Salmon in Scottish coastal waters: recent advancements in knowledge in relation to their interactions with marine renewable energy installations

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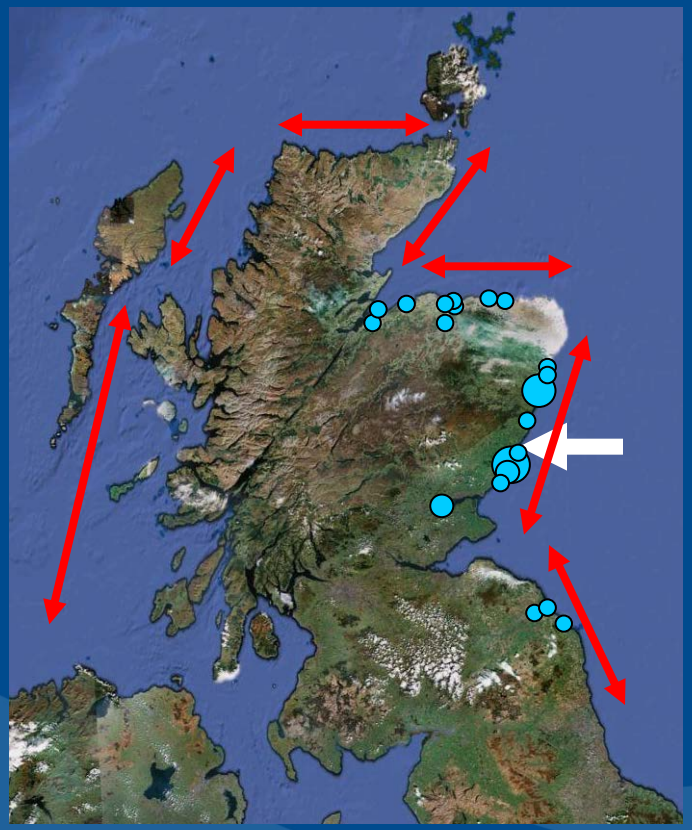
Background

- Scottish Government has set targets for the development of marine renewable energy
- Sustainably? Legal obligations - EU Habitats Directive
- Requirement for information about possible interaction between animals, including migratory fish, and MRE developments
- Atlantic salmon- economic & conservation value
- Starting point is information about spatial overlap between MRE development and fish distributions/routes

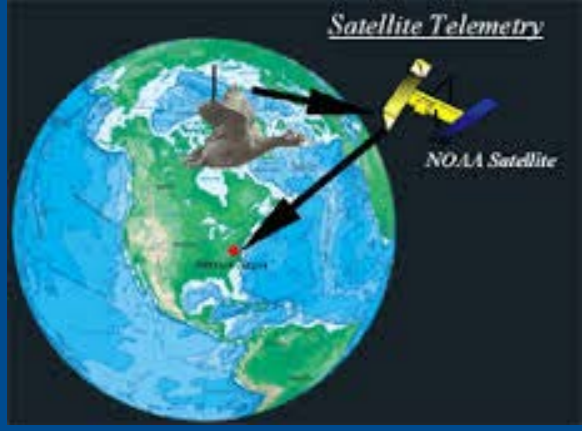
Salmon life cycle

Inshore migration of returning adults

- Adults return throughout the year
  - Highest numbers in summer, but valuable stocks in e.g. spring
- Information through physical tagging
  - Known capture and recapture points
- Overall picture is complex
  - Salmon return to coast
  - Travel to river of origin
  - No consistent patterns of movement
- Limitations of approach
  - Only have start and end points
  - Constrained by location of recapture points

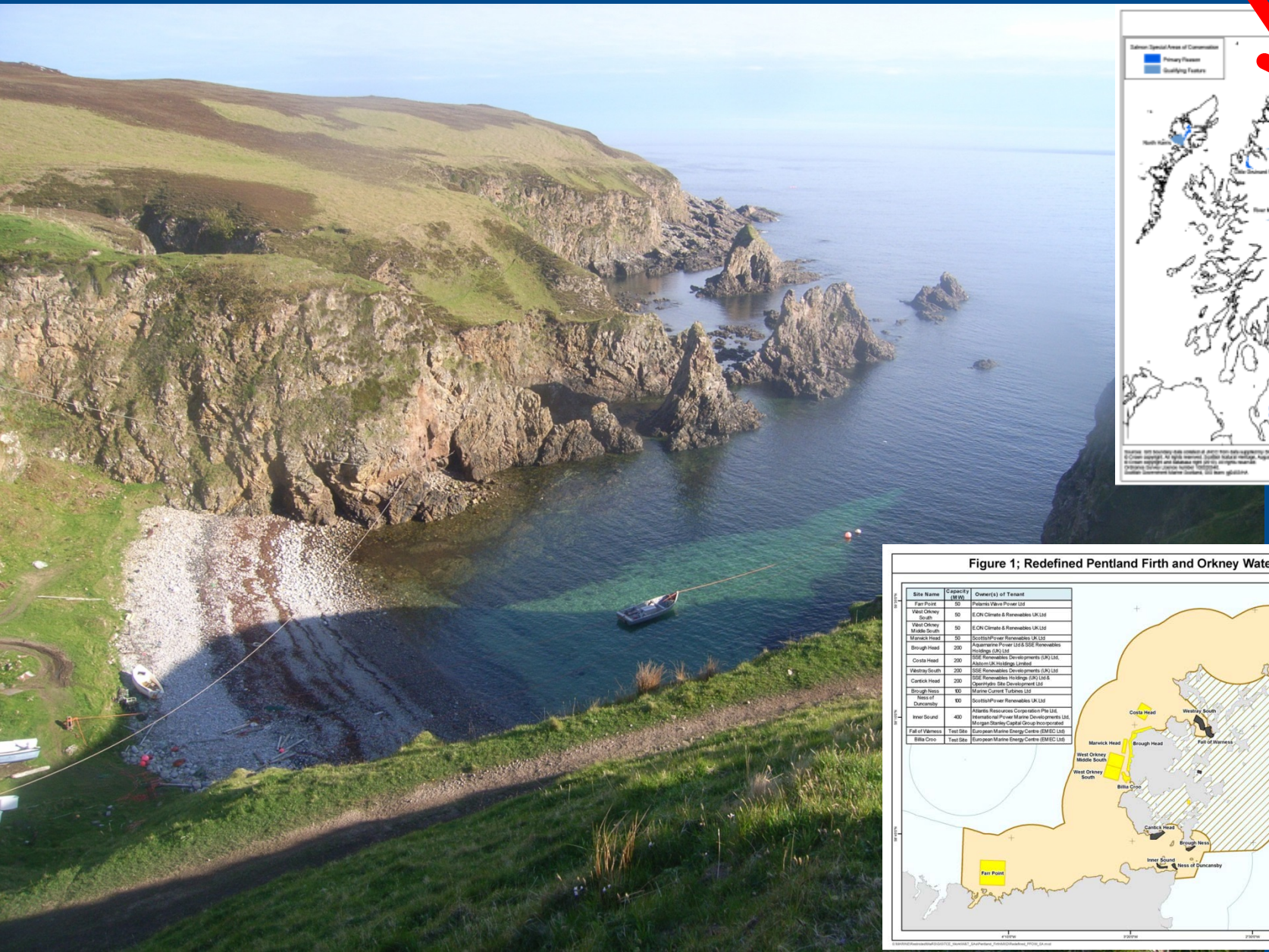


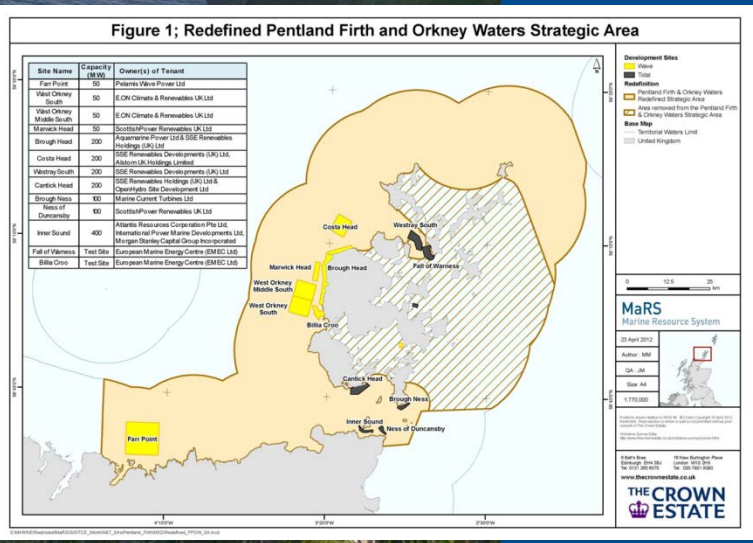
Pop up satellite tags



- Cannot transmit under water
- Record and store depth data during deployment
- Programmed to detach (pop up) from fish after defined period
- Transmit location and upload data via ARGOS satellite network
- Two week battery life after pop-up

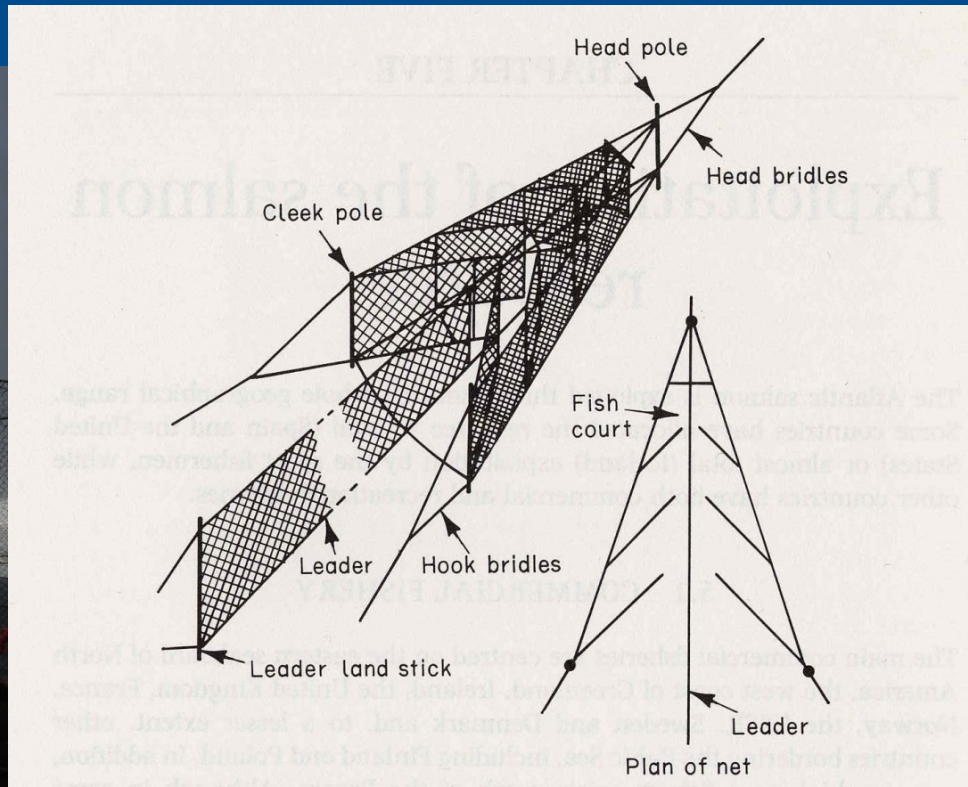
Study site -Armadale





Fish capture and tagging

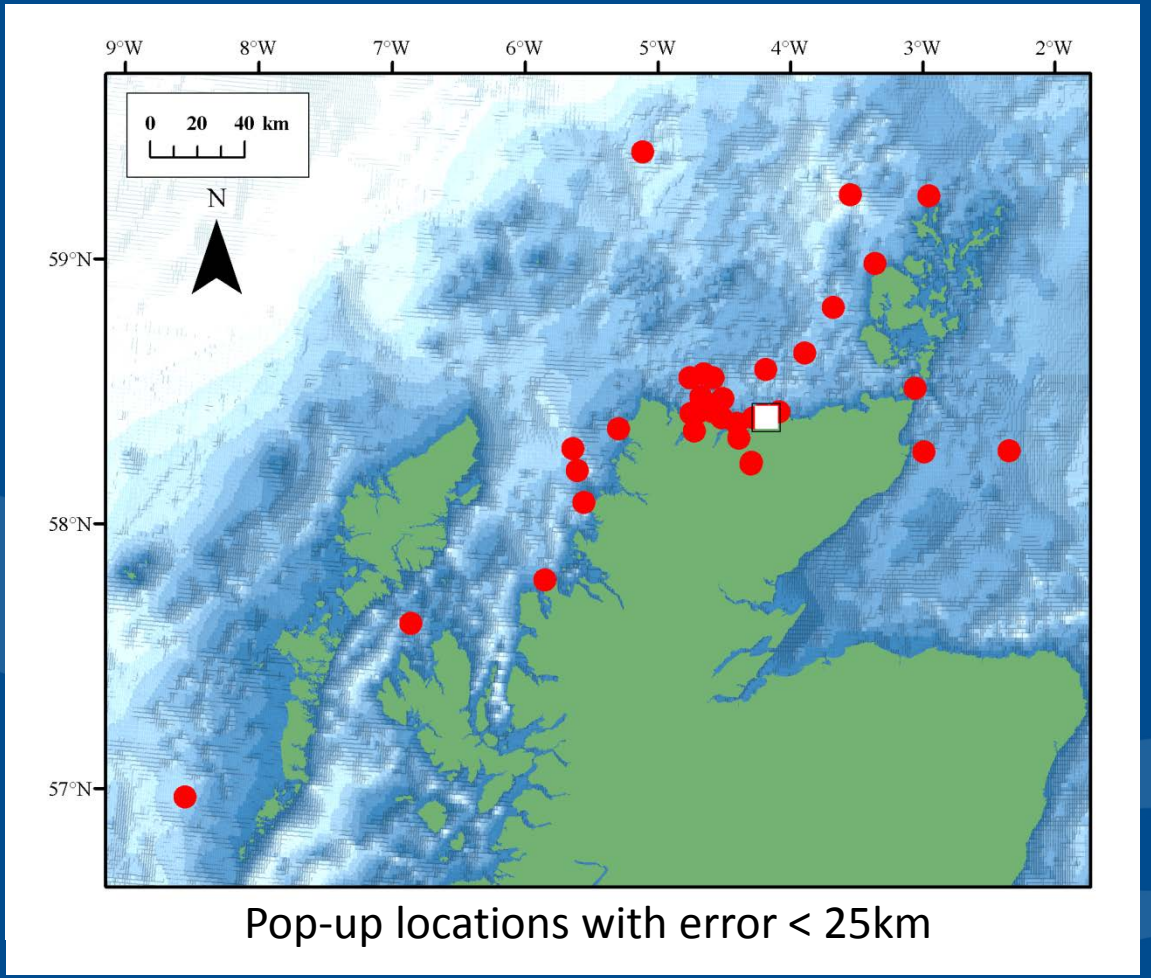
- All tagging on board boat
- 3 minute procedure
- 2 hour recovery period
- 1-10 day deployments
- Tissue sample taken for identification of region of origin



Release of tagged salmon

Pop-up locations

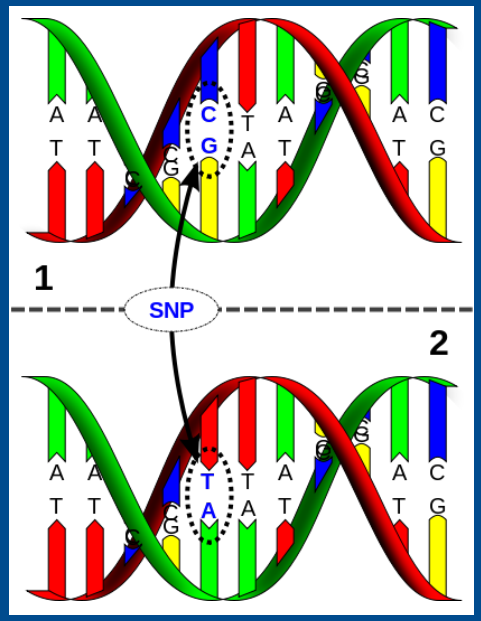
- Are the salmon in a relevant area?
- 44/50 tags reported back a location
- Mainly coastal, but up to 100km of shore
- Daily travel rates up to 55 km/day
- Destination?

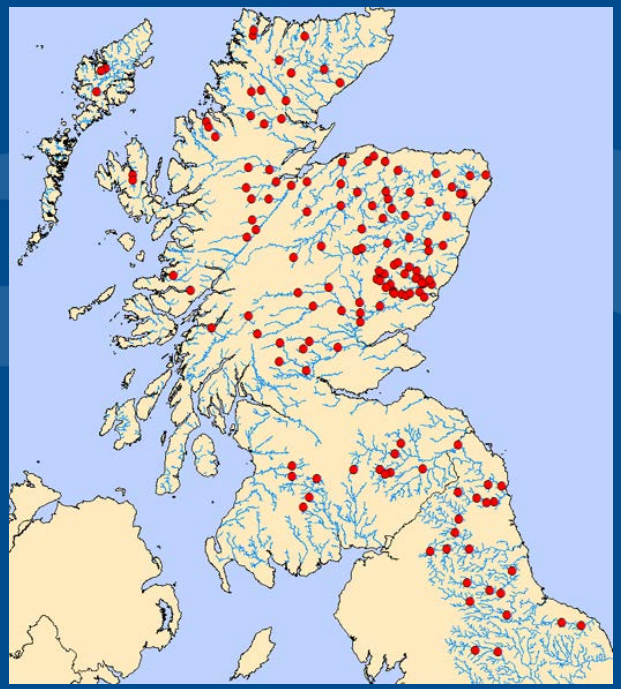


Pop-up locations with error < 25km

Genetic assignment to region of origin

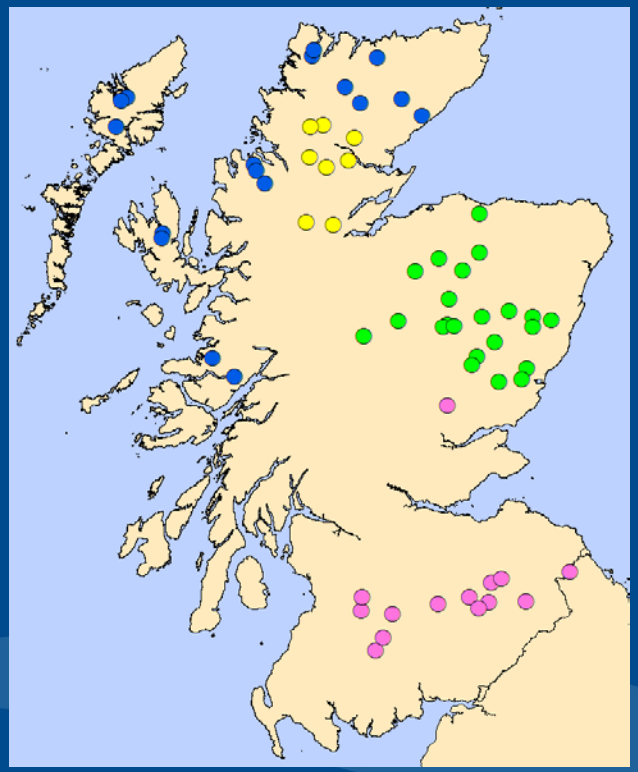
- Genetic assignment uses variations in the DNA base codes to differentiate between regions/rivers
- Single Nucleotide Polymorphisms (SNPs) used, where variation occurs at a single genetic base
- Characterises regions /rivers based on the frequency of SNP variations

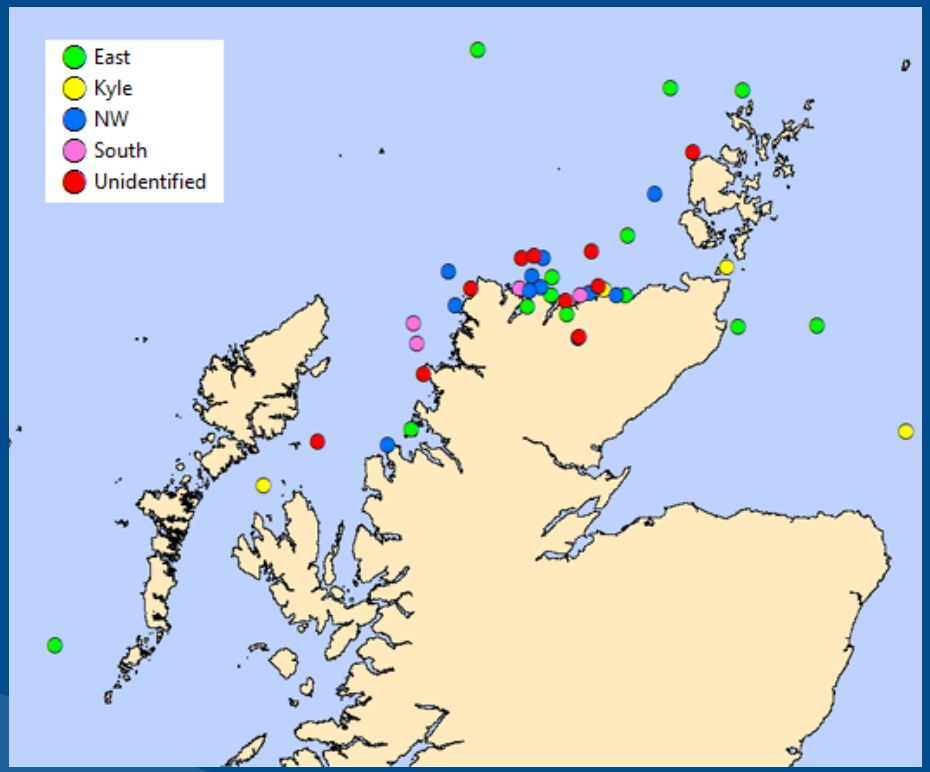




- SNPs baseline comprising 147 sites and of 3,787 fish with each fish screened at ~5,000 SNPs
- Cluster analysis performed to identify assignment units of regions with similar genetic signatures
- Identified SNPs which best differentiate between these regions

Preliminary assignment of tagged fish to the baseline regions



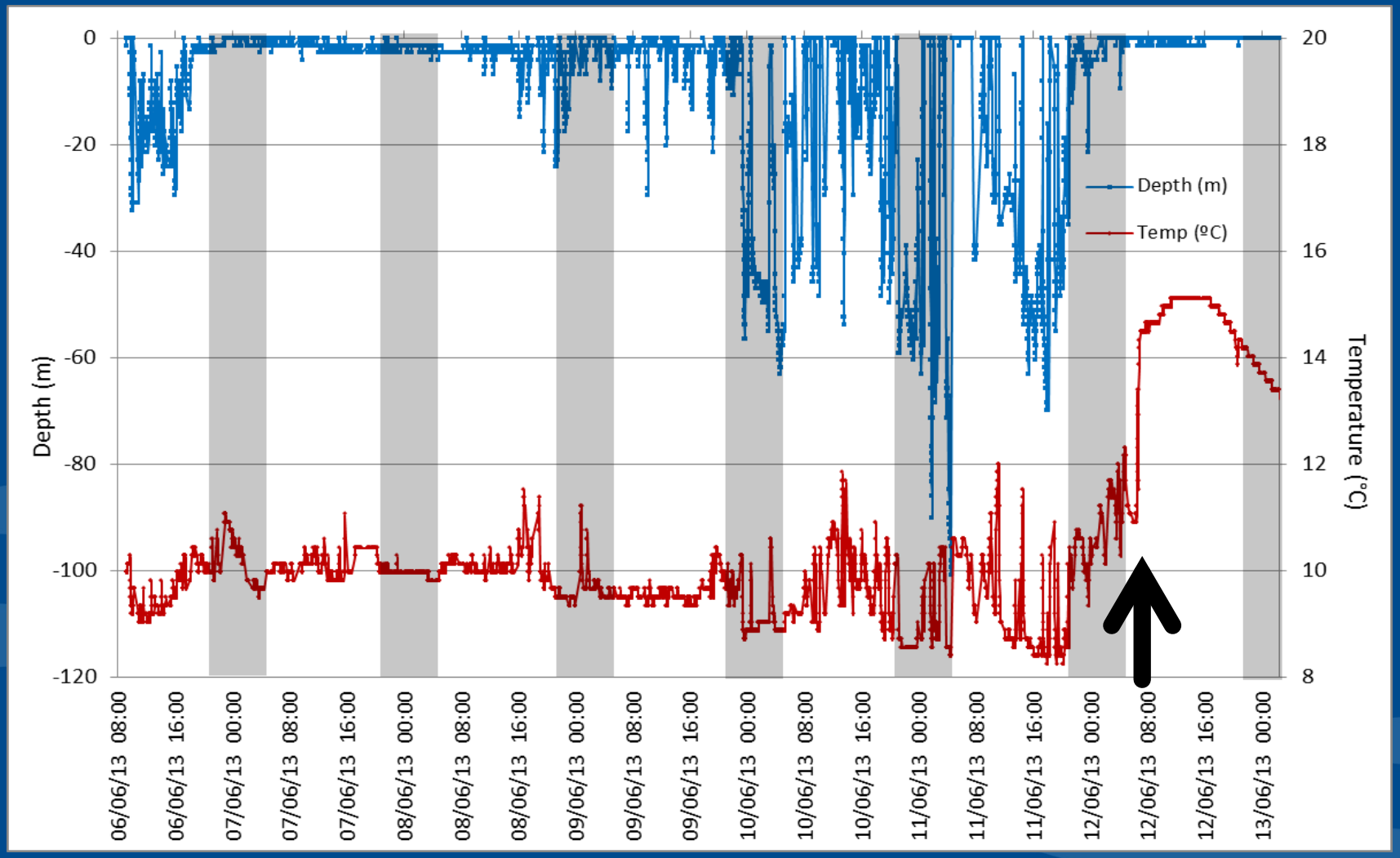


- Work in progress: only half of the available data have been analysed
- New local and international sites currently being added to baseline
- International baseline is limited: results not yet robust for these fish
- River level assignments under investigation

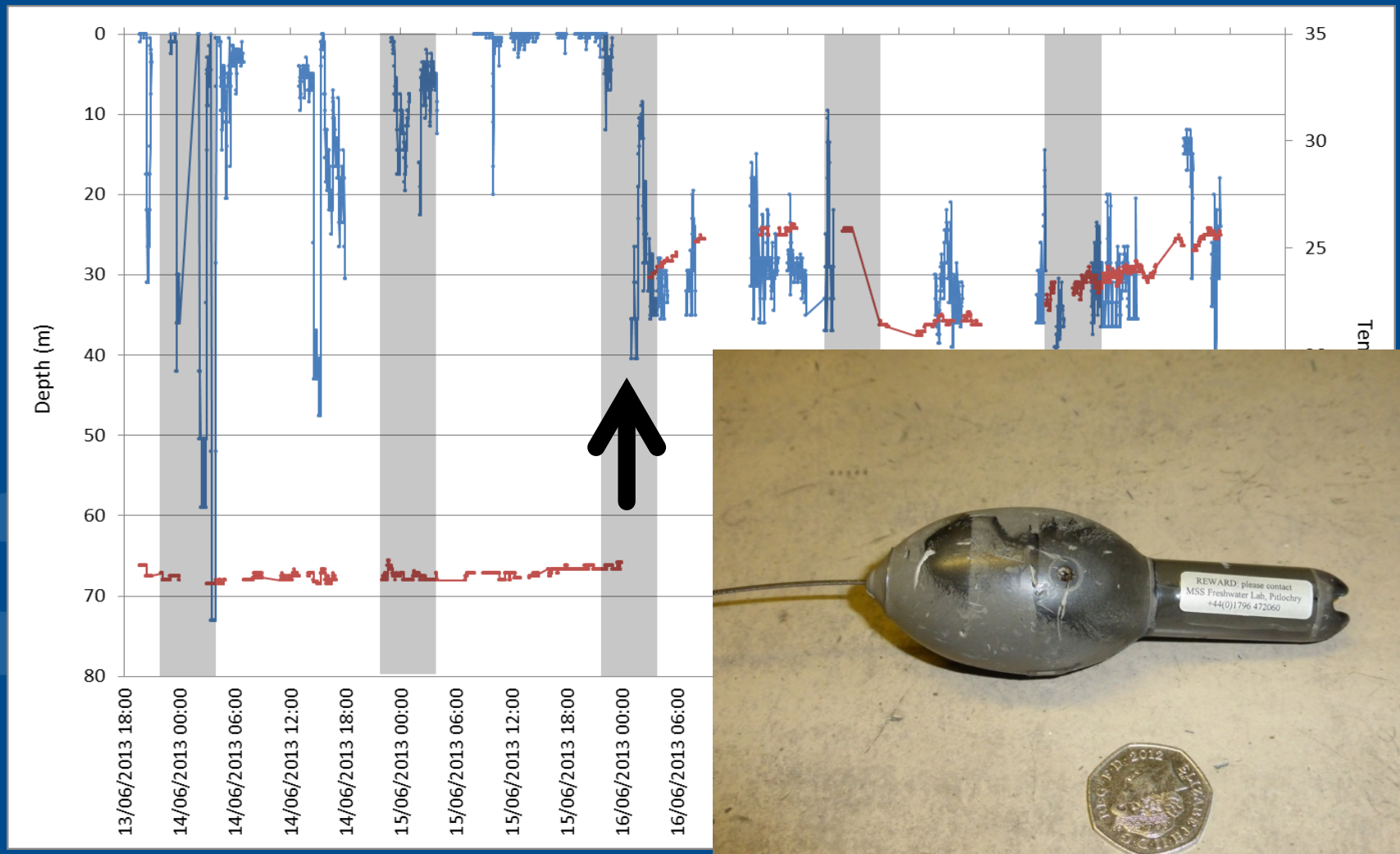
Depth Use

- Energy generation types – surface, mid-water, deep
  - Direct strike
  - Cables and electromagnetic fields
- Time at depth profiles
  - Models of strike risk

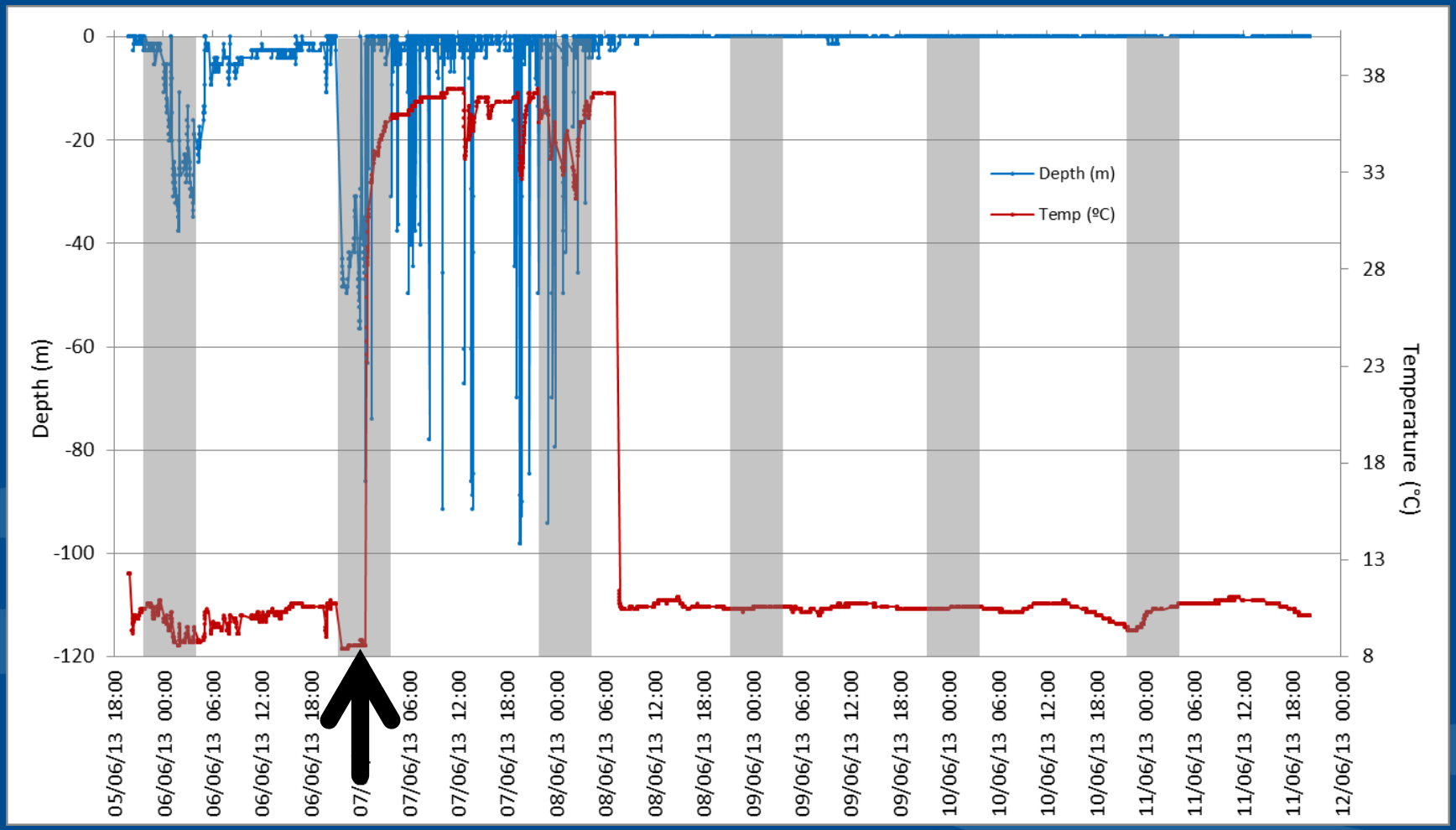
Atlantic salmon depth and temperature track - river entry



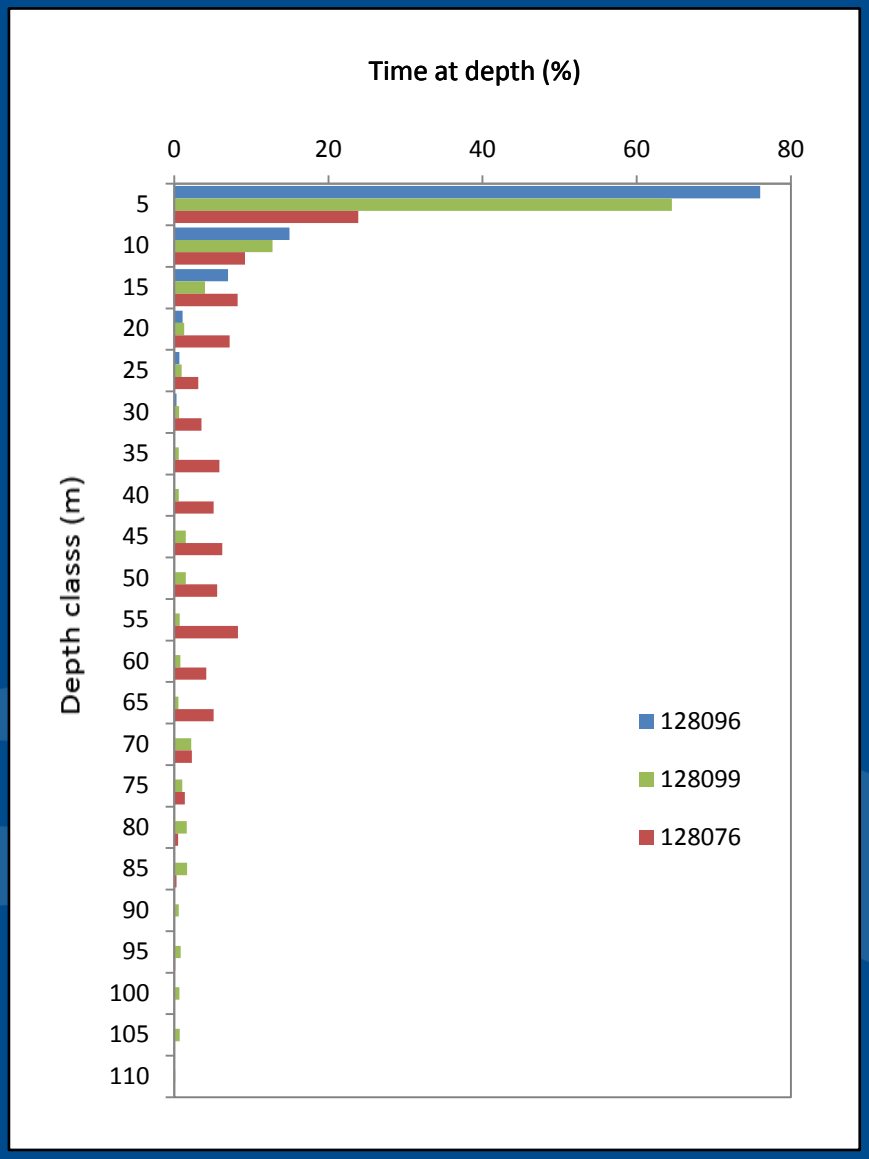
Endothermic shark predation

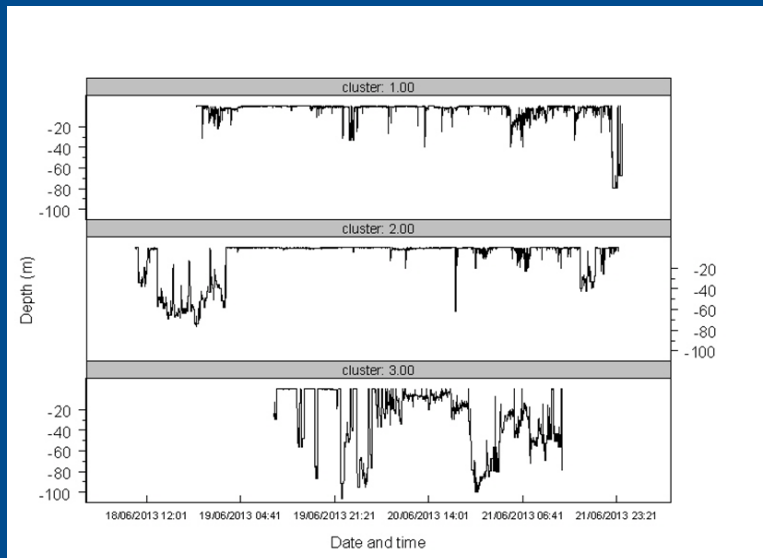


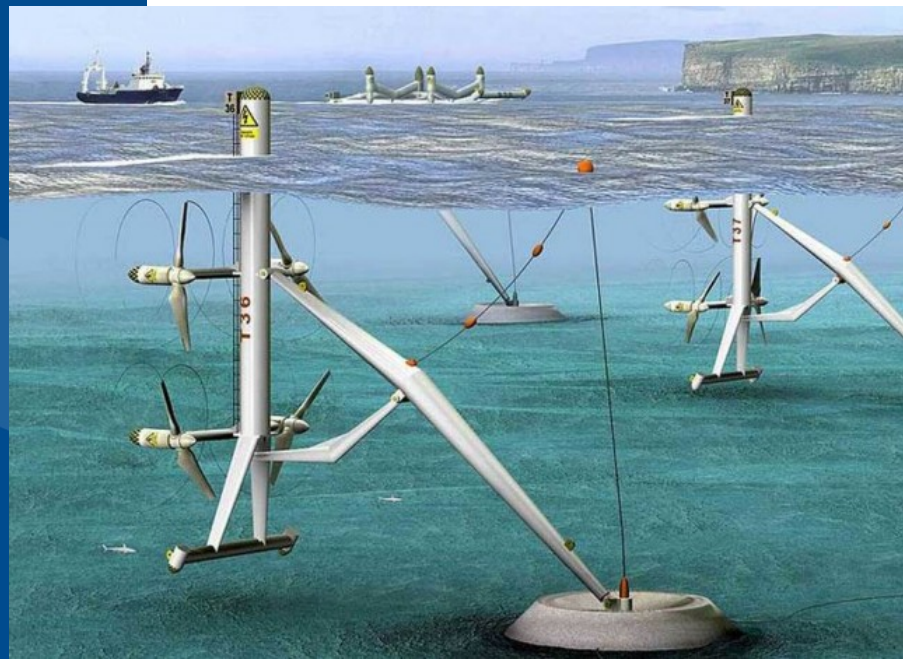
Mammal predation



Inter-individual variation in depth use







Conclusions

- Salmon may migrate at varying distances from the coast
- They predominantly inhabit the upper 5m but
  - Individuals vary (populations?)
  - All individuals undertake dives
  - Max dive depths imply that salmon use the entire water column
- Individuals from various populations may be present in zones of MRE development
- Salmon are most likely to interact with surface devices, but could come into contact with any device.

Next steps

- Tag further salmon in summer 2014 using longer tag deployments
- Completion of genetics work to identify origins of fish travelling through this area