

7. Fish

Jim Ellis (Cefas) has agreed to be the new Fish Manager for NMBAQC, starting in June/ July 2013. He has done quality assurance internationally with widespread ID issues. Thomson Unicomarine is up to date with this component. The report is circulated but there is still some discussion on the identifications.

8. Zooplankton

NMBAQC has sent out a questionnaire to gauge interest from zooplankton labs for a QA test. Currently there is a general interest zooplankton quality assurance, with only 2 of the respondents so far that have said they have no interest in it at all. NMBAQC is compiling the results and writing a report, and take it from there. The questionnaire was sent out internationally, not just to UK laboratories.

9. Finances

The Schemes finances are currently stable. The current financial year operated at +1% with the late sign-up of 2 labs. The current costing structure will continue in the new financial year. A decision was made to spread out the UK postage costs for Year 20 over all participants rather than having an additional charge for the Highlands.

Appendix 2: Thomson report

BEQUALM / NMBAQC Scheme

Invertebrate, Particle Size Analysis and Fish Components

Meeting Report # 20

Committee Meeting, 2nd July 2013

Richard Arnold
Thomson Unicomarine Ltd.
April 2013
E-mail:richard.arnold@thomsonecology.com

Scheme Membership Details

Year Nineteen (2012/13) Participation

LabCode	F_RT	F_RRT	RT	LR	MB	OS	PS	Comments
LB1901	✓	×	✓	✓	✓	✓	✓	
LB1902	✓	✓	✓	✓	✓	✓	×	
LB1903	✓	✓	✓	✓	✓	✓	✓	
LB1904	✓	✓	✓	✓	✓	✓	✓	
LB1905	✓	✓	✓	×	×	✓	✓	
LB1906	✓	✓	✓	×	×	✓	✓	
LB1907	×	×	✓	✓	✓	✓	×	
LB1908	✓	×	✓	✓	×	✓	✓	
LB1909	×	×	✓	×	✓	✓	✓	
LB1910	×	×	✓	×	×	✓	✓	
LB1911	×	×	✓	✓	×	✓	×	
LB1912	×	×	✓	✓	×	✓	×	
LB1913	×	×	✓	✓	×	✓	×	
LB1914	×	×	✓	×	×	✓	×	
LB1915	×	×	×	×	×	✓	×	
LB1916	×	×	✓	×	×	✓	×	
LB1917	×	×	×	×	×	✓	✓	
LB1918	×	×	✓	✓	×	✓	×	
LB1919	×	×	✓	×	×	✓	×	
LB1920	✓	×	✓	×	×	×	×	
LB1921	×	×	×	×	×	×	✓	
LB1922	×	×	✓	✓	✓	×	×	
LB1923	×	×	×	×	×	✓	×	
LB1924	×	×	×	✓	×	✓	×	
LB1925	×	×	×	×	×	✓	×	
LB1926	×	×	✓	×	×	✓	×	
LB1927	×	×	×	×	×	✓	×	
LB1928	×	×	×	×	×	✓	×	
LB1929	×	×	×	×	×	✓	×	
LB1930	×	×	×	×	×	✓	×	
LB1931	×	×	×	×	×	✓	×	
LB1932	×	×	×	×	×	✓	×	
LB1933	×	×	×	×	×	✓	×	
LB1934	×	×	×	×	×	✓	×	
LB1935	×	×	×	×	×	✓	×	
LB1936	✓	✓	×	×	×	×	×	
LB1937	✓	✓	×	×	×	×	×	
LB1938	✓	✓	×	×	×	×	×	
LB1939	✓	✓	×	×	×	×	×	
LB1940	✓	✓	×	×	×	×	×	
LB1941	✓	✓	×	×	×	×	×	
LB1942	✓	✓	×	×	×	×	×	
LB1943	✓	✓	×	×	×	×	×	
LB1944	✓	✓	×	×	×	×	×	
LB1945	✓	✓	×	×	×	×	×	
LB1946	✓	✓	×	×	×	×	×	
LB1947	×	✓	×	×	×	×	×	
LB1948	×	✓	×	×	×	×	×	
LB1949	×	✓	×	×	×	×	×	
LB1950	×	×	✓	×	×	✓	×	
LB1951	×	✓	×	×	×	×	×	
LB1952	×	✓	×	×	×	×	×	
LB1953	×	✓	×	×	×	×	×	
LB1954	×	✓	×	×	×	×	×	
LB1955	×	×	×	×	×	×	✓	
LB1956	×	×	✓	×	×	×	×	
LB1957	×	✓	×	×	×	×	×	ADDITIONAL FISH TEAM - TBC
LB1958	×	×	×	×	×	×	✓	
LB1960	×	×	×	×	×	✓	×	
LB1962	×	×	×	×	×	✓	×	
LB1963	×	×	×	×	×	✓	×	
TOTAL	***19***	***23***	***23***	***12***	***7***	***36***	***11***	

Progress on circulations

Scheme Year 18 (2011/12)

Exercise	Status	Returns/Notes
OS47-49	Late Year 18 Own Samples Ongoing	Eight samples (Labs 1832, 1833, 1834 and 1840) are currently being processed. They arrived at TUM on 01/05/2013, i.e. 1 year and 5 months after the deadline. Processing of samples sent to external audit is finished, report by auditor is outstanding, but should arrive at the beginning of July. Following completion of the above tasks, the Annual Report for the OS exercise and the Annual Invertebrates Report will be completed.

Scheme Year 19 (2012/13)

Exercise	Status	Returns/Notes
F_RRT04	Requests for fish specimens distributed 10-09-12. Completed.	Fifteen fish taxa to be from Northwest European waters (CSEMP samples where appropriate). Completed, with report circulated to participants but not yet published on the website.
F_RT06	Samples to be distributed 04-02-13. Analysis & reporting in progress.	General Fish Ring Test – Assorted Fish Taxa (fifteen taxa). Deadline for returns was 5th April 2013. Completed, with report shortly to be uploaded on to website.
RT44	Samples distributed 04-02-13. Exercise ongoing / Analysis & reporting in progress.	Ring Test. Deadline for returns was 5th April 2013 but a two week extension was offered. 20 out of 22 returns have been received. Reminder e-mails have been sent. Analysis of results is ongoing. Report is aimed to be ready by end of July 2013.
LR17	Requests for specimens distributed 10-09-12. Analysis & reporting in progress.	Specimens to be voucher individuals from Northwest European waters (CSEMP samples where appropriate). The deadline for returns was 14th December 2012. One of twelve sets of specimens is still outstanding. Nine reports are currently being finalised and sent to participants.
OS50-52	Request for data distributed 10-09-12. Analysis & reporting in progress.	Twenty of thirty six datasets received for OS selection and twenty sets of samples have been received. Specimen id has started and one set of samples has been reported, to date. Analysis of samples delayed due to processing of late Yr18 samples.
MB20	Samples distributed 28-09-12. Completed.	Estuarine location (0.5 mm sieve mesh). The deadline for returns was 14th December 2012. Completed, with report uploaded on to the website.
PS44	Samples distributed 10-09-12. Completed.	Muddy sample (pre-sieved <1mm). Completed, with report uploaded on to the website.
PS45	Samples distributed 10-09-12. Completed.	Sandy sample (pre-sieved <1mm). Completed, with report uploaded on to the website.
PS46	Samples distributed 04-02-13.	Gravel sample (pre-sieved >2mm). Deadline for returns was 5th April

Exercise	Status	Returns/Notes
	Completed.	2013. Completed, with report shortly to be uploaded on to website.
PS47	Samples distributed 04-02-13. Completed.	Diamicton sample (Gravel + Mud/Sand). Deadline for returns was 5th April 2013 Completed, with report shortly to be uploaded on to website.

Scheme Year 20 (2013/14)

- The Year 20 timetable, for fish, macrobenthic invertebrates and PSA, has been produced and this has been published on the NMBAQC website.

Matters Arising

Year Eighteen (2011/12)

Timetable and Circulations

- We are currently focusing on analysing and reporting of late OS.
- We are waiting for the report on our own samples sent for external audit.

Annual Reports

- The OS Annual Report and the Annual Invertebrates Report will be completed once the tasks above are completed.

Year Nineteen (2012/13)

Timetable and Circulations

- Invertebrates: We are currently working on OS, Lab references and RT. We have taken some steps to try to complete the Year 19 work in a timelier manner. This is includes more active encouragement of participants to submit specimens earlier and better organisation of the external audit of our samples.

Annual Reports

- Fish: Having just completed and reported on all exercises, we can now begin the Year 19 report for fish.
- Invertebrates: There are still some exercises to complete before work on the annual report can begin.
- PSA: Having just completed and reported on all exercises, we can now begin the Year 19 report for PSA.

NMBAQC Taxonomic Literature Database

- Nigel Grist has updated the taxonomic literature database but the update has not been circulated yet.

Workshops

- The next workshop will be a beginner's invertebrate workshop to be held in TUM's lab at Letchworth at the beginning of November. We are currently finalising the details for this workshop.

Appendix 3: Macroalgae certificate

Biological Effects Quality Assurance in Monitoring Programmes /
National Marine Biological Analytical Quality Control Scheme
STATEMENT OF PERFORMANCE
Year Nineteen (2012/2013)

Participant details:

Name of organisation: EG
CSEMP participant: Yes
Year of joining: «YearJoined»
Years of participation: «YearsInScheme»

Comment [c1]: Would this be year of NMBAQC overall or first year of macroalgal components?

Statement Issued: May 2013
Statement Number: 2013/01

Summary of results:

Component Name	Exercise	Subcontracted	Results / Flag
			Flag
Rocky Shore Macroalgae ID	RM-RT07	N/a	MA2222a 75% Acceptable MA2222b 89% Good MA2222c 95% Proficient MA2222d 60% Participated
			Results
			Flag
Opportunistic macroalgae/seagrass % cover	OMC-RT04	N/a	MA2222a Participated MA2222b Participated MA2222c Participated MA2222d Participated
			Results
			Flag
Opportunistic macroalgae biomass	OMB-RT04	N/a	Participated

n/a: component not applicable to the laboratory; n/p: laboratory not participating in this component;
n/r: no data received from laboratory
The list shows the results for all components in which the laboratory participated. See over for details.

Notes: «Note»

Details certified by:

Embossed endorsing stamp should appear here.

Scheme Manager	NMBAQCC Chair	Scheme Contractor
Clare Scanlan (SEPA)	Tim Mackie (DOE NI)	Wells Marine

Description of Scheme components and associated performance standards

Code	Component	Annual exercises	Purpose	Description	Standard
RM-RT	Rocky Shore Macroalgae Identification Ring Test	1	To assess the accuracy of identification of a range of marine and estuarine algae covering the taxa likely to be found in the British Isles, and particularly on the WFD Reduced Species Lists.	A distribution of photographs of twenty individually numbered but unnamed specimens for identification. There are up to five photographs per taxon, showing different aspects of the alga required for identification. There is a limited amount of supporting habitat or geographic information provided. Each laboratory receives exactly the same photographs and supporting information.	No formal standards are set for this component, which may also be used purely as a training exercise. However, the following are proposed indicators of proficiency: results above 90% are deemed proficient, results above 80% are deemed good, results above 70% are deemed acceptable, results below 70% are reported as "Participated". Results are presented as the percentage of differences at the specific level between the identifications made by the laboratory and those made by Wells Marine. Values in parentheses are the mean number of differences at the specific level for the circulation. Values are given for each participant from a laboratory.
OMC-RT	Percentage cover Opportunistic macroalgae/Seagrass Ring test	1	To assess the accuracy of the estimation of % cover of macroalgal blooms or seagrass within quadrats.	A distribution of photographs of quadrats showing various levels of % cover. There are 15 photographs of macroalgal blooms and 15 of seagrass. Photographs of the quadrats are provided with options for assessment using different types of quadrat; participants may select the quadrat which represents the laboratory's normal practice.	No formal standards are set for this component, which may also be used purely as a training exercise. However, >80% similarity with Wells Marine assessment, or +/- 2 Z-scores of the participants' mean are suggested as a pass rate for those using the exercise for assessing competence.

OMB-RT	Opportunistic macroalgae Biomass Ring test	1	To assess the accuracy of the participants' ability to measure the weight of synthetic algal samples for algal biomass assessment.	Consists of synthetic samples of various materials, designed to mimic samples of macroalgae. The materials are combined with sediment and shell fragments; participants wash samples to remove contaminants and then record both wet and dry sample weights. Three samples of different weights are sent out; each can only be processed once.	No formal standards are set for this component, which may also be used purely as a training exercise. +/- 2 Z-scores (wet weight) is suggested as a pass rate for those using the exercise for assessing competence.

Note: In the event of any disputes over identification or assessment, the contract manager will attempt to resolve this in the first instance with the scheme operators; failing that, an external expert will be consulted.

Appendix 4: zooplankton questionnaire results.

NMBAQC Zooplankton Questionnaire Summary

A review of current zooplankton analysis techniques worldwide

A report prepared for the NMBAQC scheme by Astrid Fischer and Marianne Wootton, Sir Alister Hardy Foundation for Ocean Science.

June 2013

Cover Note: The following report provides a review of results collated from the NMBAQC scheme's 'Review of Zooplankton Analysis' Questionnaire. This report highlights the wide range of purposes and functions for which zooplankton analysis is conducted by government agencies and private organisations worldwide. In conjunction with this, the report also shows that there is a demand for quality control. The recommendation from this report is that there is a need to standardise (or set minimum standards for) certain aspects of zooplankton analysis techniques, as no national or international standards currently exist for zooplankton analysis. We recommend that this should be in the form of an NMBAQC ring test, similar to the BEQUALM scheme to ensure the quality and consistency of zooplankton data collected in the UK which is now integral to work carried out for many European directives, such as the Water Framework, Habitats and Marine Strategy Framework Directives. Most zooplankton research being carried out is area-dependent, and a ring test scheme should therefore be divided into representative sections for participants. It could be in the format of a series of pictures per area. Another possibility is an own sample submission process, similar as currently operative for the benthic invertebrates within NMBAQC.

Table of Contents

Introduction

In January 2013 SAHFOS on behalf of the National Marine Biological Analytical Quality Control (NMBAQC) scheme sent out a questionnaire to organisations known to be involved in zooplankton research (see Appendix 1: NMBAQC Zooplankton Questionnaire). We received 57 responses including 44 completed questionnaires, from all over the world, as per table below.

Origin of the completed questionnaires

Abu Dhabi	1
Australia	2
Russia	1
Canada/USA/Mexico	6
Europe	34
of which UK based	10

The primary aim of the NMBAQC's zooplankton questionnaire was to gauge the interest for quality control of current procedures used in zooplankton analysis, in the UK and worldwide. The questionnaire focused on the type of zooplankton analysis being carried out and in which regions, and to gauge the interest for quality control. It was carried out because no national or international standard methods currently exist for zooplankton analysis.

This review is intended to help inform what type of zooplankton analysis is carried out and what type of test would be recommended to start up a zooplankton quality assurance scheme.

Review of Questionnaire Results

Of the respondent laboratories there are on average 3.3 analysts per laboratory. In general most laboratories have only 1-3 people, with the occasional laboratory that employs 6-16 people or outsources its research to contractors. Most quality control is done internally, but 18% of the laboratories have no quality control scheme at all.

Purpose of the zooplankton analysis

Ecosystem functioning	82%
Climate change	68%
Biodiversity assessments	70%
Environmental impact assessments	64%
Other : -Work for Marine Strategy Framework Directive or Marine Protected Areas -(National) marine monitoring programme -Ecosystem & predictive biogeographic modelling -Native and invasive species -Ballast water treatment research -Fisheries research -Long-term time series -Stock assessments -Forecasting returns of salmon and recruitment of other marine fishes	36%

Zooplankton analysis regions

Atlantic	57%
Indian Ocean	7%
Pacific	14%
Arctic	14%
Antarctic	16%
Other (as identified by the questionnaires): -Southern Ocean - Irish Sea -Mediterranean - English Channel -North Sea - Labrador Sea -Baltic Sea - Barents Sea -Skaggerak - Caspian Sea -Norwegian Sea - Red Sea -Greenland - Westerschelde estuary - Gulf of Cádiz -Thames Estuary -Persian Gulf - Milford Haven -Nordic Sea	70%

Sampling depth.

Epipelagic - from 0 m - 200 m	93%
Mesopelagic- from 200 m - 1,000 m	50%
Bathypelagic- from 1,000 m - 4,000 m	14%
Abyssopelagic- from 4,000 m down to above the ocean floor	5%

Habitats from which samples are collected.

Coastal	84%
Shelf	82%
Open ocean	45%
Other (as identified by the questionnaires) : -Newfoundland Shelf, Grand Banks, Labrador Sea -Sea Ice Zone, the region affected by sea-ice cover -AR7W, a transect line of 30 stations that cross the Labrador Sea from Hamilton Bank on Labrador coast to Deception point on Greenland western coast -Freshwater lakes -Estuaries	23%

Taxonomic level of identification.

Species	86%
Family	45%
Order	27%
Other (as identified by the respondents) : -Genus -Class -Phylum -Group -To confidence level/ lowest taxonomic level possible -Developmental stage -Sex -Size -Weight (biomass)	59%

Taxa identified.

Crustaceans	93%
Fish larvae	55%
Jellyfish	59%
other (as identified by the respondents): -Any/all mesozooplankton -Heliozoa -Meroplanktonic larvae -Mollusca -Amphipoda -Mysida -Annelida -Nematoda -Appendicularia -Nemertea -Arthopoda -Ostracoda -Bivalvia -Polychaeta -Brachiopoda -Pteropoda -Calanoid nauplii -Radiolaria -Chaetognatha -Rotatoria -Chordata -Rotifera -Echinodermata -Sardina pilchardus -Euphausiids -Sipunculida -Fish eggs -Tintinnida -Foraminifera -Tunicata -Protozoa - Ciliates	73%

Almost all laboratories include crustaceans and a wide range of other zooplankton, as is apparent from the table above.

Method of zooplankton collection and analysis.

CPR	9%
Plankton net (See note below)	91%
Light microscopy	86%
Zooscan/ ZooImage/Video plankton recorder	18%
Other : - Molecular genetics - Field Emission Scanning Electron Microscope - Biomass measured as dry weight -Dry weight free ash -Silhouette photography -Chitobiase assays -Remote zooplankton studies using Laser Optical Plankton Counter and acoustics -In Situ Ichthyoplankton Sensing System - Water sampler according to Ruttner	32%

Note:

The plankton nets include: towed Gulf VII's, Ring nets (usually vertically hauled), Hyper-benthic sledge, RMT1+8 (Rectangular Midwater Trawl; the RMT1 is 1 m^2 and usually 300 µm and sits above the RMT8 which is nominally 8 m^2 and 4.5 mm mesh), Norpac net, WP2 net,

Umbrella net (for working through ice holes), National Institute of Polar Research (Tokyo) - NIPR net (type of ice pump), Ocean Research Institute (ORI) net, the Bedford Institute of Oceanography Net and Environmental Sampling System (Bioness, multi-layer sampler) and Multiple Opening/Closing Net and Environmental Sensing System net.

QA test preference.

General zooplankton	80%
Crustaceans only	16%
Copepods only	23%
Other : -All zooplankton -Fish larvae -Euphausiids, calanoid copepods, and pteropods from specific ocean areas -Correct and consistent identification of zooplankton, including rare/exotic species	20%

QA procedures currently used.

None	18%
Internal, including: -In house training -Comparison of sample counts -Abundance checks on complete sets, including checking for suspicious data (e.g. warm water species in cold water) -Re-analysis of percentage of samples	64%
ISO	14%
Other : -Use of taxonomic experts -QA procedures similar to procedures of Food Standards Agency -Participation of taxonomic workshops to uphold and develop skills -Intercalibration of samples -Use of updated taxonomic lists to confirm current names and references for identification (including World Register of Marine Species and Integrated Taxonomic Information System) -HELCOM Zooplankton network zooplankton Ringtests	43%

Of the laboratories that completed the questionnaire only 5% were not at all interested in having external quality assurance on behalf of the NMBAQC, with 41% being interested and 55% possibly being interested.

Other comments received.

"Not sure what you mean by QA. QA of the identification? QA of the counting procedures? QA of data entered into the database? I suppose you mean all three."
"A workshop about this would be good."
"Organizing a practical workshop(s) where researchers could exchange experience, and producing/developing practical identification guides for zoogeographical regions, would be good aids assisting in development and achieving quality standards by researchers and laboratories." *It should be noted here that SAHFOS is currently producing a zooplankton identification guide for the North Atlantic.*
It "would be good to participate although cost might be an issue. International comparison to check everyone's IDs is a great idea. The idea of an international standard for zooplankton identification is appealing and would look good for our funders. It would bring the community together. Practically it might be quite challenging because of the different species globally and the different taxonomic level. "
"It is not clear that our laboratories, which are primarily focused on basic research and project specific problems, fall within the scope of the NMBAQC initiative. We are not currently providing data for regional ecosystem assessments or the like, although our data could be used by others doing so once we have published the data. Most of our data ends up in the Biological and Chemical Oceanographic Data Management Office (BCO-DMO - http://bco-dmo.org/) database system."
"From my perspective QA analysis <...> would need to be very carefully constructed in order to be worthwhile exercise. It <...> would mean three main things, in order of priority:

1. First most important in my view is for the taxa/species/stages/sexes to be identified correctly at whatever given level. This would be possible in its broadest form with a QA analysis involving sending around samples to the various groups to identify, but even this would work only up to a point. If *Oithona similis* females were sent around to a group that only identified them as "*Oithona* spp. – all copepodite stages" Then as long as they are correctly identified to this level it is OK. Sending an assemblage to identify that is not characteristic of the region of expertise of the analysts would similarly bias results a QA assessment.
2. Second internal consistency at any given taxon level is almost equally important. For example if the category "*Calanus* eggs" are counted in the same way and category throughout the time series (and not sometimes/in some places attributed *as Calanus helgolandicus* eggs, sometimes as *Calanus* eggs and sometimes as the bigger group copepod eggs and sometimes not even counted). This, the most important criterion in my view for a dataset spanning many years, would not be possible with a QA analysis because the old analysts are no longer around usually.
3. Third and relatively least most important (in my opinion) is the ability to recognise the appearance of relatively rare/alien or ephemeral species that might otherwise be lumped with commoner cogeners. This would also not be picked up by most formal

QA exercises, because the analysts would be on special lookout and check everything, hopefully). It is very likely that if *Calanus finmarchicus* females occur irregularly and at less than 1 in 1000 of *C helgolandicus* females, they will be overlooked by some analysts during regular sorting but not in a formal QA analysis. But if they regularly occur in higher proportions they will be more likely to be enumerated better."

Discussion of Questionnaire Results

Most laboratories only have a very limited number of analysts and therefore cross-checking and conferring with colleagues on difficult to identify species would be done via photos or by sending samples away. This reinforces that it is challenging to correctly determine the taxonomic species and a quality control mechanism seems the right way forward.

Purpose of the zooplankton analysis

There is a wide range of research purposes that requires zooplankton analysis. Most laboratories investigate ecosystem functioning, with biodiversity assessments as the second most important study purpose. There are also several marine monitoring programmes, including some long-term time series.

The breadth of zooplankton research may necessitate the development of a range of tests that are area dependent.

Zooplankton analysis regions

The largest part of the respondents (57%) sample in the Atlantic. In general, the zooplankton analysis is performed in the local area to the laboratory, unless otherwise required by marine directives. If a ring test were to be set up, it would be an idea to include the opportunity to send in own samples, similar to the procedure currently used by the benthic invertebrate component of NMBAQC[1]. That way we can be assured that the samples are representative of the area of expertise for that particular laboratory.

Sampling depth

Most samples are taken from the epipelagic layer (93%) although a few are also taken throughout the water column. The questionnaire has not focussed on diel migrations and this may be another issue that needs to be addressed.

Habitats from which samples are collected

Coastal and shelf species are sampled almost equally (84% coastal versus 82% shelf), and nearly half of the respondents also sample the open ocean. It is expected there will be a high biodiversity in the zooplankton species sampled by the different laboratories, and a quality control scheme should ensure correct and consistent identification.

Taxonomic level of identification.

In general, laboratories try to identify taxa to the lowest taxonomic level of identification they are confident with, and include as many different taxonomic groups as is needed for their purpose of work.

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1. For the Own Sample module a complete survey data set will initially be requested from which three samples will be randomly selected. The three fully analysed samples are supplied from the participant to the scheme contractor to be re-analysed. The selected samples must be split into individual species vials to facilitate the audit.

Taxa identified.

Almost all laboratories include crustaceans and a wide range of other zooplankton. Any quality control scheme should therefore at the minimum level include crustaceans, with the option to include other genera.

Method of zooplankton collection and analysis.

The general method for zooplankton collection and analysis uses plankton nets and light microscopy for identification, although different techniques including molecular genetics and video imaging methods are also used. The sampling method (e.g. mesh size of the net, speed at which it is hauled, net opening size) will determine the diversity of the zooplankton sampled, and it may be necessary to include size ranges of the zooplankton sampled for a quality control mechanism.

QA test preference.

A quality assurance control test for general zooplankton is preferred, although some laboratories may benefit from specific tests (e.g. euphausiids, fish larvae).

QA procedures currently used.

There is no general zooplankton quality control scheme currently, apart from the Baltic which is covered by the HELCOM Zooplankton network. Therefore, most laboratories perform internal quality control.

Use of taxonomic experts, updated taxonomic lists for recent references and name changes, distribution map checks and re-analysis of samples seem common used procedures, and this could be the basis for a standard operating procedure for zooplankton analysis.

Of the respondents 18% don't have any mechanism of quality control.

Concluding remarks.

From the received responses it appears that there is a general interest in quality control for zooplankton analysis, providing it is in the right format.

The recommendation from this report is for a standard to be set up for the identification of general zooplankton in the various regions. We recommend that this standard should be in the form of an NMBAQC ring test, similar to the BEQUALM scheme to ensure the quality and consistency of zooplankton data collected in the UK which is now integral to work carried out for many European directives such as the Water Framework, Habitats and Marine Strategy Framework Directives.

As most zooplankton research being carried out is very area dependent, the test should be divided in areas of interest to participants. The test could be in the form of a series of images per species, much the same as the HELCOM Ring test for the Baltic area. Alternatively, an own sample submission process, similar as currently operative for the benthic invertebrates within NMBAQC, could be an option.

The way forward is to organise an international workshop, possibly in conjunction with the ICES Working Group on Zooplankton Ecology, so that the whole zooplankton community can contribute to developing best practice guidance zooplankton analysis procedures and to discuss the development of a zooplankton ring-test as a form of external quality control.

Acknowledgement.

We would like to thank all of the government agencies and private organisations who took the time to fill out this questionnaire. We would also like to thank the NMBAQC's Zooplankton sub-committee (David Johns, Marianne Wootton and Astrid Fischer, SAHFOS) for their contribution to developing this questionnaire and providing guidance in the review of current zooplankton analysis techniques.

Appendix 1: NMBAQC Zooplankton Questionnaire
NMBAQC Zooplankton scheme

1. Name of the laboratory/contractor

2. Address of the laboratory/contractor

3. Number of analysts

4. What is the purpose of zooplankton analysis that you currently are undertaking?

- ☐ Ecosystem functioning
- ☐ Climate change
- ☐ Biodiversity assessments
- ☐ Environmental impact assessments
- ☐ Other (please specify)

5. From what regions of the World are the plankton samples taken from?

- ☐ Atlantic
- ☐ Indian Ocean
- ☐ Pacific
- ☐ Arctic
- ☐ Antarctic
- ☐ Other (please specify)

6. What depths are the samples taken from?

- ☐ Epipelagic
- ☐ Mesopelagic
- ☐ Bathypelagic
- ☐ Abyssopelagic

7. Which habitat are the plankton samples taken from?

- ☐ Coastal
- ☐ Shelf
- ☐ Open ocean
- ☐ Other (please specify)

8. To what taxonomic level are you currently identifying zooplankton?

- ☐ Species
- ☐ Family
- ☐ Order
- ☐ Other (please specify)

9. What taxa do you identify in your analysis?

- ☐ Crustaceans
- ☐ Fish larvae
- ☐ Jellyfish
- ☐ Other (please specify)

10. Which method of zooplankton collection and analysis are you using?

- ☐ Continuous plankton recorder (CPR)
- ☐ Plankton net
- ☐ Light microscopy
- ☐ Zooscan
- ☐ Other (please specify)

11. What kind of test would you prefer?

☐ General zooplankton
☐ Crustaceans only
☐ Copepods only
☐ Other (please specify)

12. Do you have any QA at the moment and at what level is it conducted?

☐ None
☐ Internal
☐ International Standards Organisation (ISO)
☐ Other (please specify)

13. Would you be interested in having external QA on behalf of the NMBAQC?

☐ Yes
☐ No
☐ Maybe

14. Any other comments/suggestions:

Appendix 5- Saltmarsh Aerial Mapping

Saltmarsh standardisation project

Geomatics Group and Marine Monitoring Service

Saltmarsh mapping standards

Introduction

Standardising the approach to mapping saltmarsh is important to ensure consistent and comparable results and to ensure outputs can be scrutinised objectively with a detailed knowledge of the process behind generating the data.

The methods described in this document were chosen to satisfy the requirements of the Water Framework Directive and represent best practice for this type of assessment. The methods have been developed by Geomatics group in conjunction with the Marine Monitoring Service of the Environment Agency. The development of standards began as a suggested follow up by the steering group for the Saltmarsh Inventory of England and Wales 2006-2009 involving Natural England, JNCC and CCW.

It is accepted that there are other approaches to mapping saltmarsh communities, including vector mapping, using other classification systems such as the Integrated Habitat System (IHS). Other approaches were considered for WFD however the approach chosen appear to provide the greatest consistency minimising the potential for error in so much as is possible.

In order to be as streamlined as possible across organisations and to eliminate multiple conflicting versions, it is preferable to have one basic agreed baseline map of saltmarsh extent for a given aerial photography imagery capture. This principle led to the creation of the Saltmarsh Inventory of England and Wales 2006-2009 (report and dataset are available for download from the Environment Agency download site). This baseline can be used as a starting point for many projects, taking the limitations of mapping into account. As is elaborated in this document remapping should also utilise this first extent map to minimise variations from various user interpretations.

To establish a WFD compliant classification tool that is an indicator of disturbance, suitable metrics (a metric is a measure of the biota that changes in some predictable way with increased human influence) relating to the structure and functioning of the saltmarsh were combined to establish a single index. Practitioners Guide to the Saltmarsh Tool Version 07. 121212

An outline tool was initially developed (see Best *et al.*, 2007) based on the current theory and previously published results. Saltmarsh classification focuses on:

(i) habitat extent,
(ii) zonation and
(iii) taxa diversity.

This document has taken the mapping part of this classification approach creating a best practice standard. This document will be revised in the future to integrate new methods to maximise consistency, accuracy while minimising the potential for error.

Data requirements

or any Vegetation mapping the Environment Agency recommends capturing 4 band Full Colour/Near-Infrared photography. Even in situations where it is only anticipated that baseline editing is going to be undertaken, for posterity's sake, NIR data should be included. It costs very little to capture Near Infrared data especially nowadays with 4-channel camera systems. The benefits of having this extra band are huge when it comes to automating mapping tasks.

Image ground sample distance or resolution should be between 10 and 20 cm to provide a balance of sufficient detail to interpret the imagery and efficiency in capturing the data. Data that is finer resolution than this will cost significantly more and take too long to capture using current technology.

Image data should be captured during summer months ideally, between May and September and when the sun angle is greater than 20 degrees. Tidal constraints should also be taken into account so that data capture only takes place when the entire saltmarsh is exposed. Data should also be captured in conditions free from cloud and cloud shadow. For these reasons it is important that the flights are planned carefully to capture data as quickly as possible.

Photographic interpretation

The validity of the outputs from photographic interpretation depends upon a wide variety of factors. It must be stressed that it is not an exact science; there are many potential sources of error and these should be properly understood before using the output classifications in further analysis or reporting statistics generated from them.

Quality of the photography

There is rarely consistency between photography data that has been captured on different days, significantly different times of day or with different camera systems. The issue of timing relates mainly to the variation in lighting conditions either due to sun elevation or atmospheric effects such as haze, water vapour or very thin high altitude clouds.

In addition, the techniques used to process photography depend on a significant amount of human input, especially during the colour balancing stage of processing. This means that for each project there is likely to be a unique contrast and brightness stretch applied to the data.

All of these factors can make the appearance of specific vegetation types inconsistent between different sets of image data, meaning that interpreters will not necessarily be able to apply their knowledge and recognition of vegetation across all water bodies.

Seasonal and developmental considerations

Other factors that will affect the appearance of certain vegetation types are the time of year of and stage of phytological development. This can have a profound impact on the appearance of the vegetation in photography acquired from 1000 metres above it. This is especially relevant during the period when saltmarsh plants flower. Photography data acquired of the same area of saltmarsh at the same time, on the same date, but in different years is likely to show variation due to variations in vegetation development. There will also be geographical differences, due partially to climatic variations, so saltmarsh in the northeast of England is likely to develop at a different rate to saltmarsh in the southeast of England.

Interpreter bias

The one constant in image interpretation is that no two interpretations will ever be the same, especially when comparing interpretations undertaken by two or more people. This suggests that outputs from photo interpretation, as with all remote sensing techniques are not one hundred percent accurate. Therefore it is important to understand the level of confidence one can have in an interpreted map.

Saltmarsh extent mapping

Two broad methods have been applied to saltmarsh extent mapping using aerial photography; semi- automated and manual digitization. The two methods have their distinct benefits and disadvantages, however, the output mapping results in comparable datasets. (see Deben report [REF?]!)

Automated extent mapping

The automated method favoured by the Environment Agency strikes a very good compromise between efficiency and accuracy. A description of the methodology is summarized below and in Figure 1.

- Upper tidal limit mask is applied to photography data to exclude areas above Highest Astronomical Tide level. In addition a water mask is applied to exclude areas of water visible within the imagery.
- Near Infrared and Red channels of the 4 band photography are combined to produce a greyscale Vegetation Index image (high values are vegetation, low values are non-vegetation)
- Pixels within Vegetation Index are assigned to one of two classes (vegetation / Non-vegetation) according to the pixel value. This is done by determining a threshold value by eye that best represents the vegetation within the imagery. Sometimes different thresholds need to be applied in different parts of the imagery, often dependent on lighting qualities/imbalances within the image or, more rarely the vegetation type.
- Digital pixel based classification is filtered to remove clumps of vegetation smaller than 5 m^2 and islands of non-saltmarsh smaller than 150 m^2.
- Filtered image converted to vector format (outline).
- Vegetation outline is visually inspected and where appropriate edited to remove non-saltmarsh vegetation (e.g. macro algae) that may have been picked up in the original classification. In addition areas of saltmarsh that have been missed by the original classification may be added back into the classification manually.
- The saltmarsh classification layer can then undergo creek width standardisation processing to dissolve any creeks picked up in the classification which are finer than 2 metres in width. This is done using 4-step process (1. external buffer of 1m applied to classification, 2. boundaries dissolved, 3. internal buffer by 1m, 4. dissolving holes that are smaller than 150 m^2. This procedure is only carried out on saltmarsh areas greater than 0.5 hectare so that fragmented areas are not over classified.

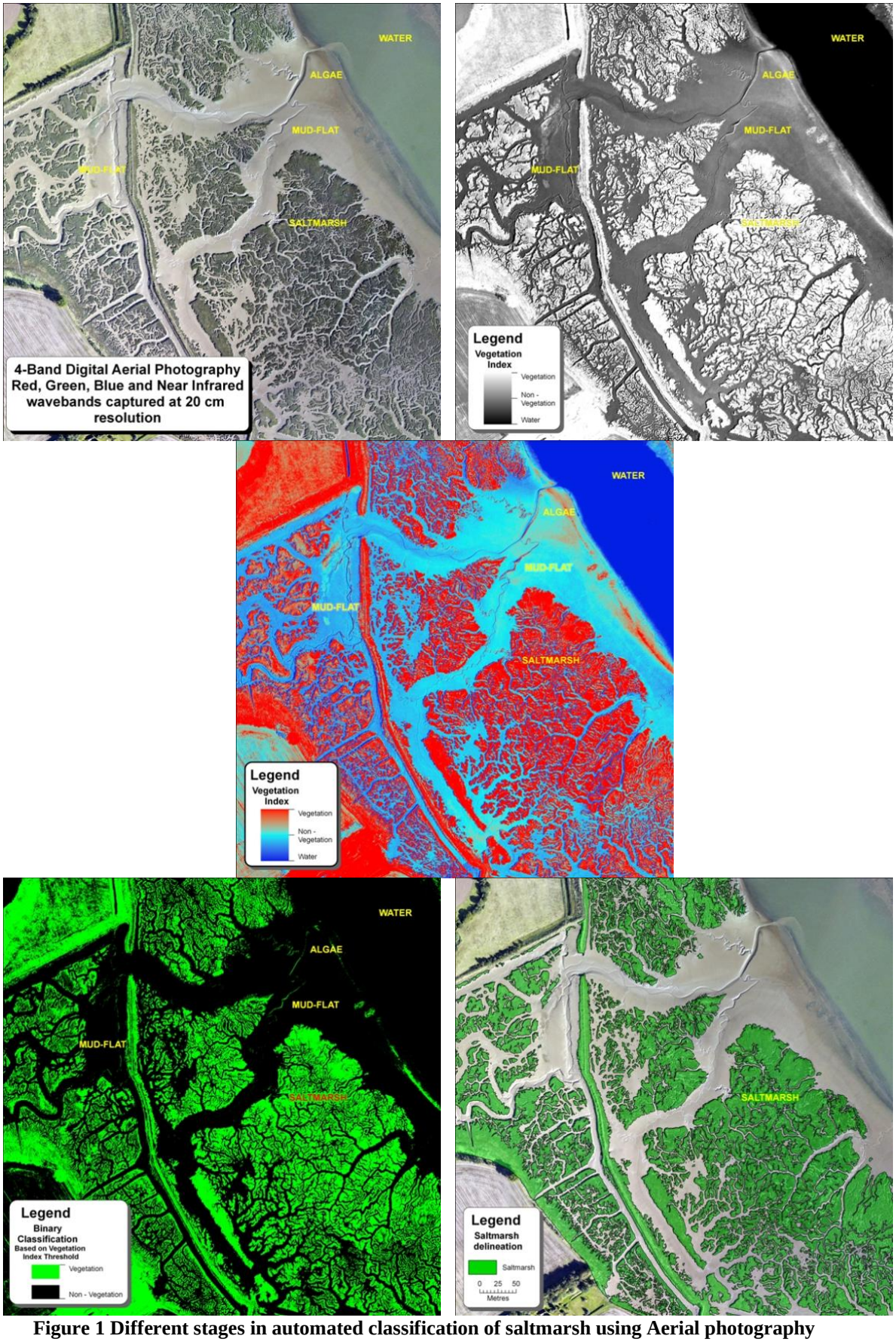

Figure 1 Different stages in automated classification of saltmarsh using Aerial photography

Benefits

Cost effective
Repeatable
Simple, standardised methodology
Most processing within standard GIS environment
20 cm photography adequate

Disadvantages

- NIR data required (should not add cost onto data capture nowadays)
- Relies on photosynthetic vegetation to work. Manual intervention required otherwise

Manual extent mapping

The manual digitizing method can produce an aesthetically pleasing smooth out put because it is not based upon pixel classifications. However, it can also be extremely time consuming, especially in areas of very high fragmentation. A typical methodology is summarized below.

- Image data displayed on-screen within GIS environment.
- Image data displayed at a standard scale to ensure consistent level of detail in mapping output.
- Boundary of saltmarsh units digitized either by using a digitising tablet or an on-screen pen display.

Benefits

- Smooth outlines
- QA process may be incorporated into digitizing
- NIR data not necessary

Disadvantages

- Very time consuming
- Potential for inconsistency in outputs between different interpreters
- Fragmented marsh may not be realistically mapped
- 10 cm photography preferable

Update mapping

There are two approaches to update mapping that could be applied, depending on how much change there is or how fragmented the saltmarsh is.

In cases where the change is purely frontal (either an accreting or eroding leading edge, then it may be appropriate to manually edit the baseline saltmarsh.

In cases where there is very significant complex change or change within a highly fragmented area of saltmarsh it may be appropriate to apply the automated method mentioned above in these sections only.

Scanning the imagery to look for areas of change is undertaken with onscreen scale of 1:1000. Where manual edits are undertaken, the digitizing process is applied at a scale of 1:500.

Due the potential for extensive areas of remapping from scratch it is advisable that NIR data is routinely captured even for update remapping

Baseline editing
Benefits

- Quick method for recording change
- Consistent results that minimise false change
- Normally does not require use 4 band imagery

Disadvantages

- Inappropriate for complex areas of change

Remapping
Benefits

- Appropriate for areas of great/complex change

Disadvantages

- Can be time consuming, although not so much if NIR data are used
- False change can be recorded due to inconsistent mapping form/technique between years.

Saltmarsh zonation mapping

The zonation metric assumes that a fully functioning saltmarsh will have all its major zones. The number of zones will vary on a number of factors, including the bio-geographical region. In England and Wales five functional zones have been outlined:

- Pioneer: *Salicornia* and pioneer species
- *Spartina* dominant marsh
- Mid-Low marsh mix (*Atriplex*, *Puccinellia*)
- High marsh (*Festuca rubra, Elytrygia* dominant marsh, *Bulboshoenus, Juncus* dominant marsh).
- Reedbeds (*Phragmites*)

Two different saltmarsh zonation mapping techniques are described in the following paragraphs. The first is a semi-automated point sampling technique and the second is a fully manual digitizing technique. The methods and results are compared.

Methodology comparison

A comparison was made between the results and speed of interpreting the aerial photography using two different recording methods.

The first method involved creating a regular grid of points spaced evenly ten metres apart. Geomatics have developed an intuitive tool in ArcGIS to facilitate a manual process of classifying each of the points according to the vegetation they lie on top of. Using this method there would be approximately 1.7 million points to classify across England and Wales. To address a concern raised that the ten metre spacing might be too coarse for some of the smaller water bodies especially where saltmarsh may be more fragmented, it was proposed that a finer 5 metre point spacing grid be used in these areas.

A cut-off of less than 30 Ha, representing a third of the surveillance water bodies, was used to determine those that would qualify for finer grid spacing.

The second method involves manually digitizing the boundaries between different saltmarsh zones as defined at the beginning of this section. When digitizing there are three decisions to make, each of which can take time, slowing the interpretation down:

1. Where is the boundary?
2. Is the block of vegetation large enough to be worth while mapping?
3. What class does the block of vegetation belong to (also required in the first method)?

In addition the boundary needs to be drawn.
The national saltmarsh extent layer was used as the template for the digitization. Polygons from this layer were split up according to where the interpreter decided a boundary lay between class and another. This was done at an on-screen scale of 1:1000 using the "Cut Polygon Features" in ArcGIS with the aid of an on-screen digitizing tablet (Wacom Cintiq 21 UX). The scale 1:1000 was chosen as a compromise between detail visible in the image data and efficiency of digitizing. The larger the scale used the more detail can be digitized but at the expense of efficiency.

Using the point method, there are fewer decision processes to undergo. The only key decision to make is: "what class does the vegetation belong to that lies directly beneath a point?" There is no need to decide on where a boundary lies, because the boundaries are essentially defined by the grid of points being used. Every point is mapped, so no decision needs to be made as to what the minimum mappable unit is when processing the points. The image data were viewed at the same scale as the digitizing method, 1:1000.

For this assessment, 2 areas in the Humber estuary totalling an area of 2.4 km^2 were interpreted. The first area near Skeffling (E,N 533,419), is a 1 km^2 section of marsh which is characterised by upper marsh, mid-low marsh, *Spartina* and pioneer marsh. The second area near Broomfleet Island (E,N 491,427), is a 1.4 km^2 section of marsh which is mainly characterised by upper marsh, reed beds and low-mid marsh.

Without ground data, there is no way of determining the accuracy of the classification using the two methods. However, a comparison could be made to determine the level of agreement between the two outputs.

Times taken to undertake the two methods were also recorded so that a comparison could be made for how long it would take to complete the task using the different methods. This time does not include set up time, as they would be identical for both methods.

	Points	**Digitization**
Number of units to classify	23,804 points	363 polygons
Length of digitized boundaries (m)	N/A	93,683
Time taken to complete task (Hours)	7	11.5

Table 1 Comparing the point and line digitization methods for classifying saltmarsh with respect to work required.

The point classifying method was significantly faster than the line digitizing method. In addition, it was far more robust. There were several times when the working on the line digitizing method that the ArcGIS tools failed to function properly. Occasionally artefacts would appear in the digitized data layer (Figure 2) due to the extreme complexity of the shapefile being worked on. It is not uncommon for the programme to crash completely when digitizing such complex shapefiles, so it is important to break any work down into small chunks and to save regularly. This is not conducive to an efficient way of working and can slow the procedure down considerably.

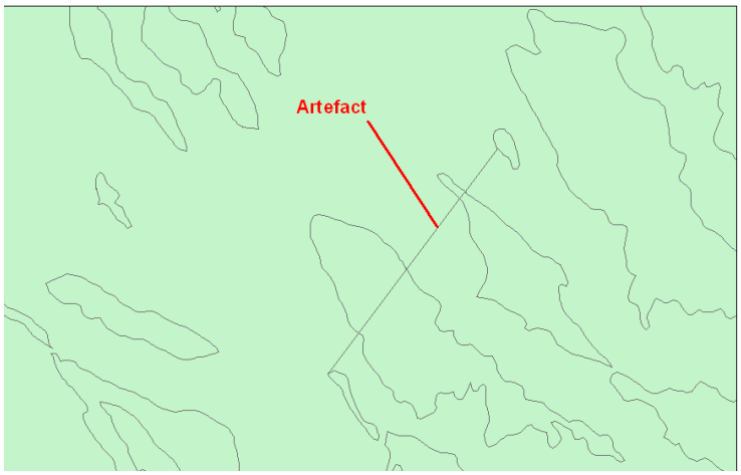

Figure 2 Showing an artefact inadvertently introduced by bugs in the programme, during the digitizing process. This is a relatively common occurrence when manipulating extremely complicated shapefiles.

The point method has none of these concerns because the only process that is taking place is to update the class field of an existing shape. If mistakes are made the class field can simply be updated with the correct class. The table is automatically saved with each class assignment. Many points can be selected using the range of selection tools (by rectangular box, by irregular polygon, or everything on the display screen) available within ArcMap.

Comparison of classification recording methods

The outputs from the two classification recording methods were compared by updating the point shapefile with the "Class" field from the digitized polygon layer table using a spatial join. It is worth noting that the two classifications were carried out by the same interpreter. An example of how the two different classifications appear can be seen in Figure 3. The contrast of the visual appearance of the two methods is quite stark. Clearly by its nature, the point method looks fragmented and the digitized classification looks more cohesive. This appearance may be misleading, as the key factor is which method is most accurate and can be used for monitoring change over time. Aesthetically pleasing maps do not necessarily equal more accurate ones.

There are two key measures that can be extracted from the data to compare the level of agreement between the two methodologies. First, the absolute overall number of points which were assigned to the same class using both methods. 91% of points were assigned to the same class using both methods. The problem with this statistic is that it tells you very little about the level of agreement of individual classes. This is because one class that is very heavily represented in the saltmarsh and which is possibly easier to discriminate by eye than other classes would have an undue influence over this absolute overall figure. It is therefore appropriate to normalise the data and produce a weighted overall percentage of agreement based on individual classes. However, as there is no independent reference against which to measure this statistic, it is necessary to perform this analysis twice: once assuming that the point classifier is 100% accurate and once assuming that the polygon digitisation method is 100% accurate. Thus, for each class, 2 percentages of agreement are calculated. There

are 6 classes overall. So the mean of the 12 percentages of agreement can be reported as a weighted overall agreement percentage which is 70%.

The statistics representing the level of agreement between the two different classification methods are presented in Table 2. The Mean Percentage Agreement figure is somewhat depressed due to the two classes that have low representation (Pioneer, average of 12 points per method and Transitional Grassland average of 78 points per method)

This representation of the results highlights the difficulty in discriminating the classes that have low representation.

There are two sources of disagreement at play. Firstly, the positioning of the boundary between different classes and secondly the actual class assignment. As the same person was responsible for the two different outputs, one might have expected a higher level of agreement about class assignment than that represented in this table. This demonstrates that an interpreter can have significant level of inconsistency when revisiting the same site. This would likely be amplified with multiple interpreters.

Some example areas which compare the classifications from the two different methods are shown in Figure 5 and Figure 6.

		Point classification as a reference		**Digitization classification as a reference**	
CLASS	**Number of points in agreement**	**Points classified (area Ha)**	**Percentage in agreement**	**Points classified (area Ha)**	**Percentage in agreement**
Pioneer	7	12 (0.12)	**58.3**	12 (0.12)	**58.3**
Spartina	1415	1573 (15.73)	**90.0**	1644 (15.73)	**86.1**
Mid Low	5805	6687 (66.87)	**86.8**	6453 (64.53)	**90.0**
Upper	10595	11223 (112.23)	**94.4**	11673 (116.73)	**90.8**
Reedbeds	3818	4153 (41.53)	**91.9**	4023 (40.23)	**94.9**
Transitional grassland	0	156 (1.56)	**0.0**	0 (0.0)	**0.0**
	Total percentage of points commonly classified			**Mean Percentage Agreement**	
	90.9%			**70.1 %**	

Table 2 Showing percentage of agreement for each of the classes and a normalised weighted overall level of agreement between the two methods of classification.

Much of the disagreement between the outputs of the two methods occurs close to boundaries between different classes. 64 % of all the disagreement is represented in a buffer region of within 10 metres distance from boundaries between the different classes. 87 % of all disagreement is within 30 metres of these boundaries (Table 3). This suggests that boundaries are extremely important to understanding the dynamics of disagreement between classifications.

It is worth noting that the differences in the class assignment are more likely to be due to interpretation inconsistency than due to the nature of the method employed. This comparison highlights one of the limitations of photography interpretation i.e. that an

interpreter can be inconsistent with the interpretation if they repeat work in the same location.

The main disadvantage in using the point classification method is that areas where there are narrow strips of saltmarsh (which are thinner than the resolution of the point grid), an example of this is the Camel estuary, may be missed in the analysis. However, over a whole water body, the overall statistics are likely to even out.

Buffer distance (m)	Border disagreement (%)	Accumulative border disagreement (%)
10	64	64
20	14	78
30	11	87
Remaining Points	13	100

Table 3 Showing the spatial relationship of inconsistency between the two classification methods and distance away from class boundaries. The border disagreement figure is the number of mismatched points within each of the buffer zones expressed as a percentage of the total number of mismatched points across the entire study area. The majority of the disagreement is within the 10 metre buffer zone.

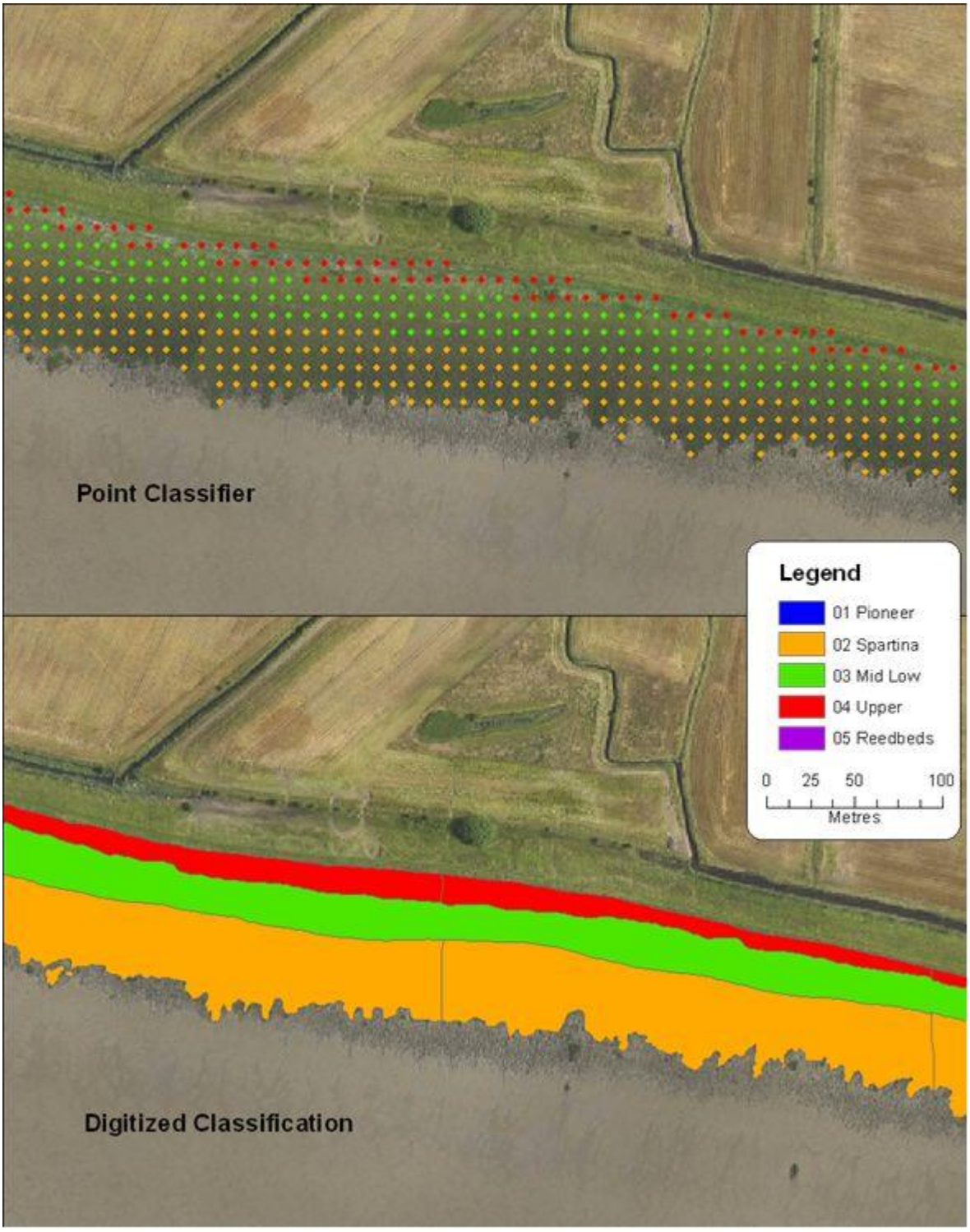

Figure 3 Showing an example of the point classification (top) and the manual digitization (bottom). This section of saltmarsh is relatively simple in structure with a coherent transition between *Spartina*, mid low marsh through to upper marsh.

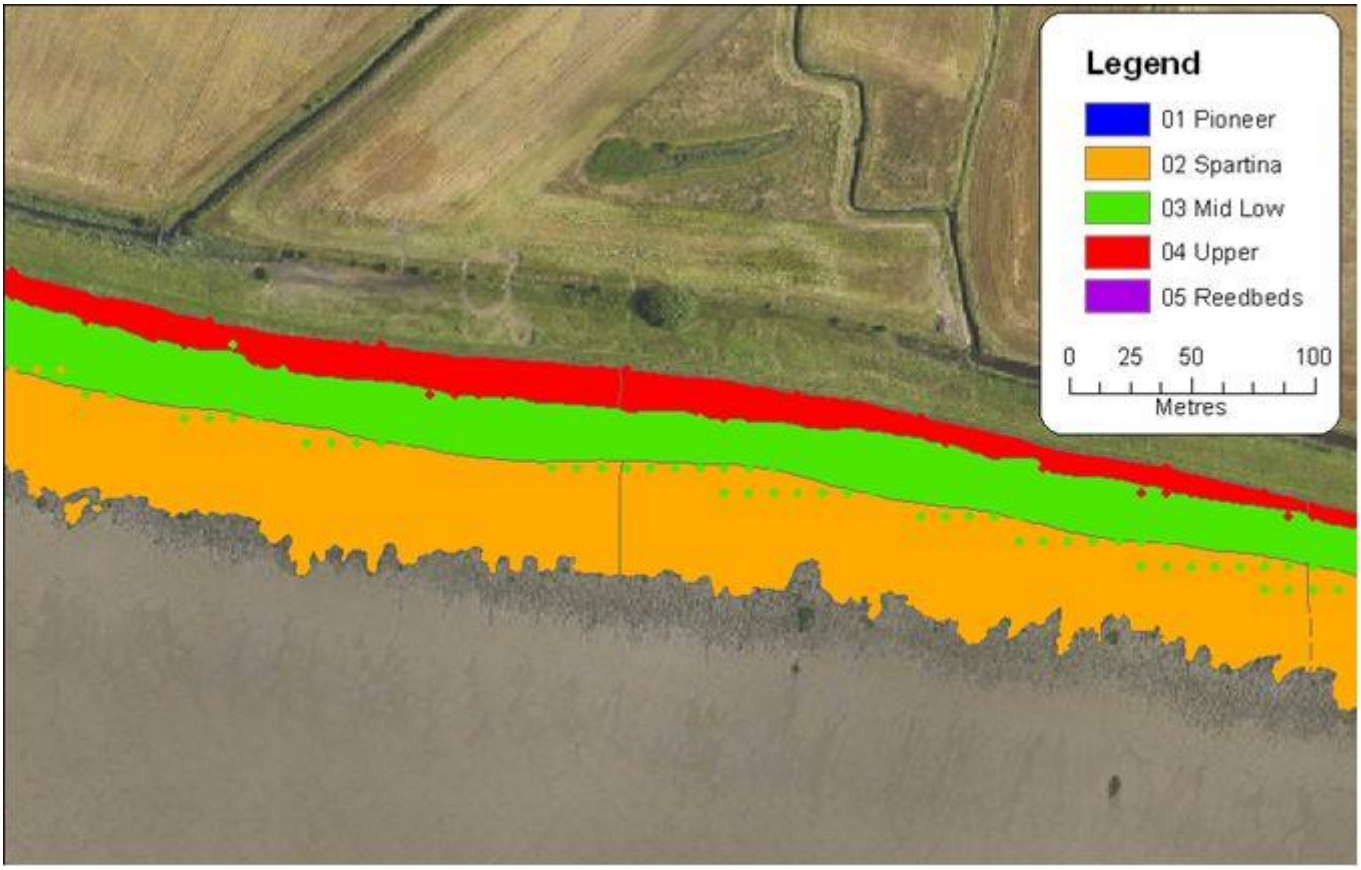

Figure 4 Showing the point classification overlaid on top of the digitized classification. Areas where there is disagreement are characterized by the appearance of the points in the point classification. Areas of agreement are shown up as a solid colour. In this image most of the disagreement is represented by inconsistent positioning of the boundaries.

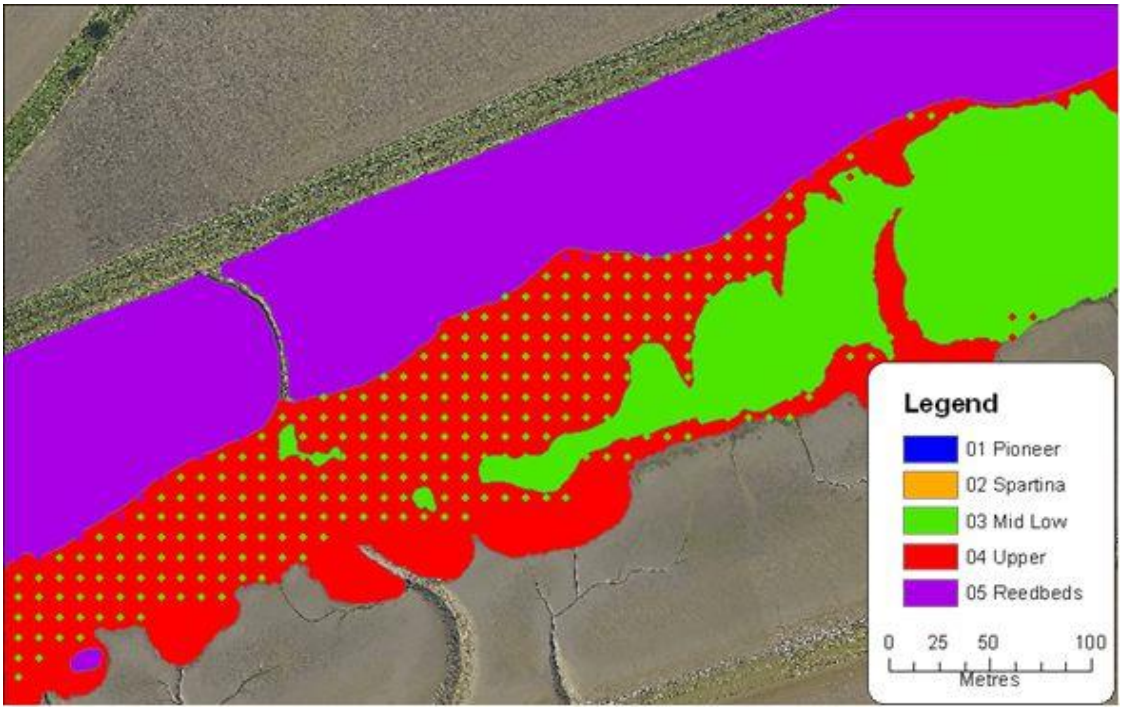

Figure 5 Showing an area near Broomfleet Island where the both the digitizing and point based classification methods have been carried out. The top image shows the classification, and the bottom image shows the underlying photography data. In the classified image, the point classified layer is overlaid on top of the solid digitized polygon layer. Areas of disagreement between the two classifications are represented by coloured dots in the imagery. Solid colours with no dots signify agreement. The large area of green dots is an example of disagreement that is caused by inconsistent class assignment. It is likely that this is an area of mixed *Agrostis* and *Festuca rubra* which could be assigned to either Mid Low class or Upper class.

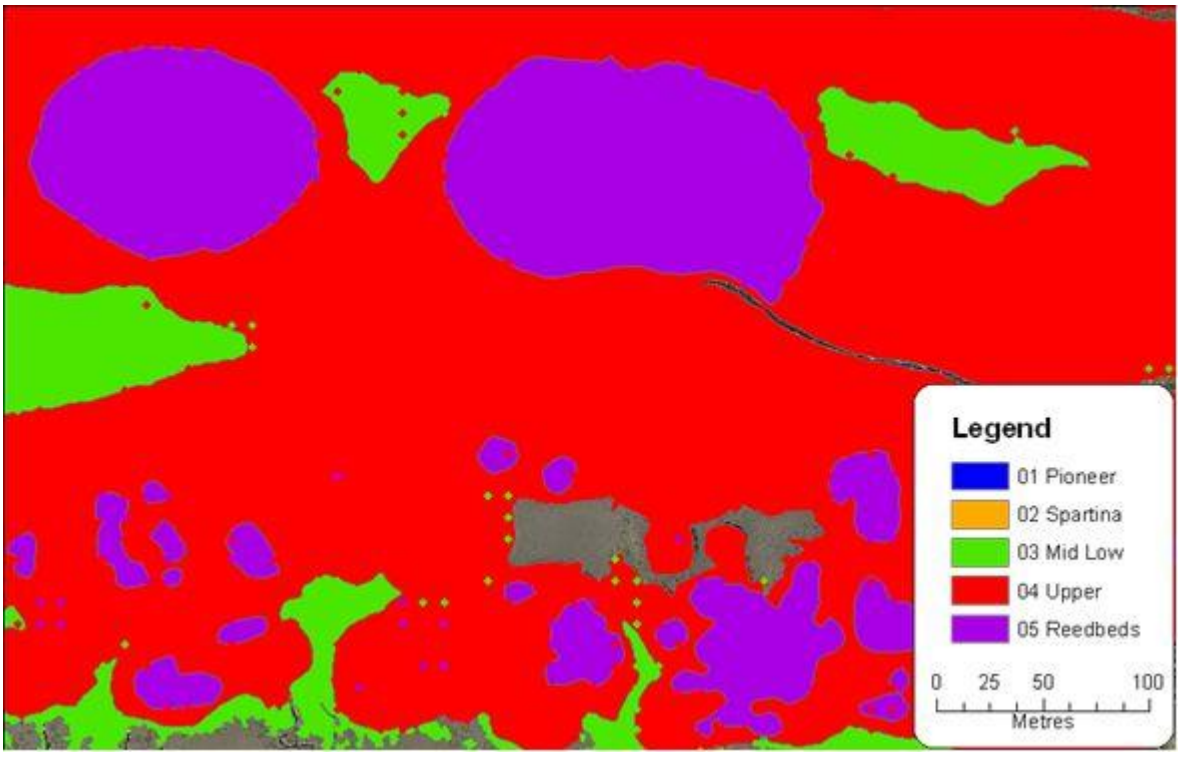

Figure 6 Showing another area near Broomfleet Island. The classification here is more consistent both in terms of class assignment and boundary positioning. The areas of disagreement are represented by dots in the classification image.

Classification uncertainty

The variations in interpretations are partially due to uncertainty in an interpreters mind as to exactly where boundaries between habitats may lie. These may be because of inconsistent image data, errors in the transects or inexperience on the part of the interpreter. In some cases the interpreter has high certainty that a particular area belongs to a certain class. However, there will be areas where this certainty is greatly reduced, sometimes to the point where the interpreter believes that the area could potentially occupy one of several classes. This uncertainty can be the product of two main issues. The first and most obvious is the uncertainty in the interpreter, partially due to inexperience, either generally or due to a specific factor such as unfamiliar lighting conditions, geographical extent or time of year. However, another issue is that the boundary between classes may be a gradual transition, known as an ecotone (Figure 7), rather than a hard boundary where the class suddenly changes from one to another. Within the ecotone there will be more than one class present, so there will be uncertainty as to which class is most appropriate. When drawing a boundary the ideal position would be where each habitat type makes up 50% of the cover, but this is very difficult to do on the ground, let alone from data acquired at 1000 m above ground level.

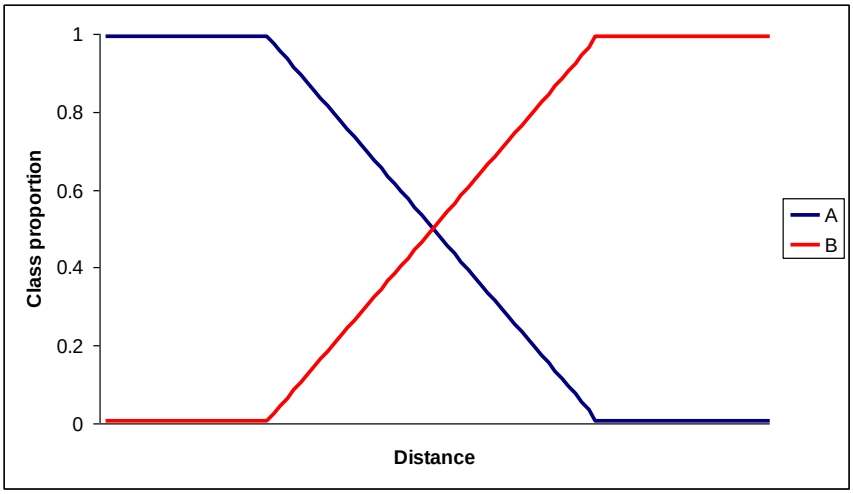

Figure 7Simplistic example of an ecotone with 2 classes, A and B.

The form of mapping where a point can only belong to one class is called 'hard' mapping. Not only does hard mapping not represent the uncertainty in the interpreters mind, it does not necessarily represent reality. If, when an interpreter maps a boundary, that boundary is contained within an ecotone, one could interpret the map to be correct. However, it is unlikely that two interpreters will map the boundary in the same way, i.e. the position of the line through the ecotone will vary (Figure 8b and Figure 8c). This would result in an error when data are compared (Figure 8d).

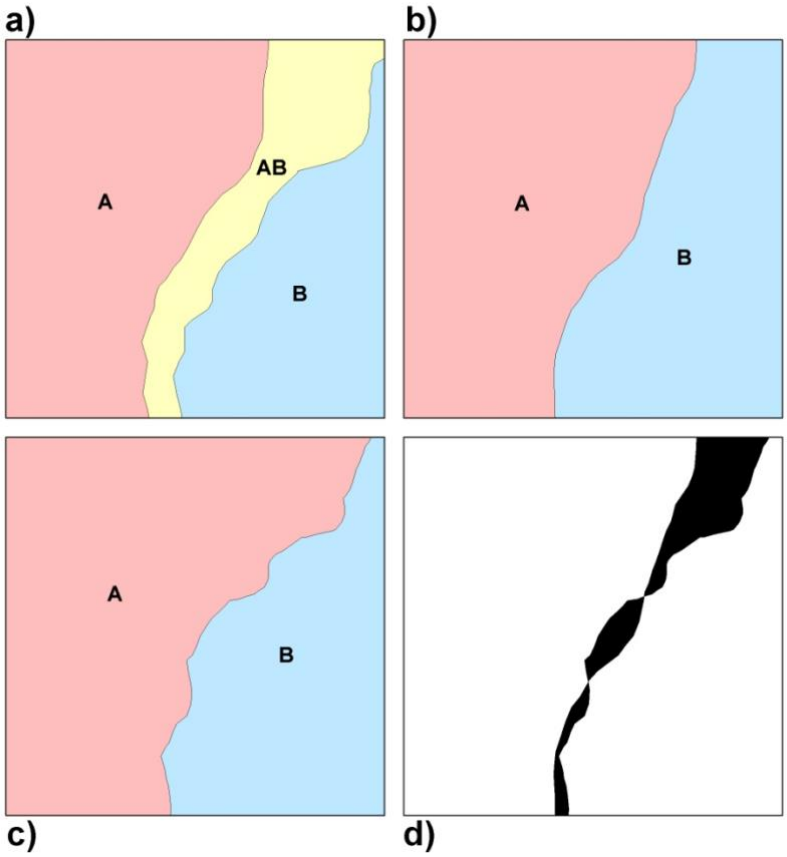

Figure 8Hard interpretations of the same reality. a) Actual ground classes A and B, with ecotone (AB) between them (yellow). b) One photo-interpreter's map. c) Other interpreter's map output. d) Areas of difference between interpretation in black.

To address the issue of uncertainty surrounding photo interpretation an alternative approach to the analysis was undertaken in a subset of the Humber estuary. In this approach known as 'soft' or 'fuzzy' mapping, points where there was low confidence in the classification may be assigned to more than one class. Soft mapping will allow mapping of areas of uncertainty and ecotones and will reduce errors when change detection is carried out, as errors at boundaries should be reduced. If multiple classes were allowed, then the interpreter uncertainties could be incorporated in the map, as well as effects such as ecotones. This soft approach does have disadvantages:

- It is more complicated to carry out.
- It may take longer to carry out.
- The data could be more difficult for people used to traditional maps to understand and analyse.
- There is also the danger that multiple classes are allocated in a high proportion of areas where there is only a single class present. This may be from an inexperience point of view, or just to get the job done as quickly as possible. In this case the resultant map would be much less use for change detection.

Mapping using a soft approach could greatly increase the interpretation time and complexity if practical issues are not properly considered. Care has to be taken that multiple classes are not used to provide easy way of evading difficult decisions, for example by specifying a maximum percentage of points that are allocated to multiple classes. If large areas that belong to a single class are mapped as belonging to multiple classes, this will reduce the usefulness of the map and the sensitivity of future change analysis.

Assuming that the point method adopted above was used, multiple classes could be allocated to points in uncertain areas or in ecotones (Figure 9). If required this approach could be used to generate the most likely class. For future change detection, points where the classes allocated are completely different would have a high certainty of change. Points where some, but not all, of the classes were different would have a low certainty of change (Figure 9.d). These areas may be a focus for potential field surveys in following years.

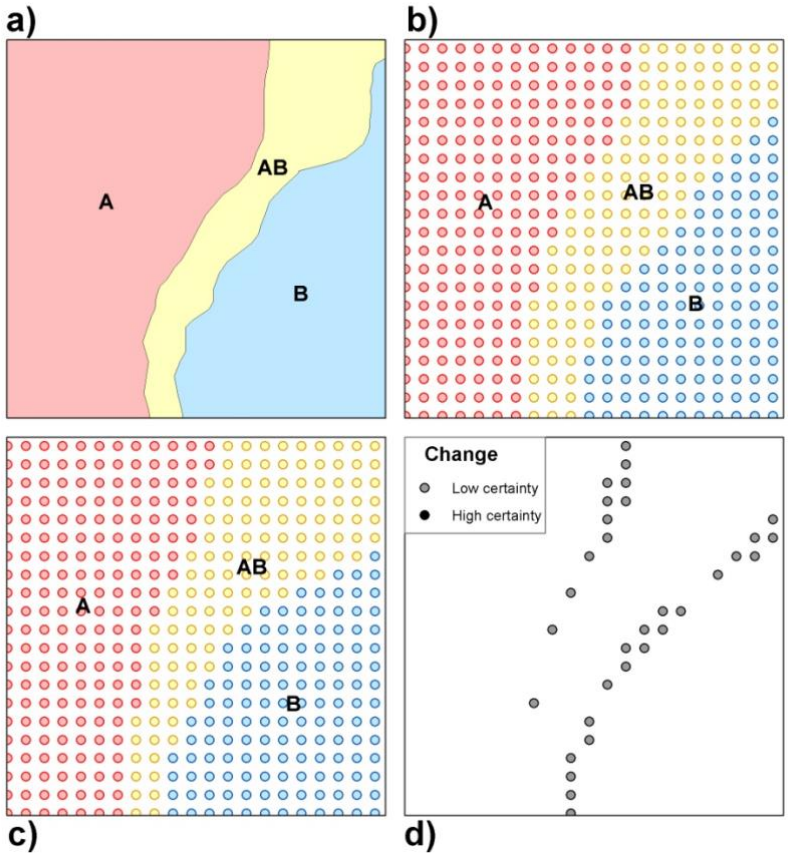

Figure 9Soft point interpretations of the same reality. a) Actual ground classes A and B, with ecotone between them (yellow). b) One photo-interpreter's map with ecotone. c) Other interpreter's map output with ecotone. d) Areas of difference between interpretations. All the points of predicted change are assumed to be uncertain (grey points).

Comparisons were made between the two interpretations using all possible combinations of the alternative classifications to detect matches (Table 4). In this preliminary test it was possible to reduce differences in interpretation from 13.5% to 3.3%. This is a large reduction in error, which has the potential to greatly reduce errors when change analysis is applied in the future.

Levels of agreement	Logical statement of agreement	Percentage of points consistently classified
1	Matches where: Interpreter 1 first choice = Interpreter 2 first choice	**86.5%**
2	Matches where: Interpreter 1 first choice = Interpreter 2 first choice OR	**96.4%**
	Matches where: Interpreter 1 first choice = Interpreter 2 second choice OR	
	Matches where: Interpreter 1 second choice = Interpreter 2 first choice	
3	Matches where: Interpreter 1 first choice = Interpreter 2 first choice OR	**96.7%**
	Matches where: Interpreter 1 first choice = Interpreter 2 second choice OR	
	Matches where: Interpreter 1 second choice = Interpreter 2 first choice OR	
	Matches where: Interpreter 1 second choice = Interpreter 2 second choice	

Table 4 Showing different levels of agreement according to different matching criteria when introducing an alternative class in areas of least certainty.

Further work needs to be carried out on this to understand the impacts of the work, both in terms of mapping saltmarsh and mapping saltmarsh change. Issues that should be examined include:

- The maximum number of alternative classes. In this brief study only two classes were considered, but there is potential to have more. However, the maximum number of classes for a single point will have impacts on accuracy, sensitivity of analysis and time taken.
- How would the work be carried out? Would the current tools being used be adequate or appropriate for this soft approach to interpretation?
- What are the impacts on time of interpretation? This is likely to be a function of the complexity of the area, the interpreter's experience and the number of classes allowed at a single point.

This is an approach that could be used in the roll out to provide the end user with more information about the limitations of aerial photography interpretation. It would clearly take more time to complete the mapping exercise than providing just a hard classification, but it is important that the data are used appropriately and understood by the end user rather than regarding the interpreted work as an absolute truth.

An alternative approach of providing a measure of uncertainty which would probably be even more robust is to have multiple interpreters, allowing the interpretation to be repeated once or twice, although this is probably impractical. In this way every area would be assigned a class multiple times. In points where there is a match in all of the interpretations, there would be strongest confidence in the output data, and in areas where there was no match there would be least confidence in the output. These areas could be flagged up and treated with caution when analysing the data further.

Remapping and uncertainty

In future years where repeat mapping has taken place, areas which show change could be scrutinized by the current year interpreter to assess whether real change is taking place or whether the change is due to misinterpretation. In those areas where it is likely to be due to misinterpretation, the original classification may be edited to the more appropriate class.

It is not anticipated that the workflow for including the uncertainty element to the mapping would be prohibitively time consuming. In areas where there is doubt, the interpreter would assign most likely class to the points, then digitize a polygon around those points to flag them up for revisiting later in the mapping exercise, possibly once more experience has been gained about that waterbody, or once the area is not at the front of the interpreters mind. When revisiting the polygons, the interpreter would assign a single alternative class. This exercise doubles up as a stage in the QA process too.

When re-mapping is undertaken, those areas where there is any class assignment overlap either between first choice classes and alternative classes could then be ignored as being unlikely candidates for actual significant change, More likely is that they are change due to either misclassification or ecotone boundary interpretation.

Ground data for Zonation work

As time goes on a database is being built up of transect and transition samples on saltmarshes throughout England and Wales. Part of this ground data acquisition is driven by some of the uncertainty of classification described in the section above.

This ground database can be used to enhance and validate the existing zonation maps and to inform future classifications as new aerial photography data becomes available.

What has been mapped so far?

Saltmarsh extent

All of the saltmarshes in England and Wales have been mapped since 2007. This has been undertaken by the Environment Agency (largely for Anglian, North East, North West and Welsh Regions) and by external contractor for Channel Coastal Observatory (CCO) for South East and South West Regions. In addition, many water bodies have been mapped using a second round of Aerial photography by the Environment Agency (Figure 10)

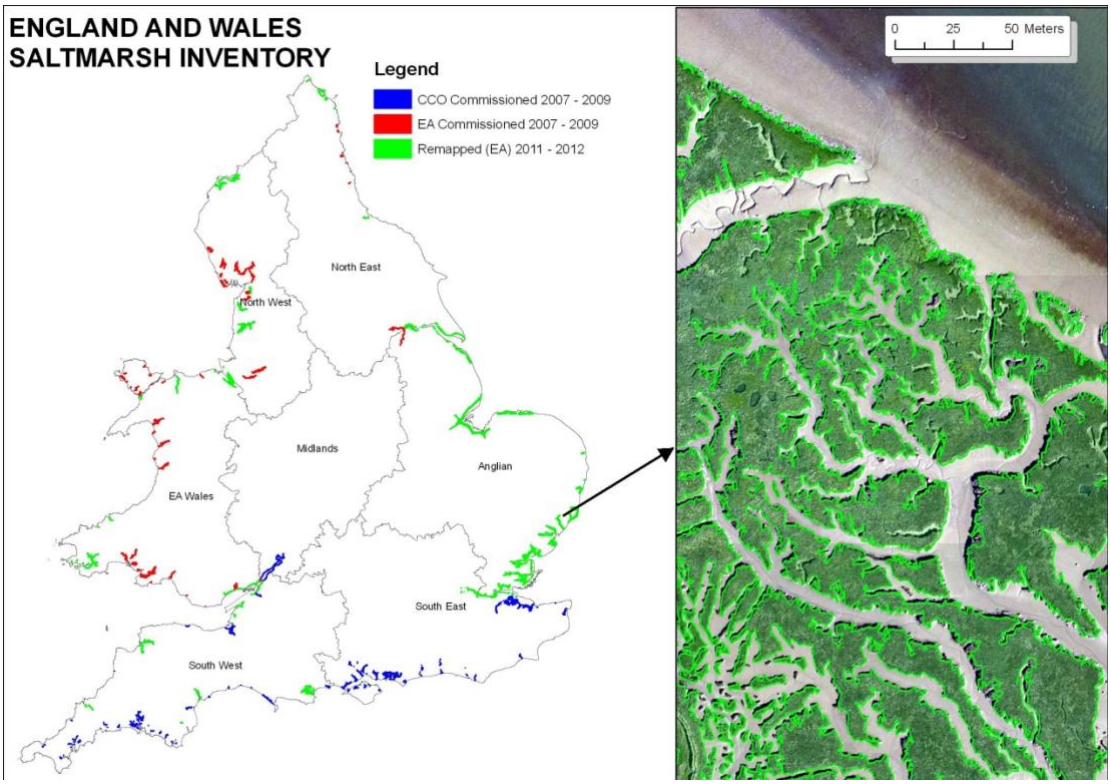

Figure 10 showing the spatial distribution of saltmarsh in England and Wales and how it has been mapped. The CCO commissioned data were largely mapped by manual digitization and the EA commissioned mapping by semi-automated techniques. The image on the right shows a section of saltmarsh to give an idea of the level of detail it has been mapped to.

Saltmarsh Zonation

The mapping undertaken for saltmarsh zonation in the Environment Agency has largely been driven by Water Framework Directive Surveillance water body requirements. This is reflected in Figure 11 which also shows the areas so far mapped for Natural England using the same technique as that used for the Environment Agency mapping. It should also be noted that a different classification system has also been used in the South East, and South West regions in non-Surveillance water bodies which delineates (not the point method described above) different IHS zones.

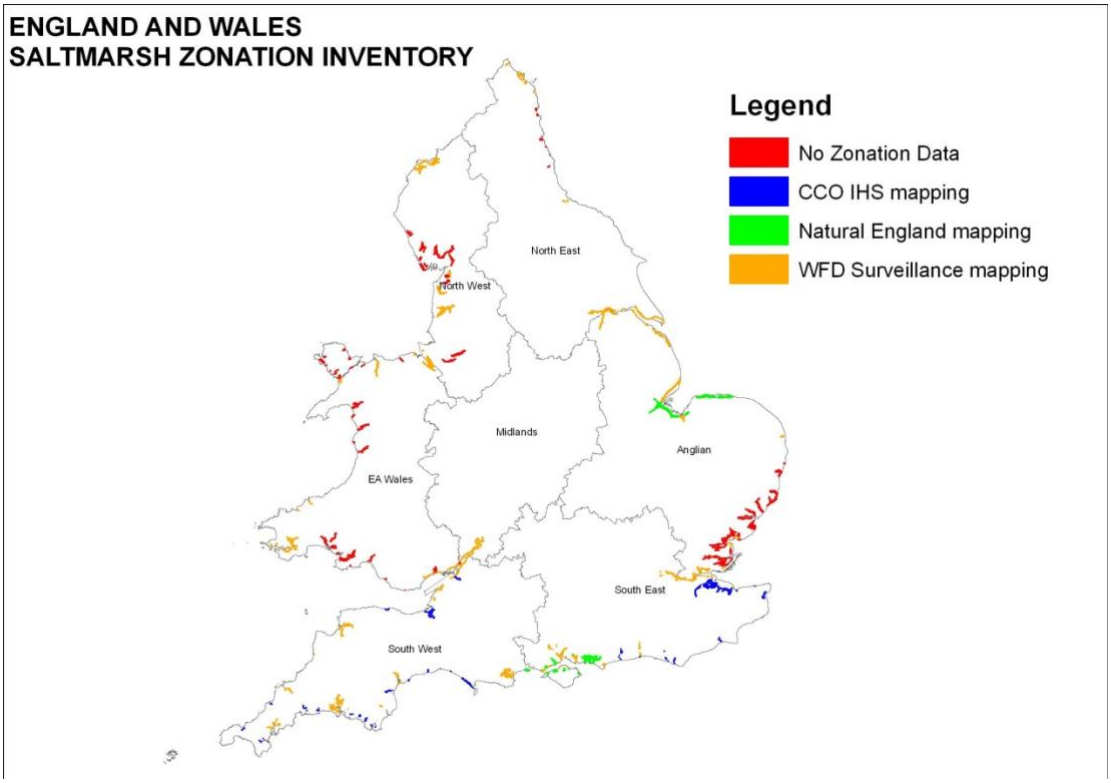

Figure 11 Showing the distribution of Zonation mapping around England and Wales