Recent investigations into the marine migration of salmon smolts in the context of marine renewable development

Scottish Government
Riaghaltas na h-Alba
gov.scot

Redacted, **Marine Scotland Science**

with acknowledgements to many other parties

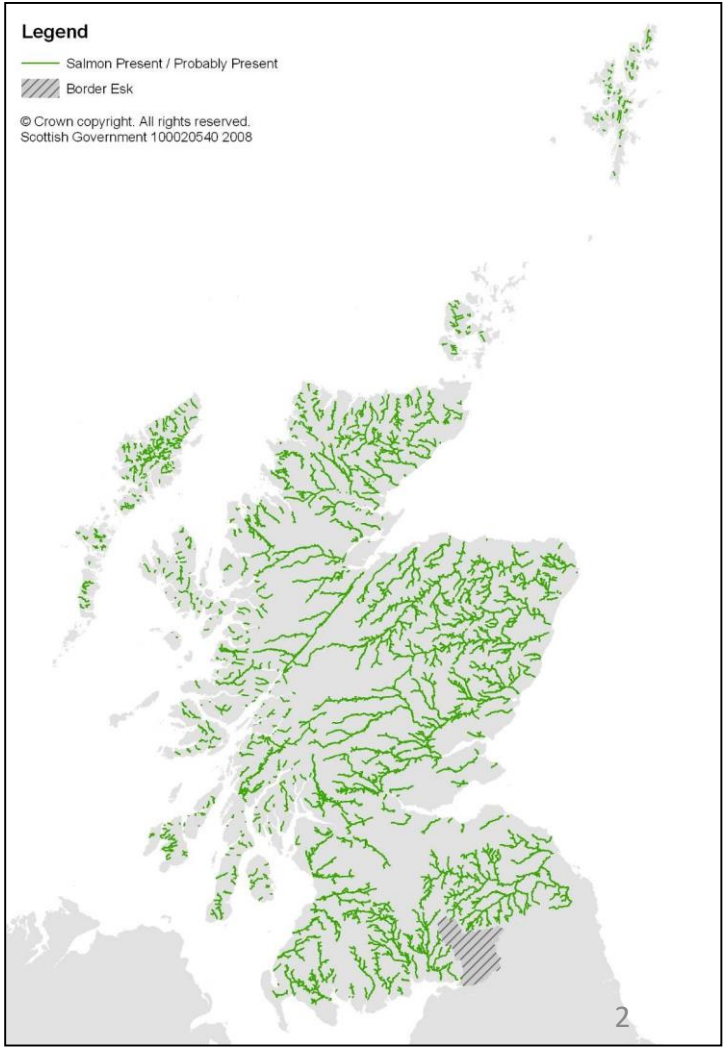
Scotland's International Marine Conference, Glasgow, 20-21 February 2019

INTERNATIONAL YEAR OF THE SALMON

marine scotland science

Salmon – a key species to protect

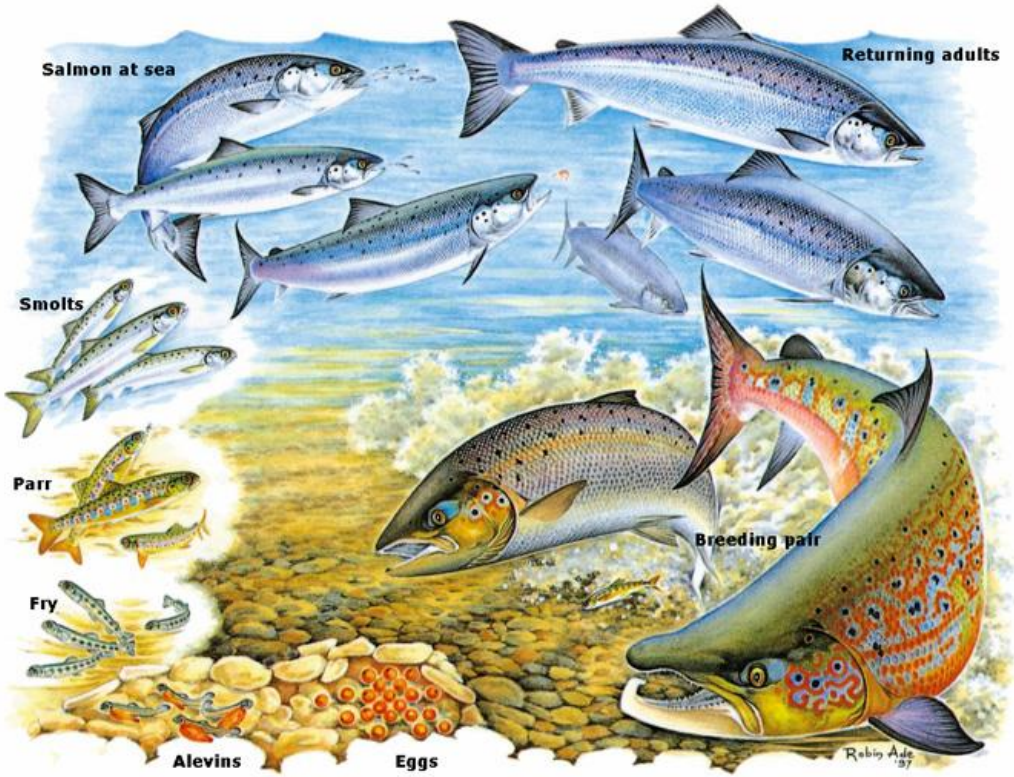
- Scotland is a stronghold of salmon
- Obligations to protect from adverse impacts



Routes taken by salmon at sea

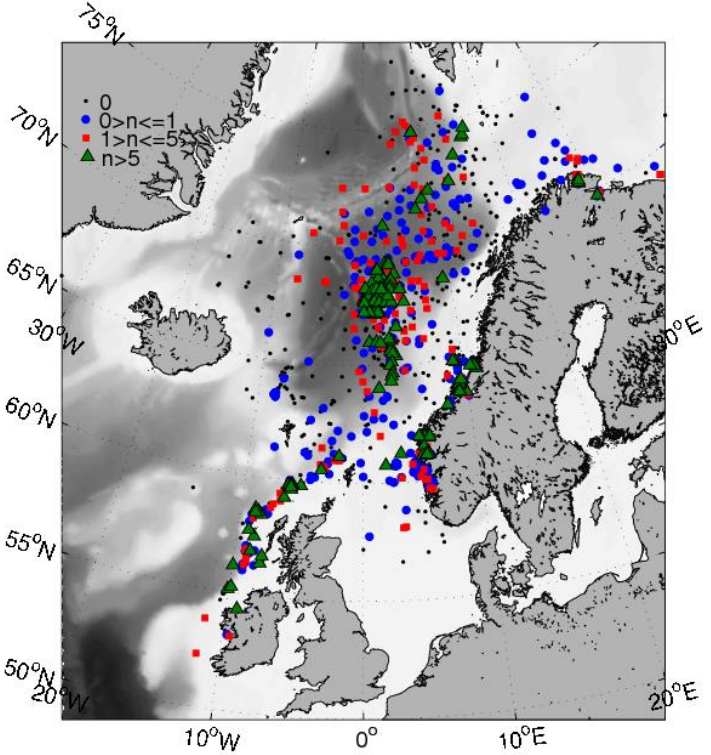
- Sea feeding areas discovered in the 1960s off Greenland and the Faroes

- Initially, no information on what routes are taken by salmon smolts to reach these areas



Salsea-Merge Project 2008-2012

- In 1990s, methodology was developed for catching salmon smolts at sea using near surface trawling.
- International project Salsea-Merge established by trawling in 2008-2012 that the Norwegian Sea is an important staging area.
- Many smolts were found to migrate along the line of the continental shelf edge in the Slope Current

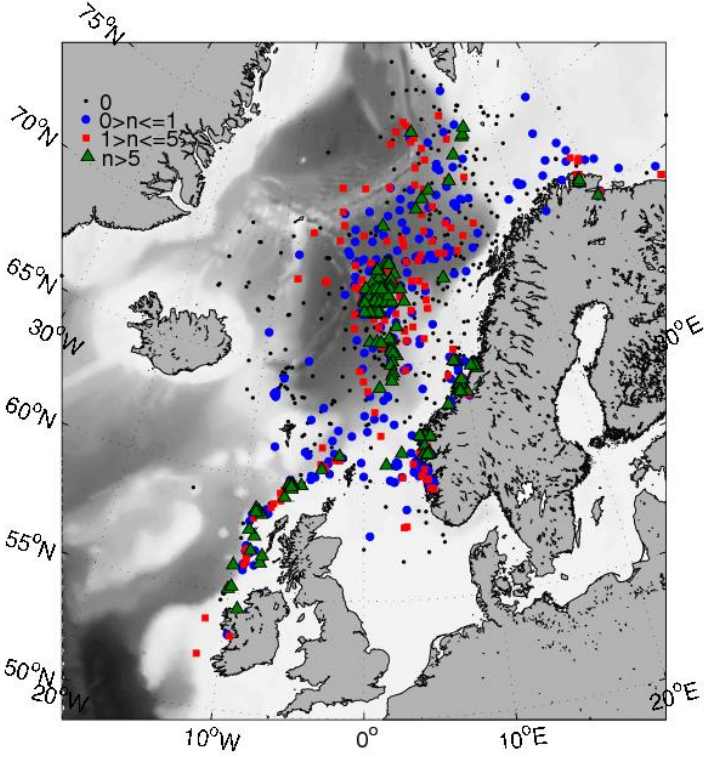


Scottish east coast

No information for the Scottish east coast, where most of the marine renewables developments are taking place.

Two main hypotheses

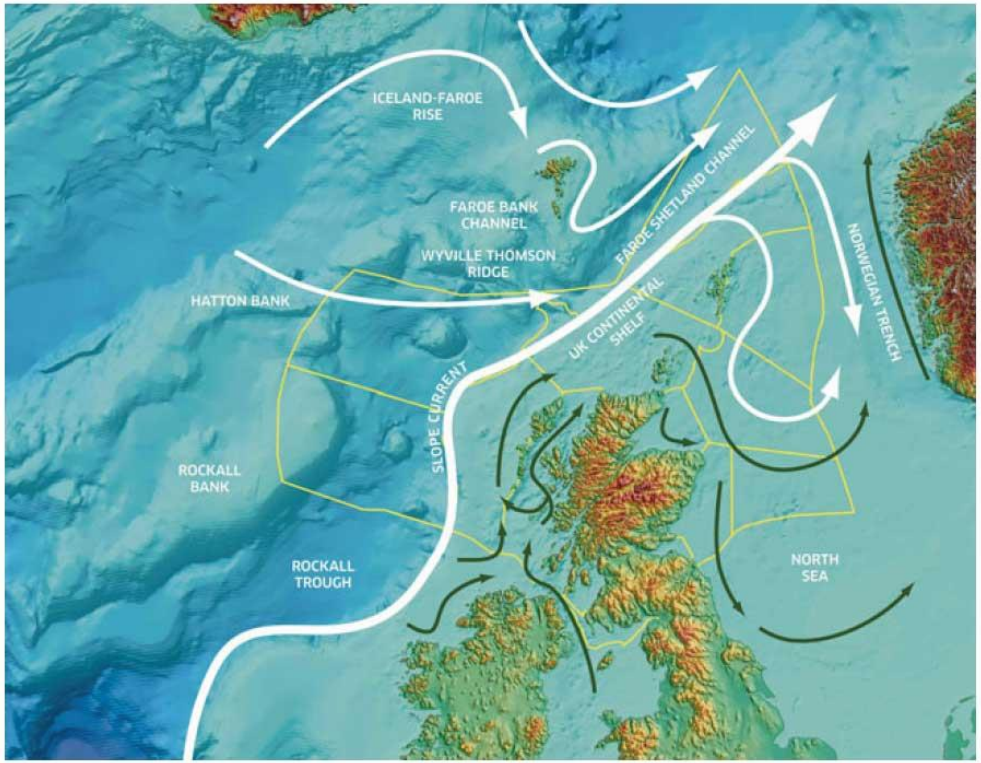
1. That smolts approximately follow the coast north, then head north west to feed into Slope Current route
2. That smolts cross the North Sea, then head north.



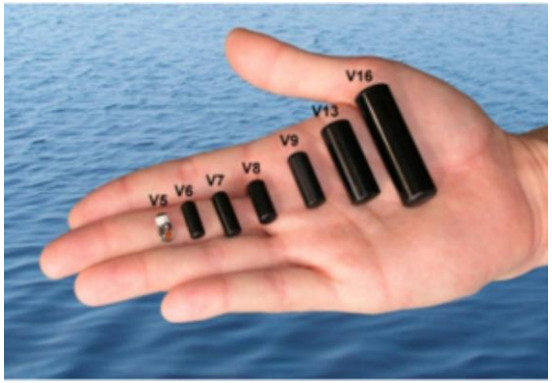
Main currents and the two hypotheses

- Smolts directly crossing the North Sea and following the Norwegian Coastal Current north is the more energetically efficient option

- Since 2016, information to test the two hypotheses has been getting obtained by acoustic tracking and by trawling for smolts



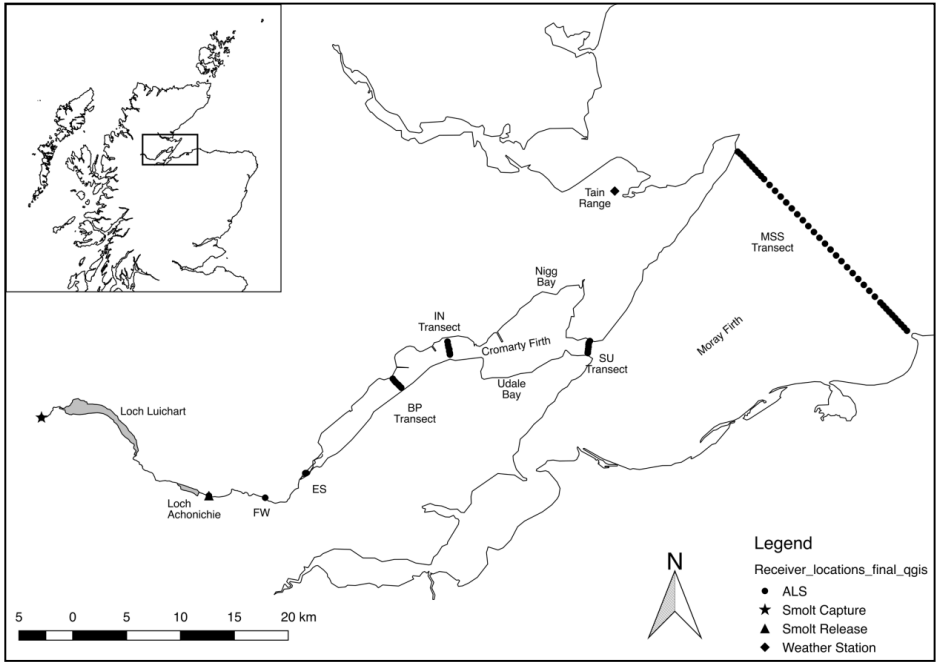
Acoustic tracking



Smolts are tagged in rivers, then detected at sea by arrays of acoustic receivers

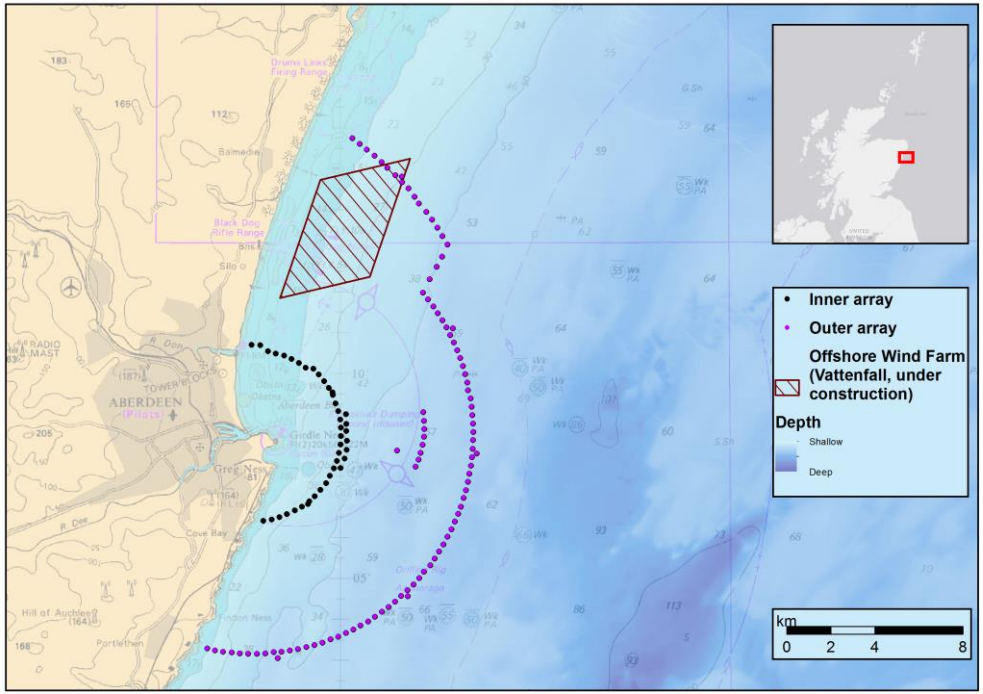
Acoustic tracking in 2016 in the Moray Firth

- Beatrice Offshore Wind Ltd / University of Glasgow / MSS
- Smolts migrated quickly through the outer Cromarty Firth and inner Moray Firth
- The majority of the smolts crossed the MSS curtain close to the southern shore
- Smolts were heading east and not following the coast north
- Not following local water currents



Acoustic tracking in 2017 and 2018

- 2017 MSS - River Dee Trust. Single receiver curtain at 4 km
- 2018 MSS - River Dee Trust, sponsored by Vattenfall. Additional curtain at 10 km (1st year of 3y project)
- Results again showing that smolts are heading out across the North Sea and not following the coast north
- Again, rapid movement out.



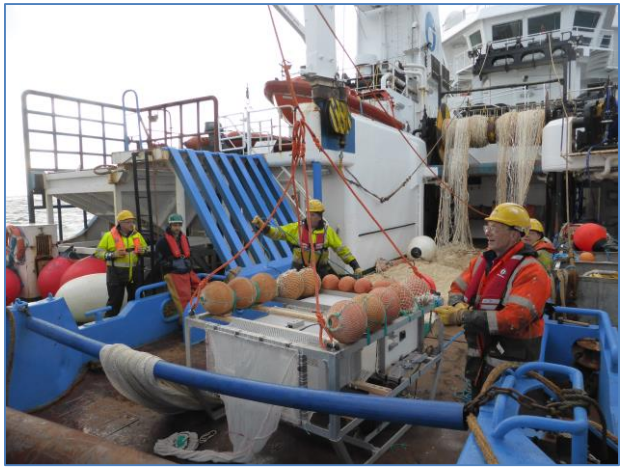
2018 - array layout at mouth of River Dee

Smolt trawling in 2017 and 2018

- MSS
- Large net towed at over 3 knots close to the surface
- Powerful vessel needed - 2017 our research vessel Scotia; 2018 chartered commercial pelagic trawler Sunbeam
- Camera and PIT tag detector box
- Net can be used open ended just with the camera / PIT tag detector box or with a cod end also attached to retain fish
- Samples taken for genetic assignment to rivers or regions of origin

Trawling from Scotia

MRV SCOTIA



GEAR GETTING PREPARED FOR LAUNCH

NET BEING SHOT

Trawling from Scotia

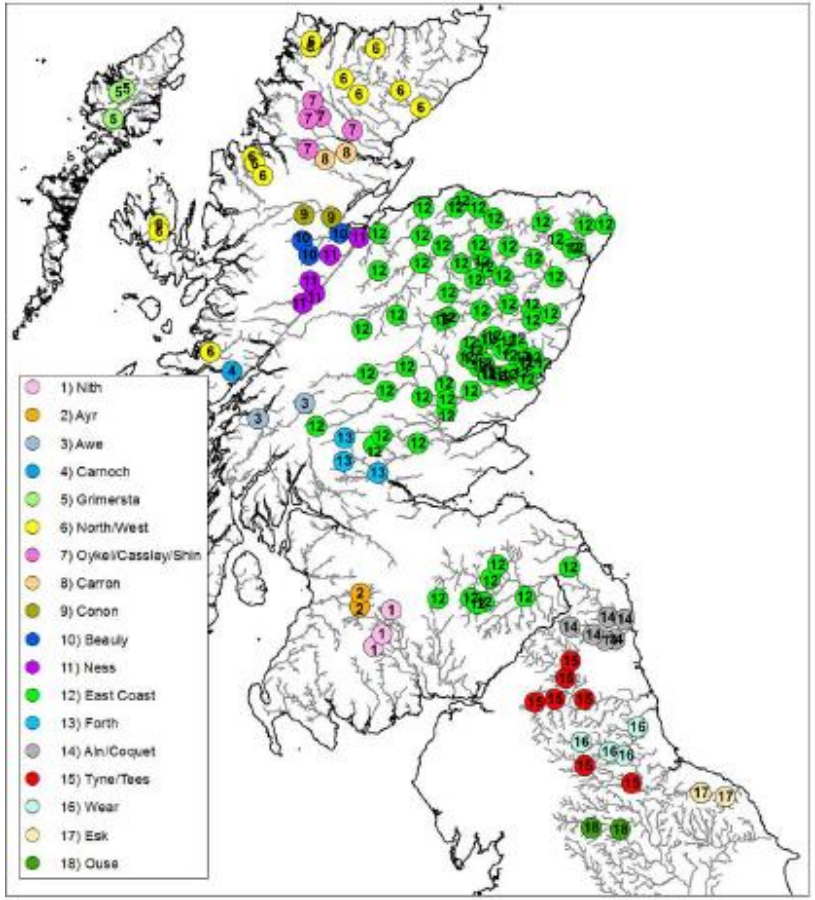
NET GETTING LIFTED, CAMERA GEAR TO THE LEFT OF FRAME, PIT TAG DETECTOR TO THE RIGHT

CHECKING THE RECORDINGS – TWO SALMON SMOLTS VISIBLE

Genetic Assignment

- Genetics work carried out by MSS colleagues.

- Sampled smolts assigned by genetics tools developed by MSS colleagues to rivers or regions of origin as in the map.



Smolt trawling in 2017 and 2018

- 2017 - Moray Firth

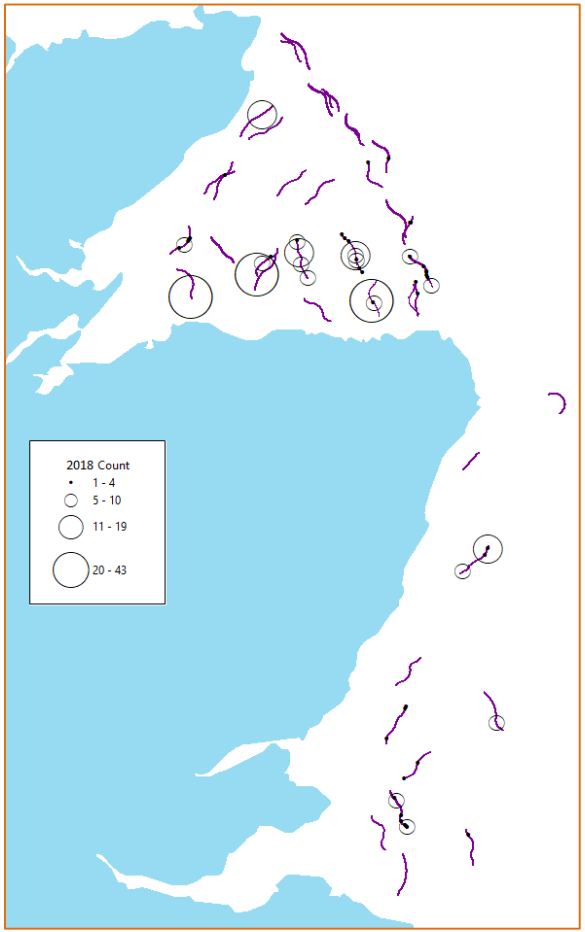
- 2018 - two periods of trawling in the Moray Firth plus a period of trawling off the east coast.

- In the Moray Firth, many smolts move out in an approximately eastward band through the southern part of the firth

- Supports hypothesis that the smolts are heading directly across the North Sea.

- The double sampling in 2018 shows that the smolts move quickly across the firth

- Genetics assignments



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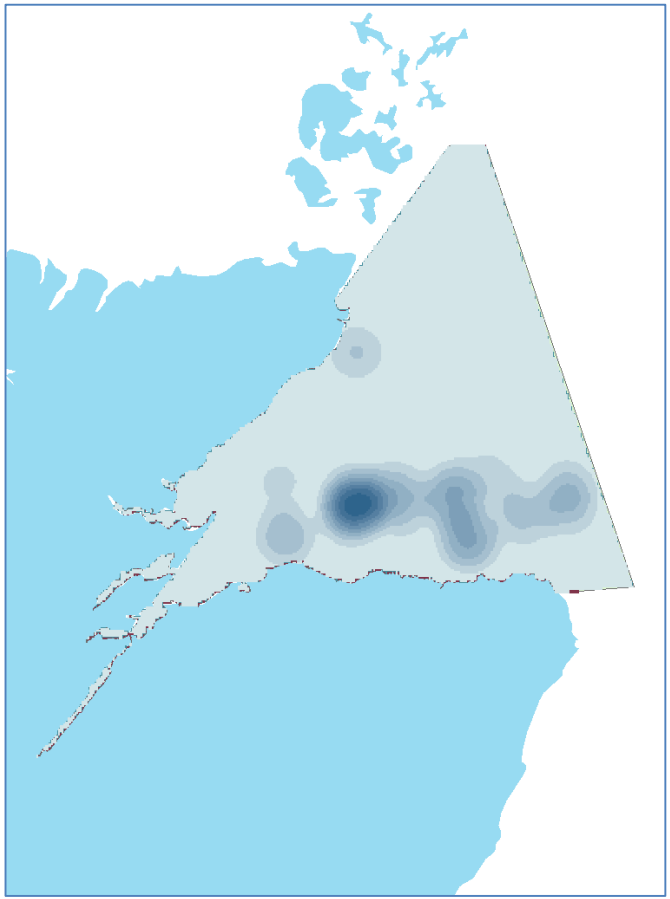

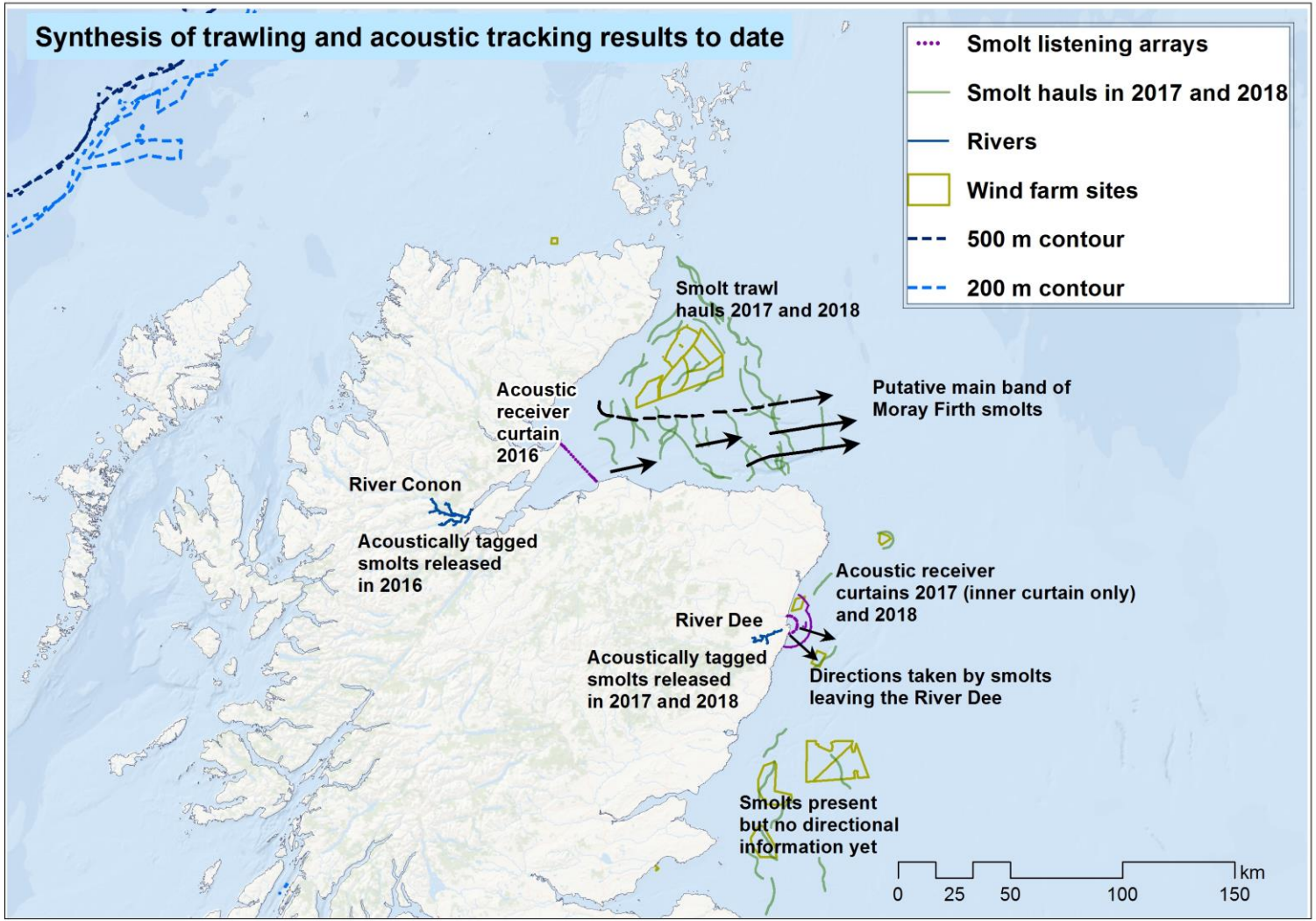
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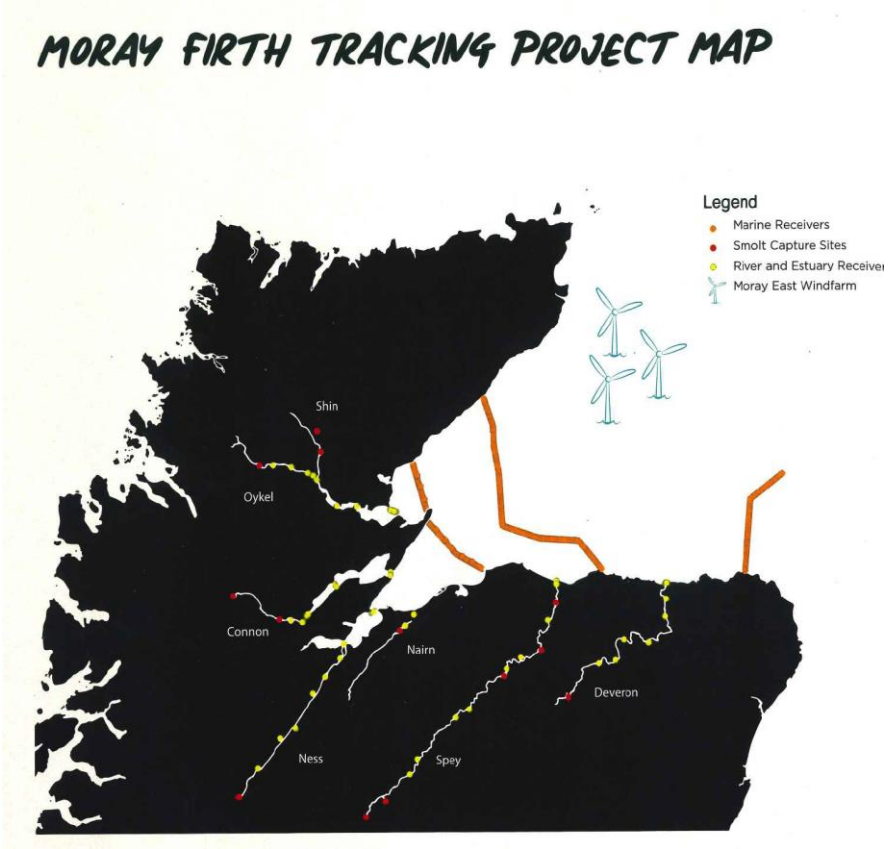
Smolts present but no directional information yet
0
25
50
100
150
km

Studies which will be taking place in 2019

- Further acoustic tracking of salmon (and sea trout) smolts leaving the River Dee.
- Further trawl work
- A very ambitious Moray Firth Acoustic Receiver Array project led by the Atlantic Salmon Trust with tagging in several rivers



Summary

- Migration routes of salmon smolts out from Scottish rivers were investigated by
  - Acoustic tagging
  - Trawling
  - Genetic tools

- The acoustic arrays produce detailed information for the study rivers over the full migration period.

- Trawling just provides snapshots in time, but over more extensive areas.

- Data obtained to date by these methods is showing that smolts move quickly and directly away from the coast

- Information is key to better understanding and managing potential impacts from human activities

Acknowledgements

Many thanks to all the parties who contributed to the success of the work outlined, including within Marine Scotland Science,

Redacted

and many others

Netting to investigate smolt passage through the coastal zone

Scottish Government
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Marine Scotland Science

Fisheries Management Scotland Annual Conference, Edinburgh, 28 March 2019

INTERNATIONAL YEAR OF THE SALMON

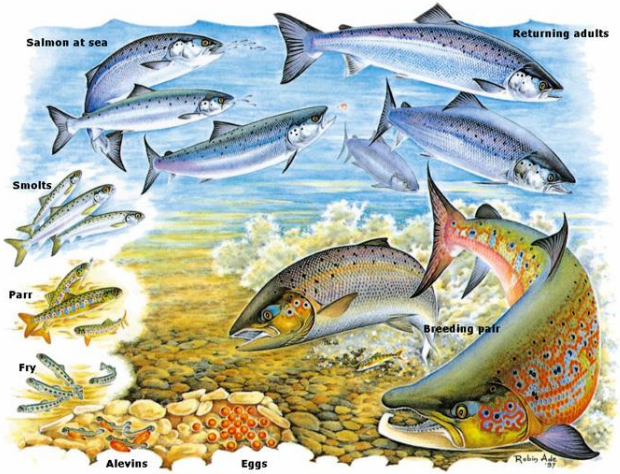
marinescotland science

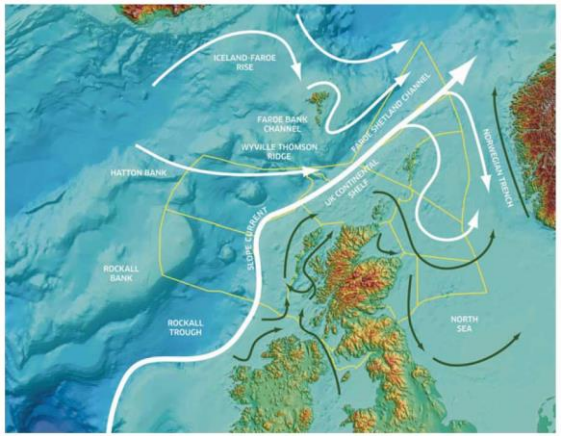
Salmon – risk assessment

- Need to know the routes salmon smolts use to cross the coastal zone to get to the sea feeding areas.

- Already known that Norwegian Sea is an important staging area and that many smolts migrate along the current on the continental shelf edge to get there.

- But no information for smolts leaving the Scottish east coast, where marine renewables developments are taking place.





Recent smolt trawling by MSS

- Large net towed at over 3 knots close to the surface
- Net can be used open ended just with cameras and PIT tag detector or with a cod end also attached
- Samples can be taken for genetic assignment to rivers or regions of origin

2017 MSS research vessel Scotia


2018 commercial pelagic trawler Sunbeam


Lifting net, camera gear and PIT detector


Gear getting prepared for launch


Net being shot

Checking the recordings, two salmon smolts visible

Smolt trawling in 2017 and 2018

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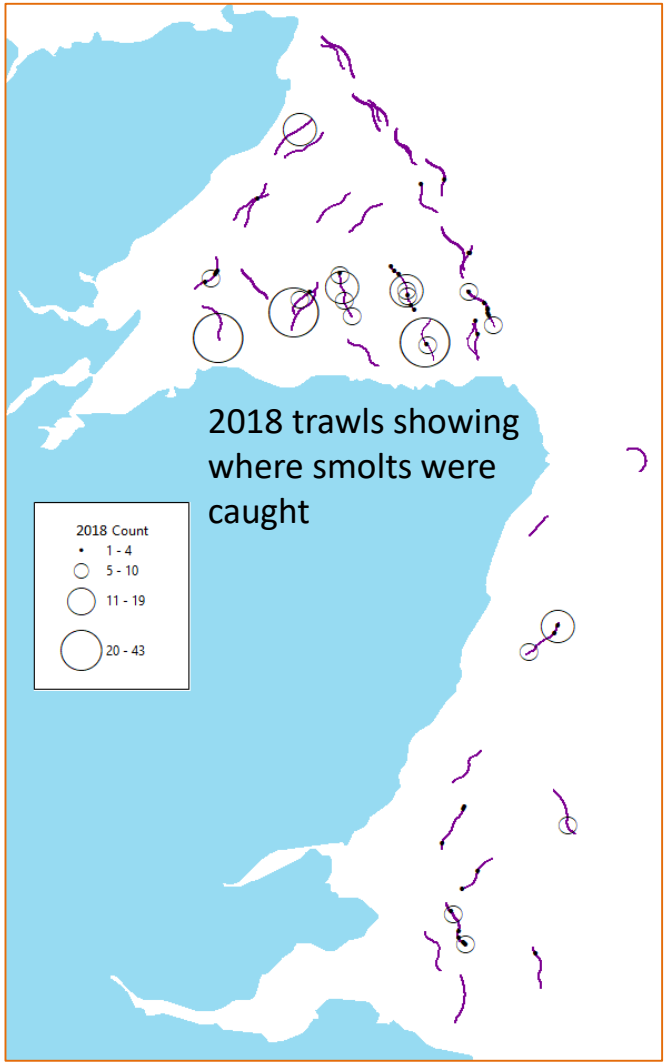
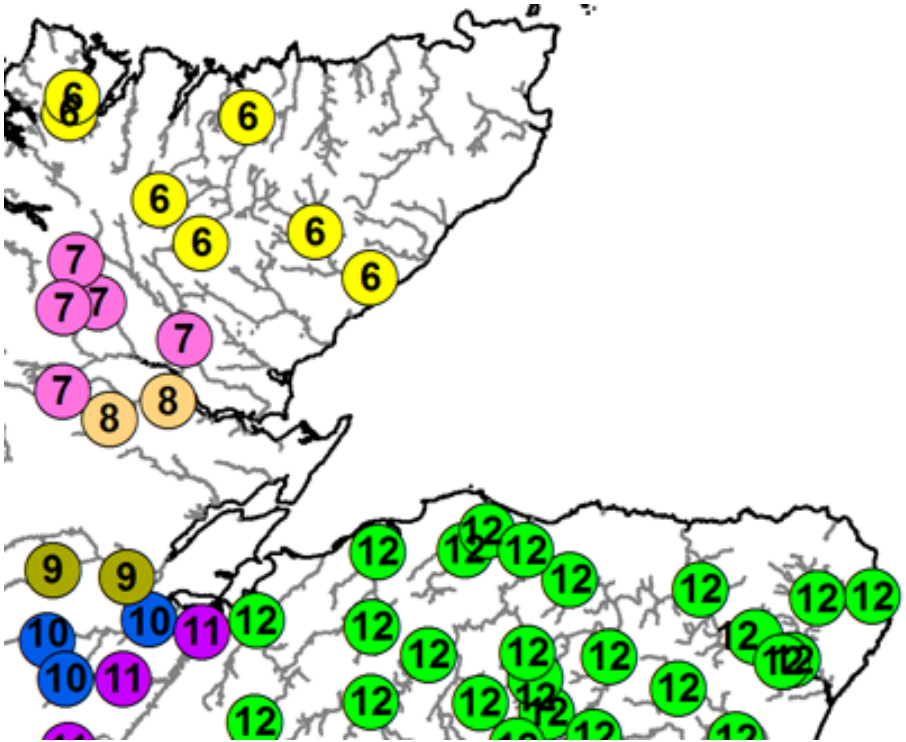
- In the Moray Firth, many smolts move out in an approximately eastward band through the southern part of the firth

- The double sampling in 2018 showed that the smolts moved very quickly across the firth

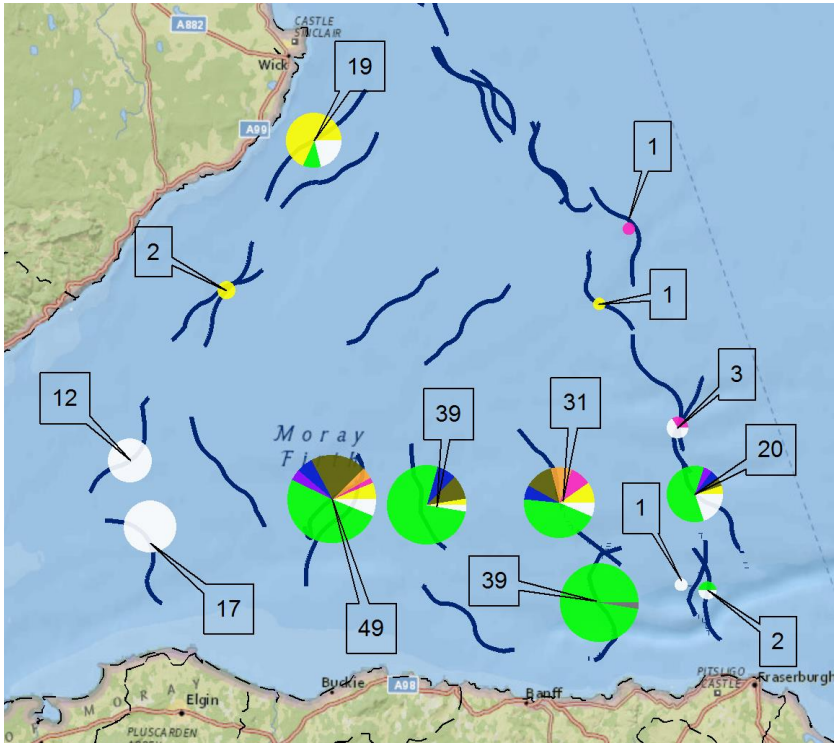


Genetic Assignment

- Sampled smolts assigned genetically to rivers or regions of origin by MSS colleagues



How salmon in rivers assign genetically to regions or separate rivers (Gilbey et al, 2016)



Numbers of smolts in trawls in 2018 and split of smolts into not assigned, and into different regions and rivers

Summary

- Information is key to better understanding and managing potential impacts from activities such as marine renewables development

- Trawling provides snapshots in time for smolts over extensive areas, but not the detailed information for particular locations over the whole run, which acoustic tracking can provide.

- Data obtained to date has shown that smolts move quickly and directly away from the coast and can be concentrated, although not tightly, in particular routes

- Genetics tools can identify which regions and in some cases rivers smolts are from.

Acknowledgements

Many thanks to the many people who contributed to the success of this work including from within Marine Scotland Science,

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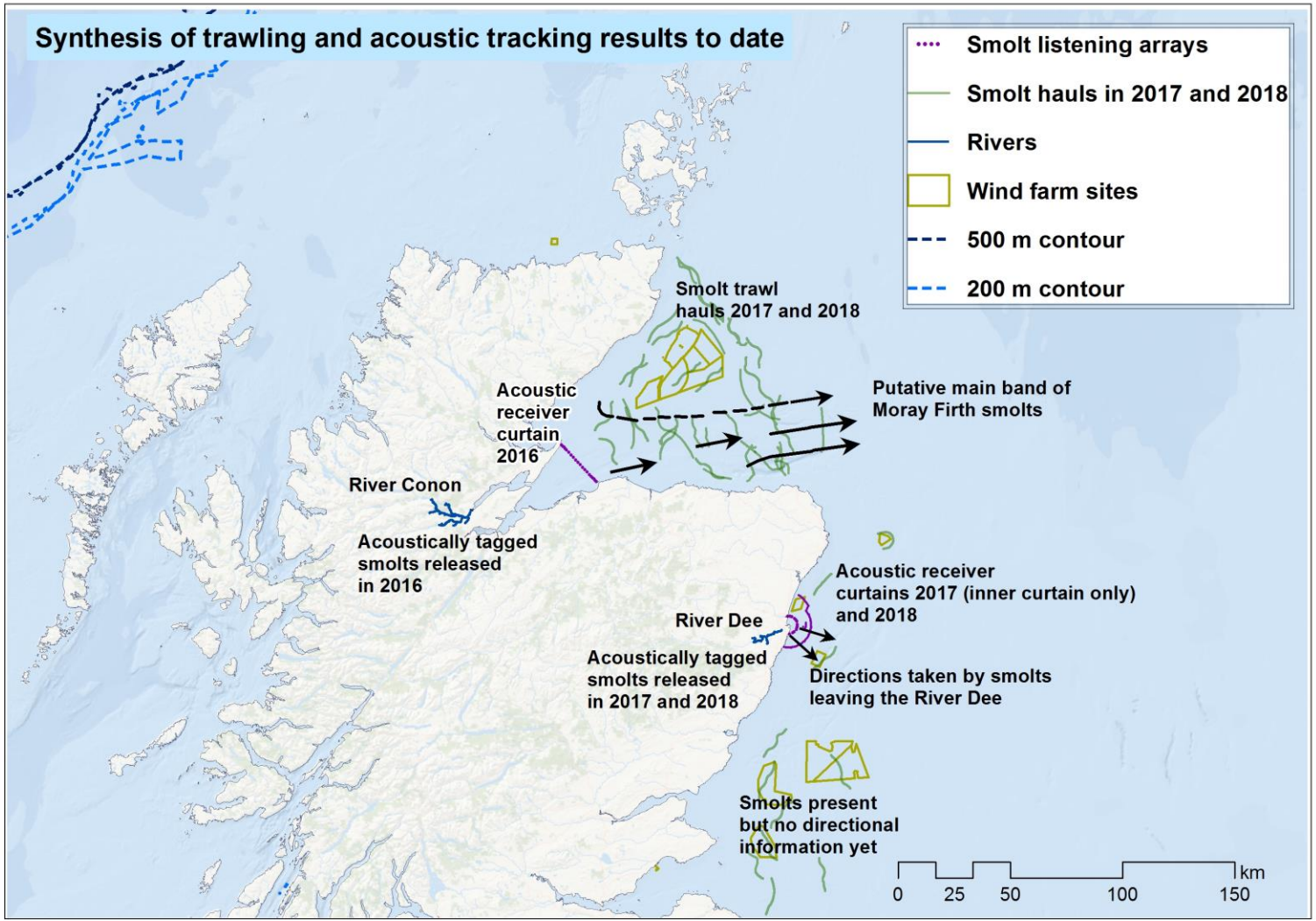
Extra 1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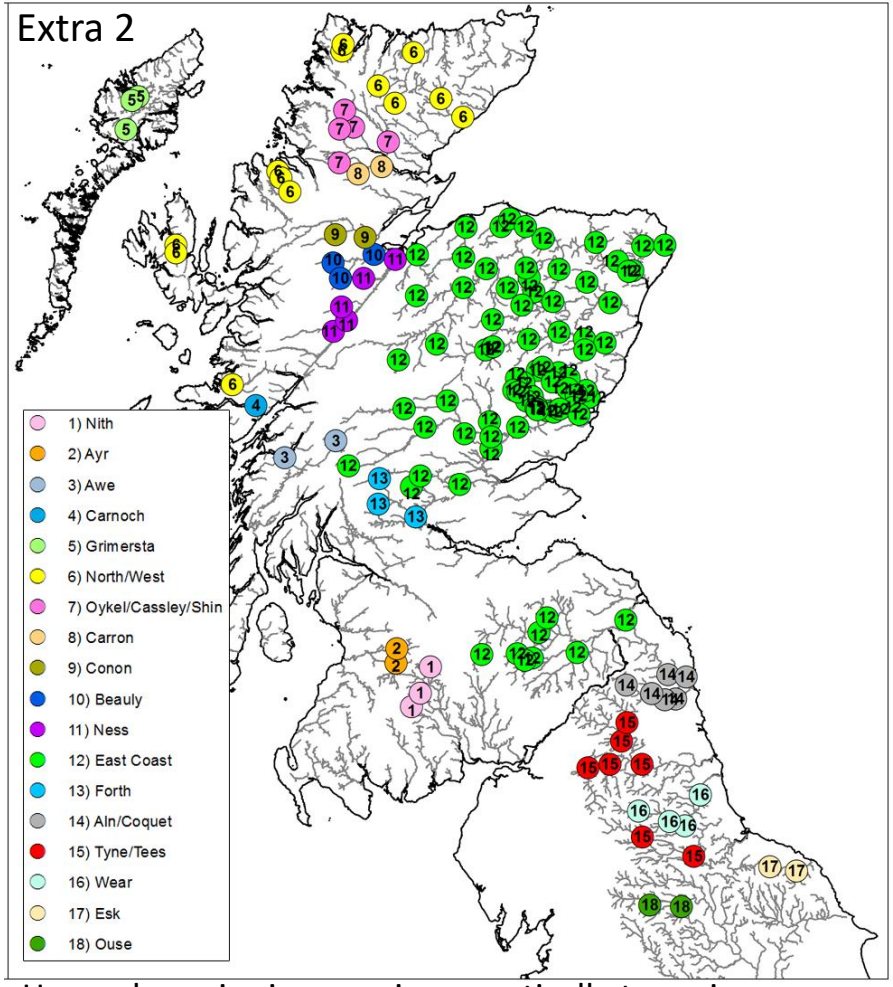
Extra 2



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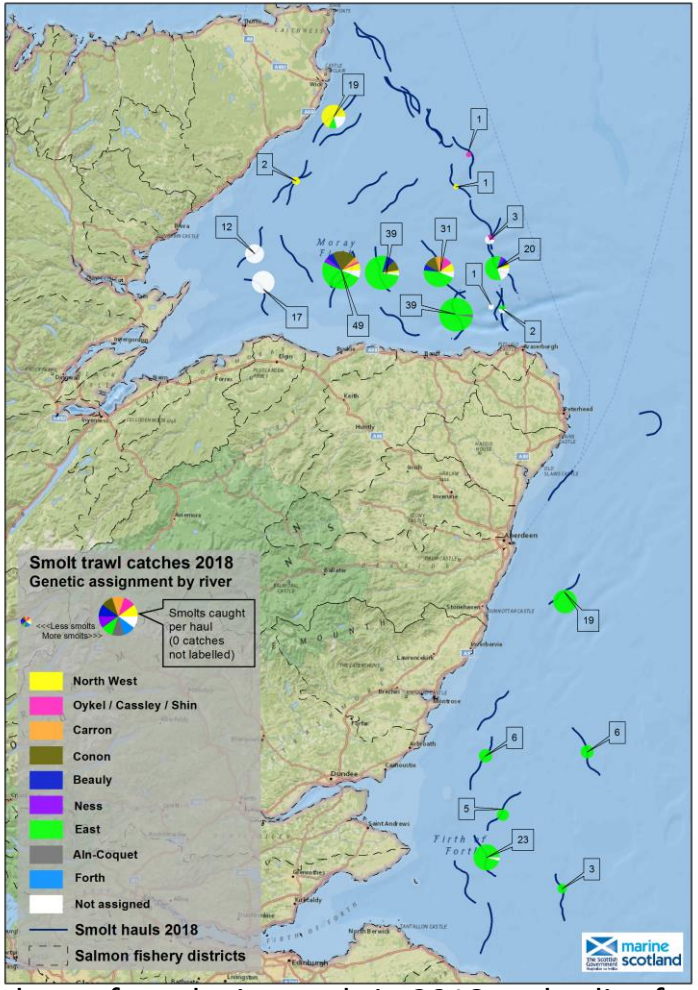

Numbers of smolts in trawls in 2018 and split of smolts into not assigned, and into different regions and rivers

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From: Redacted
Sent: Redacted

bject: onsultation on Wind Farm Piling Strategy ("PS") - by 10/04/2019

Follow Up Flag: Follow up
Flag Status: Completed

Dear Redacte

Thanks for the consultation on the revised post-consent Piling Strategy (PS) for Moray East.

As the PS is a large document, it would have been more helpful if Moray East could have supplied an addendum simply detailing the changes in comparison to what was in the existing PS.

Nonetheless, we have now reviewed the document, but focused on Appendix 1 pg 57 (underwater noise modelling); Appendix 2 pg 94(Piling protocol)plus the addendum to the Moray east OWF piling protocol March 2019 pg 128; Appendix 6 pg 219 (ADD protocol)March 2019 ; Appendix 7 pg 236 (Phased piling mitigation strategy)March 2019.

The changes to the design and construction methods and the underwater noise modelling has all been presented to us previously and, therefore, we are not offering any further advice on these elements here.

The Addendum (pg 128) to the piling strategy details the changes to this protocol based on our advice from last year. This is to reflect learning from BOWL and is intended to maintain pre-piling auditory injury mitigation, but reduce the extended disturbance influence of the ADDs. This protocol reflects our advice.

The main elements are; that the initial ADD deployment is for 5-10 minutes (previously this was 15 minutes): The ADD is deployed at the beginning of the set of three piles, rather than being deployed for each one (as long as these piles are installed in one session): And the duration that governs the redeployment of the ADD has increased from 2.5 hours to 6 hours (to better reflect the HP return time). These measures should hopefully reduce the disturbance impact.

We have no further comments on the Addendum (other than it will be interesting to see if this does indeed result in smaller disturbance distances that we should see from the monitoring programme).

Appendix 6 details the ADD protocol. There doesn't appear to be much change here. They intend to use the same device as BOWL ie. The Lofitech.

We have a question regarding the length of the cable needed for deployment from a jack up barge – is there likely to be any power loss/drain due to the length of the cable itself?

Appendix 7 details the phased piling mitigation strategy. This is essentially the same as we saw for BOWL. The phases involve employing the JNCC mitigation protocol (ie MMO/PAM) phase 1; Phase 2 is employing both the JNCC protocol and the ADD protocol. This is over the same period as for BOWL – ie 28 days.

Also, in keeping with BOWL, these trial phases will not necessarily be conducted at the beginning of the construction period, it will be timed to coincide with the greater likelihood of animals being present, and to align with the MMMP. This is fine.

However, there is one key difference to note between stage 1 and stage 2. In stage 1 (JNCC protocol) the 500m mitigation zone will be monitored and if animals sighted in this zone the piling will be delayed. However, in stage 2, they state that although the 500m zone will be monitored (and any animals noted), piling will only be delayed if an animal is sighted within the 60m injury zone. If the idea here is to look at any added benefit the MMO and PAM bring to the mitigation, it would make sense for both stages to use the same 500m zone. Our thoughts here are that if there is an animal within the 500m mitigation zone during stage 2, then that could suggest the ADD is not working to the same level of precaution, and would signal that there is added benefit to having MMO/PAM mitigation. In practice this might not make any difference in terms of species protection, as we consider the ADD will do the intended job. However, this point requires further clarification.

We hope these comments are helpful.

Kind regards

Redacted

From: Redacted
Sen
Redacted

ltation on Wind Farm Piling Strategy ("PS") - by 10/04/2019

ELECTRICITY ACT 1989

The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017

MARINE (SCOTLAND) ACT 2010 & MARINE AND COASTAL ACCESS ACT 2009, PART 4 MARINE LICENSING
The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 (as amended)
The Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended)

Dear Sir/Madam,

Moray Offshore Windfarm (East) Limited ("Moray East"), on behalf of Telford Windfarm Limited, Stevenson Windfarm Limited and MacColl Windfarm Limited, having received consent under the above legislation in order to discharge conditions of their Section 36 consents (as varied), have submitted to MS-LOT a revision to the post-consent Piling Strategy ("PS").

Please find enclosed the proposed Version 3 of the PS. The purpose of the PS is to satisfy the requirements of condition 11 of Moray East's Section 36 consents (as varied) awarded to Telford Windfarm Limited, Stevenson Windfarm Limited and MacColl Windfarm Limited on the 19 March 2014 (varied on 22 March 2018).

The Decision Letter and Conditions, as well as other relevant documents, can be found on our website, following the link below:
http://www.gov.scot/Topics/marine/Licensing/marine/scoping/Moray3

The conditions state that the plan is to be submitted to the Scottish Ministers for their written approval, following consultation with SNH and any such other advisors as may be required at the discretion of the Scottish Ministers. Any updates or amendments made to the PS by the Company must be submitted, in writing, by the Company to the Scottish Ministers for their written approval.

We would appreciate any comments you may have on the proposed Version 3 of the PS, in order to determine whether it is fit for purpose for the Scottish Ministers to give it their written approval. Please note that we do not seek comments on the Consent, the Marine Licence nor on the conditions, which will not be amended.

If you wish to submit any comments, please send to MS.MarineRenewables@gov.scot before **10 April 2019.**

Yours Faithfully

Redacted

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Tha am post-d seo (agus faidhle neo ceanglan còmhla ris) dhan neach neo luchd-ainmichte a-mhàin. Chan eil e ceadaichte a chleachdadh ann an dòigh sam bith, a' toirt a-steach còraichean, foillseachadh neo sgaoileadh, gun chead. Ma 's e is gun d'fhuair sibh seo gun fhiosd', bu choir cur às dhan phost-d agus lethbhreac sam bith air an t-siostam agaibh agus fios a leigeil chun neach a sgaoil am post-d gun dàil.
Dh'fhaodadh gum bi teachdaireachd sam bith bho Riaghaltas na h-Alba air a chlàradh neo air a sgrùdadh airson dearbhadh gu bheil an siostam ag obair gu h-èifeachdach neo airson adhbhar laghail eile. Dh'fhaodadh nach eil beachdan anns a' phost-d seo co-ionann ri beachdan Riaghaltas na h-Alba.
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mearachd, cuiribh fios dhan manaidsear-siostaim no neach-sgrìobhaidh.

Thoiribh an aire airson adhbharan gnothaich, ‘s dòcha gun tèid sùil a chumail air puist-dealain a’ tighinn a-steach agus a’ dol a-mach bho SNH.

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marinescotland science

T: +44 (0)131 244 2500
MS_Renewables@gov.scot

The Scottish Government

Redacted
Licensing Operations Team
Marine Scotland
375 Victoria Road
Aberdeen
AB11 9DB

MORAY OFFSHORE WIND FARM (EAST): PILING STRATEGY: UPDATE FOR REVIEW - PILING STRATEGY

Marine Scotland Science has reviewed the submitted and has provided the following comments.

marine mammals
MSS have reviewed the Moray East revised post-consent piling strategy and the associated appendices. MSS acknowledge that the addendum to the piling strategy does reflect learning from BOWL and has incorporated the updated advice from SNH, in regard to the use of ADDs for marine mammal mitigation during pile driving.

MSS note that the underwater noise assessments for marine mammals were done using the Southall et al. (2007) criteria (Appendix 1). MSS acknowledge that at the time of the report, the NOAA criteria were not finalised. MS-LOT are aware that the NOAA (2016, 2018) criteria have been used in recent assessments for several other wind farm developments. MSS acknowledge that Moray East was consented under the assessment using the Southall et al. (2007) criteria; however, relevant to the injury zone for high-frequency cetaceans (harbour porpoise), the NOAA (2018) criteria are more precautionary and therefore, if assessed under NOAA, the injury zone would be greater. From work conducted by Cefas for MS, in a report that will be published imminently, Cefas compared the two criteria and several activities, including pile driving. From this work, indicatively for Moray East, the injury zone is not likely to be significantly greater (than 60 m) and would most likely be within the 500 m mitigation zone (if this project were re-assessed using the NOAA (2018) criteria). Consequently, using current best scientific knowledge and applying the precautionary principle, MSS suggest that the mitigation zone during the phased piling is maintained at 500 m throughout (as opposed to reducing the mitigation zone to the injury zone of 60 m). Given what has been learnt from BOWL, MSS expect that the mitigation measures in place will result in few if any marine mammals occurring within the 500 m mitigation zone prior to the commencement of pile driving.

Comments relating to Appendix 7:
Sections 2.6.2, 3.5.1 and 3.6 suggest that the duration of ADD use could extend beyond 25 minutes in certain situations. MSS suggest that MS-LOT seek clarification on the likelihood of ADD use extending beyond 10 minutes. Should circumstances dictate the recommended 10 minutes (as per SNH advice) are to be extended, MSS suggest that this is clearly outlined in the addendum and is explicitly noted as part of the requirements for reporting to MS-LOT (Section 6).

In Section 2.6.2, it is unclear how the distance of a cetacean from the pile is to be calculated from PAM. MSS note the method applied for this calculation is provided as a footnote later in the Appendix, on page 21; this should be in the main body of the text. The footnote acknowledges that exact distances are not possible, stating that ground-truthing (matching sightings to vocalisation detections during daytime) will be used to estimate this. MSS agree that exact distances are not possible to achieve with this technique, in addition, the sample size for ground-truthing will be low, and the accuracy of this technique will depend on several factors, including environmental conditions and animal behaviour. However, as noted above, given what has been learnt from BOWL, MSS expect that the mitigation measures in place will result in few if any marine mammals

within the 500 m mitigation zone. Therefore, MSS are content that, any inaccuracy with respect to this technique poses little risk in regard to potential injury to cetaceans.

Section 3.1: Box 1 summarises the key differences from Stage 1 mitigation. The text here, and in places throughout confuse the monitoring and the mitigation zones once the injury zone is phased in. MSS recommend that the text is made explicitly clear with respect to when the 500 m zone is used for mitigation or for monitoring.

marine fish ecology
The marine fish aspect contained within this version (version 3) of the piling strategy does not appear to vary from that of the previous version. As such, MSS have no further comment to make.

Comments made on version 2:
MSS is content with the Piling Strategy with regards marine fish species. The document addresses the requirements of consent conditions for species of concern and incorporates the relevant mitigation related to piling, as identified within the ES and during consultation on the application and supporting information.

Section 3.5.1.1 relates to potential seasonal restrictions for herring, the requirement of which will be based on herring surveys that MORL has committed to undertake. The document highlights that the details of the scope of surveys and assessment will be presented within the PEMP. MSS look forward to reviewing the PEMP document and any results of the herring survey work.

diadromous fish
Salmon are not as sensitive to piling noise as fish with specialist hearing adaptations. Nonetheless, they are of considerable economic and conservation value, and it is important that the emigrating salmon smolts and returning adult salmon are exposed to as little piling noise as possible as they migrate across the Moray Firth to minimise any potential for injury close to the piling or adverse effects on behaviour further away.

Four sections of this new version of the Piling Strategy are either updated or new: the main document; Appendix 2 Piling Protocol Addendum; Appendix 6 ADD Protocol; and Appendix 7 Phased Piling Mitigation Strategy. Appendix 4 Underwater Noise Modelling – Fish Ecology and Appendix 5 Fish assessment have not been updated.

No specific mitigation was proposed for salmon, partly because of a lack of information on migration routes of emigrating salmon smolts and returning adult salmon in the vicinity of the development and the timing of smolt migration. As a result of new studies which are mentioned in 4.2 of the main report as taking place, although no results are given, information on the migration of smolts across the Moray Firth https://www2.gov.scot/Topics/marine/Licensing/marine/scoping/Beatrice/DFM/cromartyfirthsmolttracking and the timing of this in now becoming available. Some of this has been published or presented at meetings – see https://www2.gov.scot/Topics/marine/Licensing/marine/scoping/Beatrice/DFM/cromartyfirthsmolttracking and the attached pdfs of two recent presentations by MSS.

The results indicate that emigrating smolts move out quickly across the main Moray Firth and that, although some smolts are likely to pass through the development area, the main band of smolts is to the south of this. The results also give information on smolt timing across the firth. In 2017, the smolt netting in the Moray Firth found high numbers of smolts in this main band had reached the mid and outer firth, and probably beyond, on 15 and 16 May. In 2018, only small numbers of smolts were present in this main band in 5-7 May, but smolts had arrived in the main band in the main part of the firth in high numbers by 11-15 May, although they had not reached the outer firth in numbers by then. So the results these years indicate that the peak period for smolts in the main part of the firth is around 10-20 May.

Further information will be obtained in this year's smolt run from the Atlantic Salmon Trust's Moray Firth Tracking Project supported by Moray East and from further trawl / genetic assignment of smolts to rivers or regions of origin work by MSS which will improve the available information on the extent to which smolts are likely to cross the development area, and the timing.

Also mentioned in 4.2 of the main report, again without any results being included is the research involving MSS on the effects on salmon of underwater noise generated by piling. This has been published (Harding et al [2016]. Measurement of Hearing in the Atlantic salmon (Salmo salar) using Auditory Evoked Potentials, and effects of Pile Driving Playback on Salmon Behaviour and Physiology. Scottish Marine and Freshwater Science Report Vol 7 No 11) https://www.gov.scot/publications/measurement-hearing-atlantic-salmon-salmo-salar/. The results indicate that salmon may not show immediate avoidance behaviour in the present of piling noise,

although the sound level is greatly above that which they can detect. As such, the soft start which is included as mitigation for effects on fish (3.5.3.4 of the main text) is not likely to be effective for salmon.

The advice of MSS is that there should be further consideration of the above in the strategy. Although the information to date would not indicate the need for any change in the current plans, which are for piling to begin in May 2019, there will be fresh information obtained this year, and if piling looks likely to continue into May 2020, the updated information which will be available by then on smolt movement and timing in the Moray Firth should be used in an updated assessment closer to then for any piling plans for that month.

aquaculture
We have considered the request and have no advice to provide

Hopefully these comments are helpful to you. If you wish to discuss any matters further contact the MSS Renewables in-box at MS_Renewables@gov.scot

Yours sincerely

Redacted

10 April 2019