

# From river to sea: freshwater and coastal migration by salmonids

An introduction to the theme

Colin Adams

**SCENE – University of Glasgow**

- Introduce the technology
- Idea of how telemetry can be used for migration in fresh and marine waters
- Scale and the scope of salmonid migration work



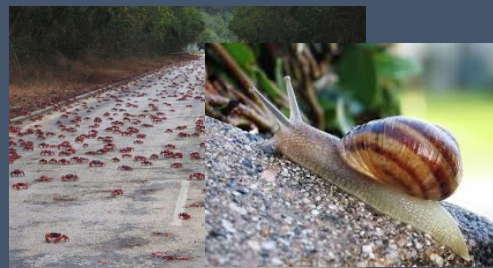


Baker 1978

Coelenterates,  
Platyhelminthes,  
Nematoda,  
Annelida,  
Crustacea,  
Uniramia,  
Insecta,  
Arachnida,  
Mollusca,  
Echinodermata,  
Fishes,  
Amphibia,  
Reptilia,  
Aves,  
Mammalia terr. & aquatic



- Migration exhibited in almost all animal groups
- Estimated trillions individuals migrate each year
- Evolved– multiple times in unrelated lineages







Atlantic salmon



Sea trout

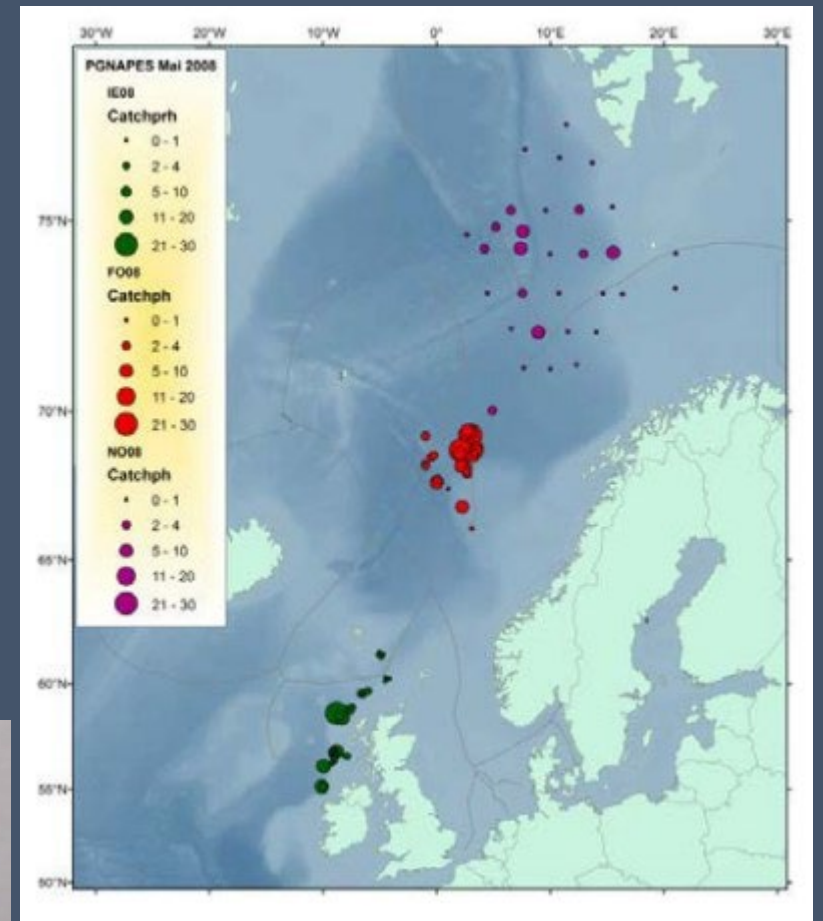


# Salmon migration is poorly understood

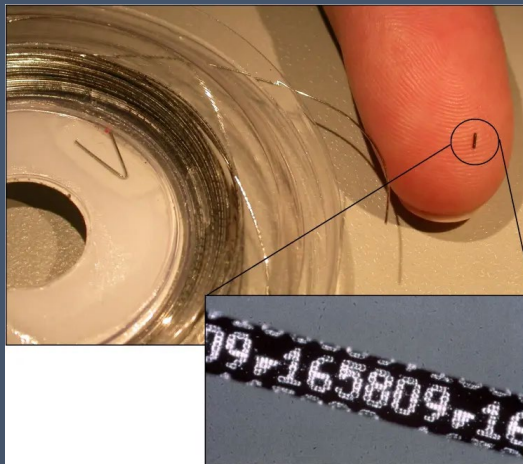
- Migration pathways
- Navigation mechanisms
- Intersection with human pressures

Until very recently – most information –

- At sea capture by trawling
- Conventional tag returns



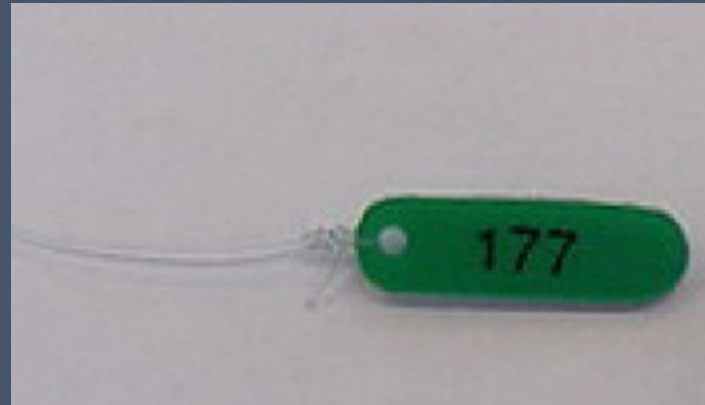
Detections of salmon post-smolts – Salsea Merge project



Coded wire tag



Floy tag



Carlin tag

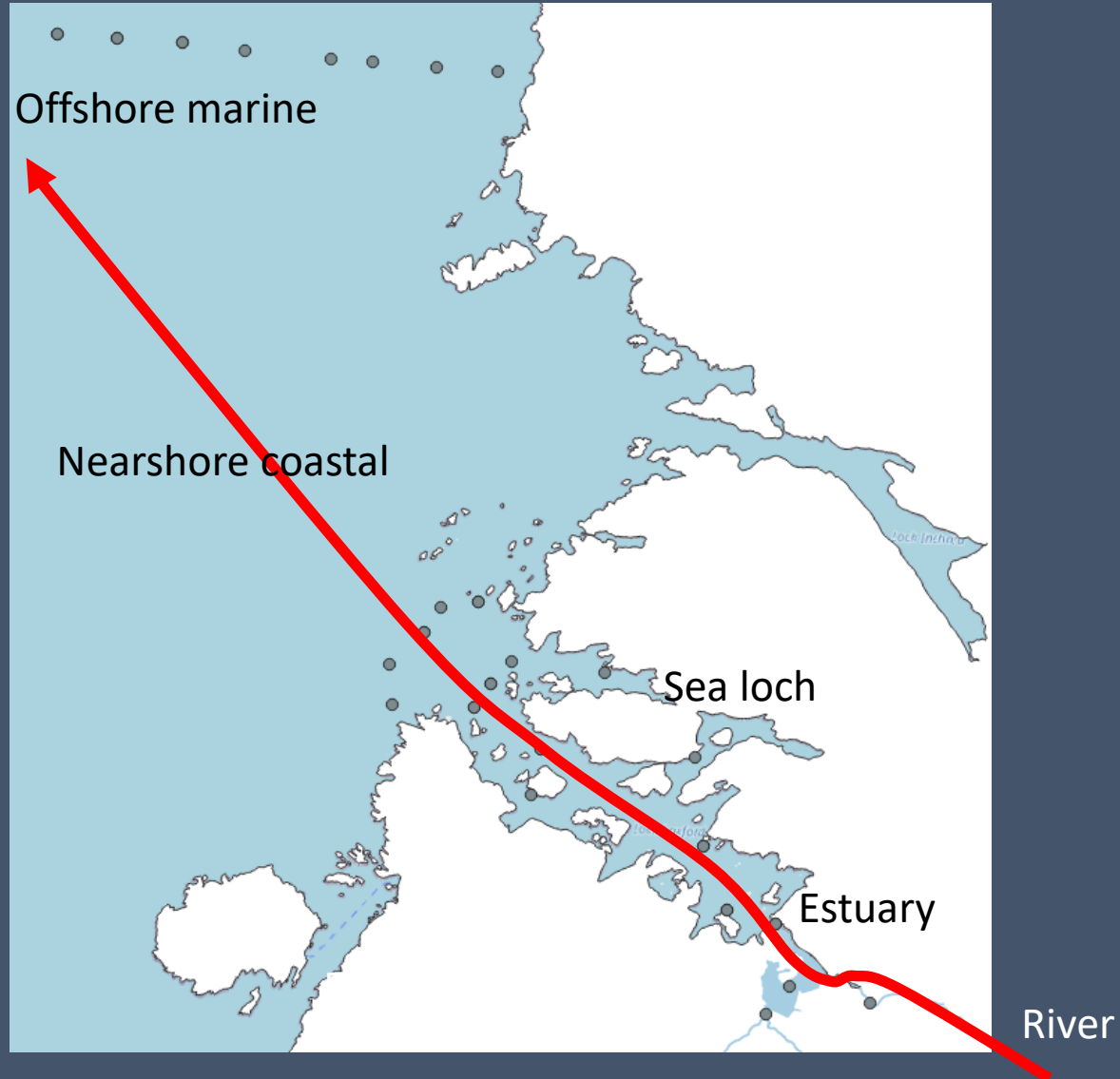


RV Celtic Voyager



# Alternative approach – telemetry

- Tracking migrants natal streams to sea

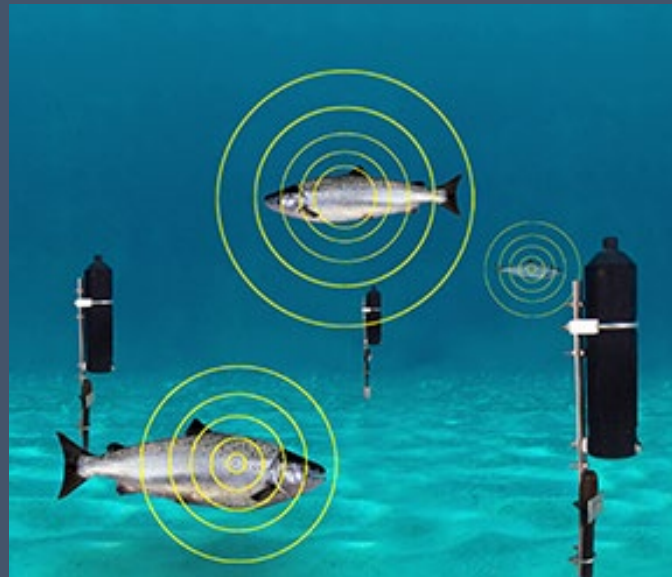


# Fish tracking technology has developed rapidly in the last decade(ish)

- Acoustic telemetry – works in deep water and sea water cf radio tags
- Distance tracked fish extending every year out to sea



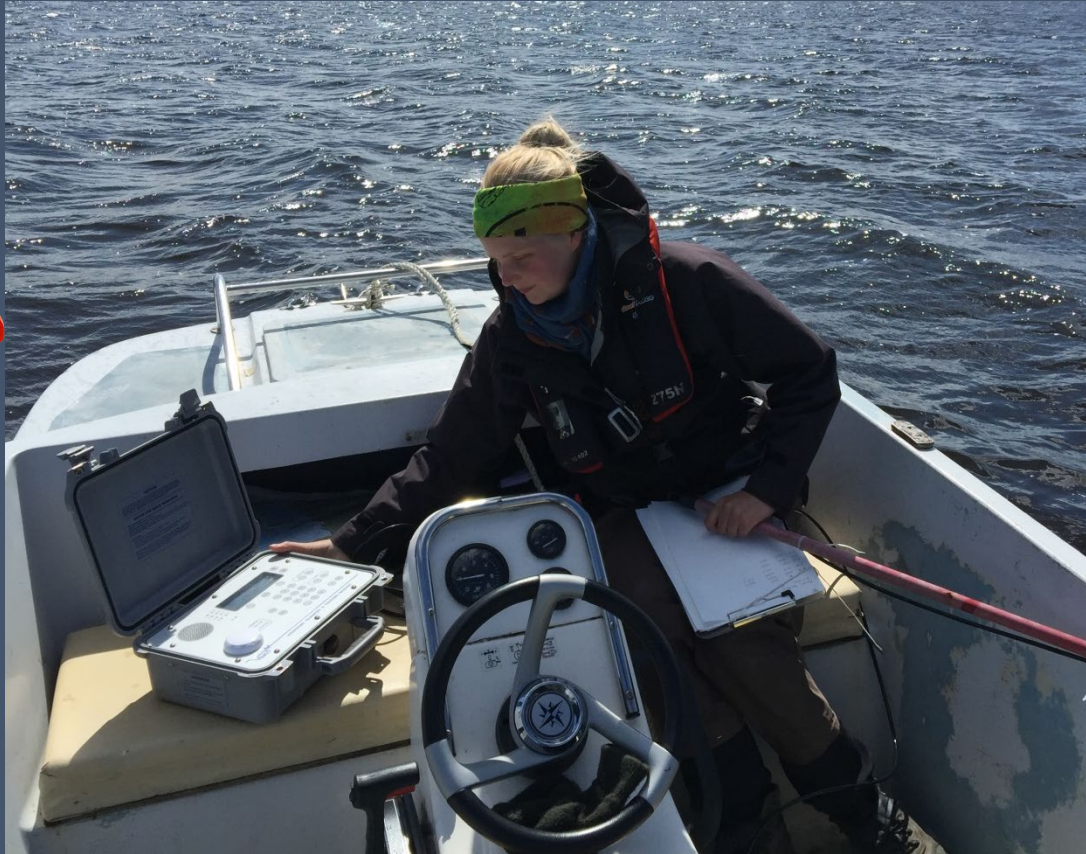
Tags: acoustic signal 69 kHz; coded to allow fish ID



Receiver: detects and logs acoustic signal




# Active / Manual tracking



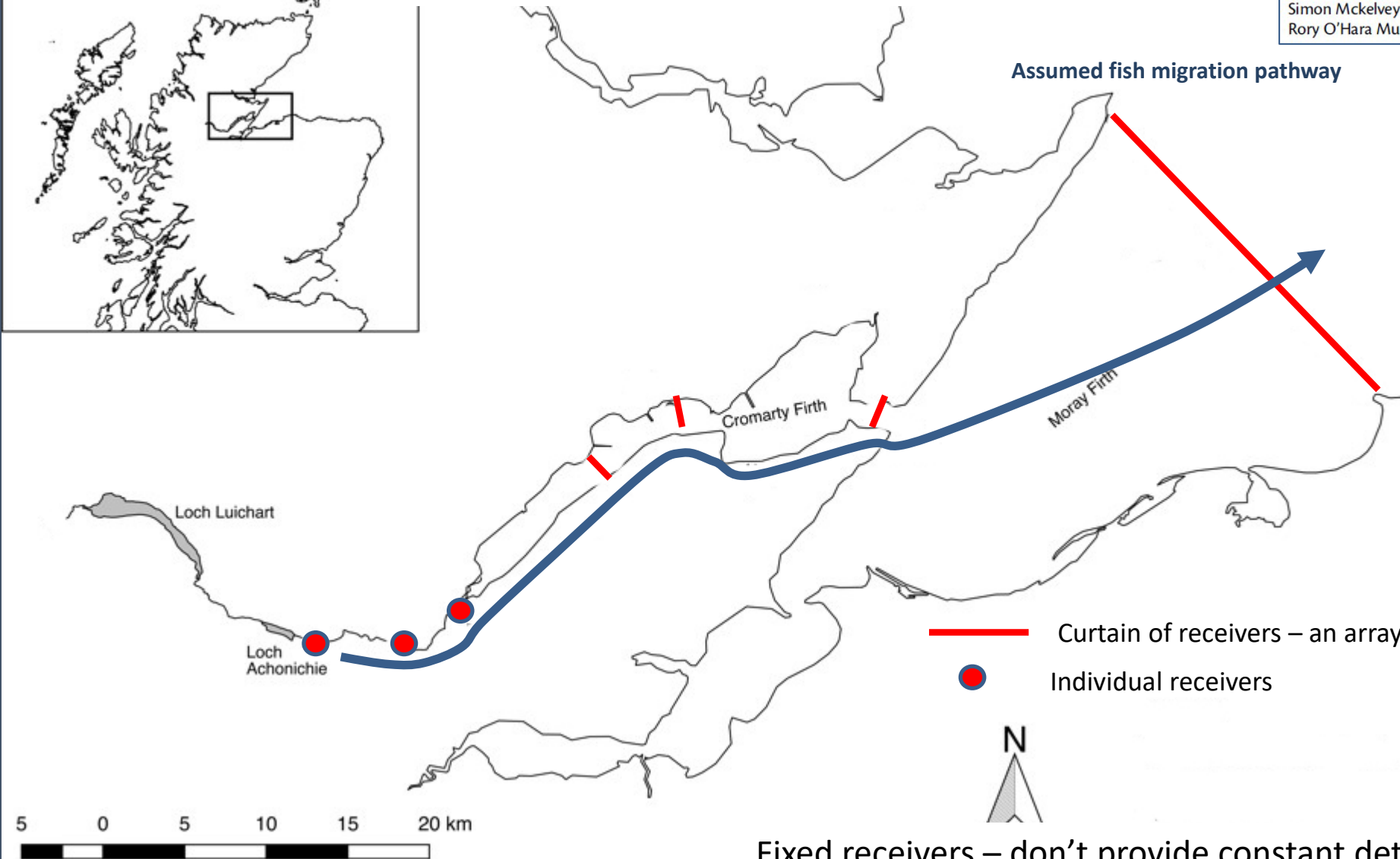
Mobile acoustic tag detection

# Fixed Position Receivers - curtain

Counterintuitive active directional swimming behaviour by Atlantic salmon during seaward migration in the coastal zone

Matthew Newton<sup>1</sup>, James Barry<sup>1</sup>, Angus Lothian<sup>1</sup>, Robert Main<sup>2</sup>, Hannele Honkanen<sup>1</sup>, Simon Mckelvey<sup>3</sup>, Paul Thompson<sup>4</sup>, Ian Davies<sup>2</sup>, Nick Brockie<sup>3</sup>, Alastair Stephen<sup>5</sup>, Rory O'Hara Murray<sup>2</sup>, Ross Gardiner<sup>6</sup>, Louise Campbell<sup>2</sup>, Paul Stainer<sup>2</sup>, and Colin Adams  <sup>1+</sup>

ICES Journal of Marine Science (2021), 78(5), 1730–1743.

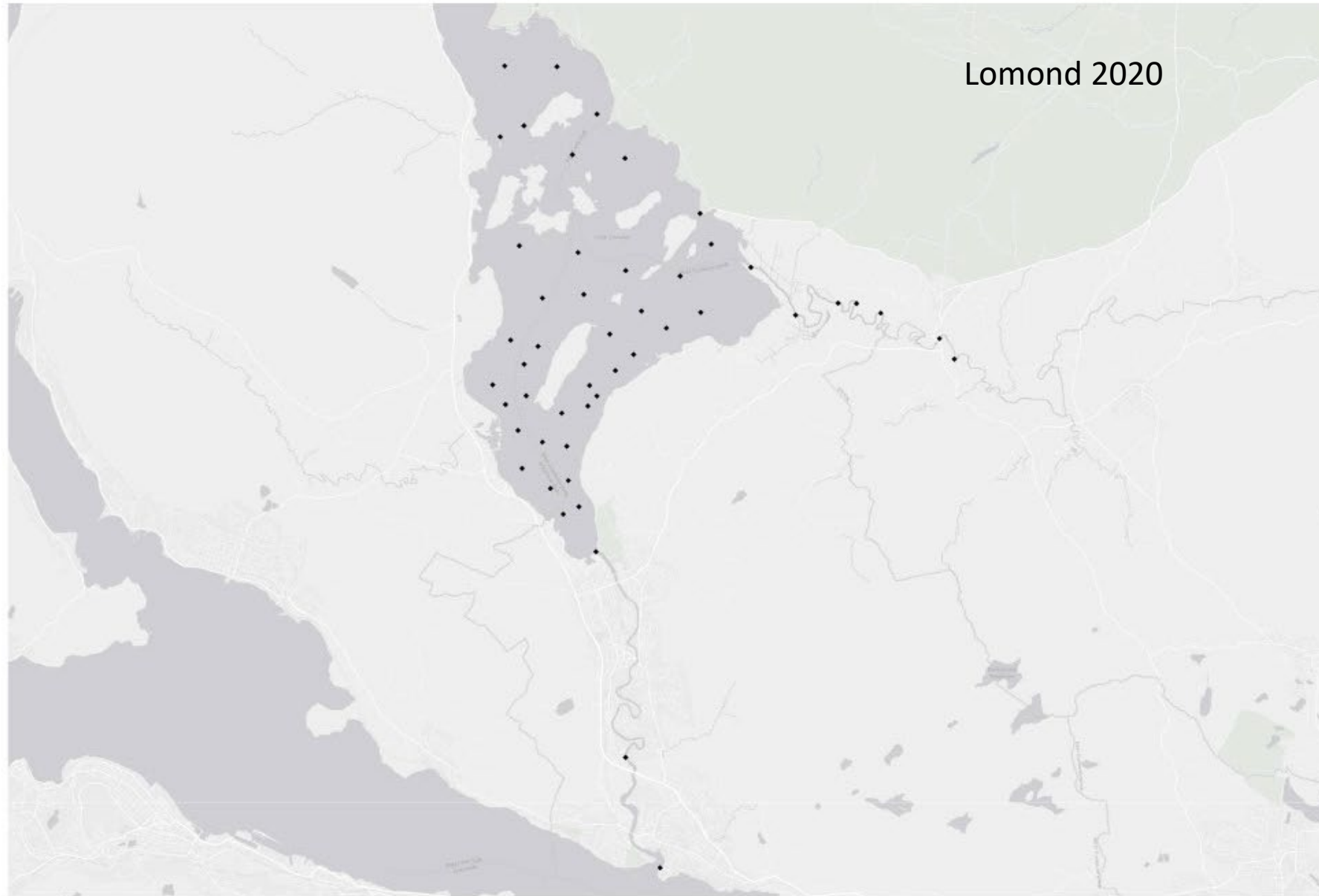


Fixed receivers – don't provide constant detection  
Affects the questions we can ask of the data



# Receivers in a Grid system

where the direction of migration is not clear

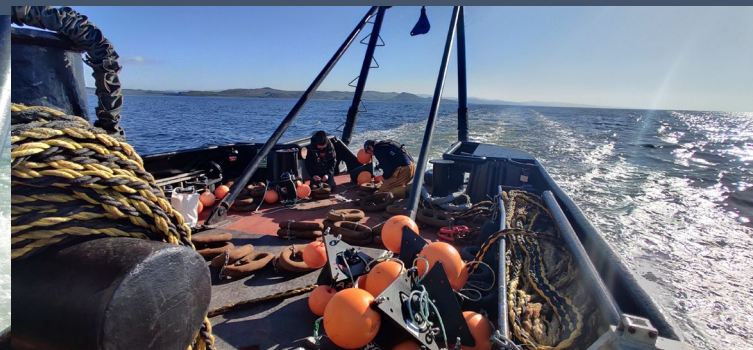


# Required steps in a salmonid sea migration telemetry study

## Deploying static receivers



In rivers



In coastal zones – out to sea



Detection with a wave glider away from the coast





# Capture fish for tagging



Fyke trapping



Rotary screw trap



Seine netting

# Fish Tagging



Photos: Jim Freeman



# Receiver recovery, data download, cleaning and analysis

Detections:

$N > 10^6$

	Filter									
	i..Date.and.Time..UTC.	Receiver	Transmitter	Transmitter.Name	Transmitter.Serial	Sensor.Value	Sensor.Unit	Station.Name	Latitude	Longitude
1	2022-01-11 14:44:40	VR2Tx-483244	A69-1601-63313	NA	NA	NA		BLAD05	NA	NA
2	2022-01-11 15:03:33	VR2Tx-483245	A69-1601-63312	NA	NA	NA		ETIV01	NA	NA
3	2022-01-11 15:03:33	VR2Tx-482007	A69-1601-63312	NA	NA	NA		AWE01	NA	NA
4	2022-01-11 15:03:33	VR2Tx-482008	A69-1601-63312	NA	NA	NA		AWE02	NA	NA
5	2022-01-11 15:03:33	VR2Tx-482012	A69-1601-63312	NA	NA	NA		BLAD02	NA	NA
6	2022-01-11 15:03:33	VR2Tx-483246	A69-1601-63312	NA	NA	NA		ETIV02	NA	NA
7	2022-01-11 15:04:21	VR2Tx-483244	A69-1601-63312	NA	NA	NA		BLAD05	NA	NA
8	2022-01-11 15:04:21	VR2Tx-483242	A69-1601-63312	NA	NA	NA		BLAD03	NA	NA
9	2022-01-11 15:04:21	VR2Tx-482010	A69-1601-63312	NA	NA	NA		BLAD01	NA	NA
10	2022-01-11 15:04:21	VR2Tx-483243	A69-1601-63312	NA	NA	NA		BLAD04	NA	NA
11	2022-01-11 15:10:28	VR2Tx-483245	A69-1601-60521	NA	NA	NA		ETIV01	NA	NA
12	2022-01-11 15:10:28	VR2Tx-482007	A69-1601-60521	NA	NA	NA		AWE01	NA	NA
13	2022-01-11 15:10:28	VR2Tx-482008	A69-1601-60521	NA	NA	NA		AWE02	NA	NA
14	2022-01-11 15:10:28	VR2Tx-482012	A69-1601-60521	NA	NA	NA		BLAD02	NA	NA
15	2022-01-11 15:10:29	VR2Tx-483246	A69-1601-60521	NA	NA	NA		ETIV02	NA	NA
16	2022-01-11 15:11:08	VR2Tx-483245	A69-1601-63311	NA	NA	NA		ETIV01	NA	NA
17	2022-01-11 15:11:08	VR2Tx-482007	A69-1601-63311	NA	NA	NA		AWE01	NA	NA
18	2022-01-11 15:11:08	VR2Tx-482008	A69-1601-63311	NA	NA	NA		AWE02	NA	NA

# Multiple active telemetry projects

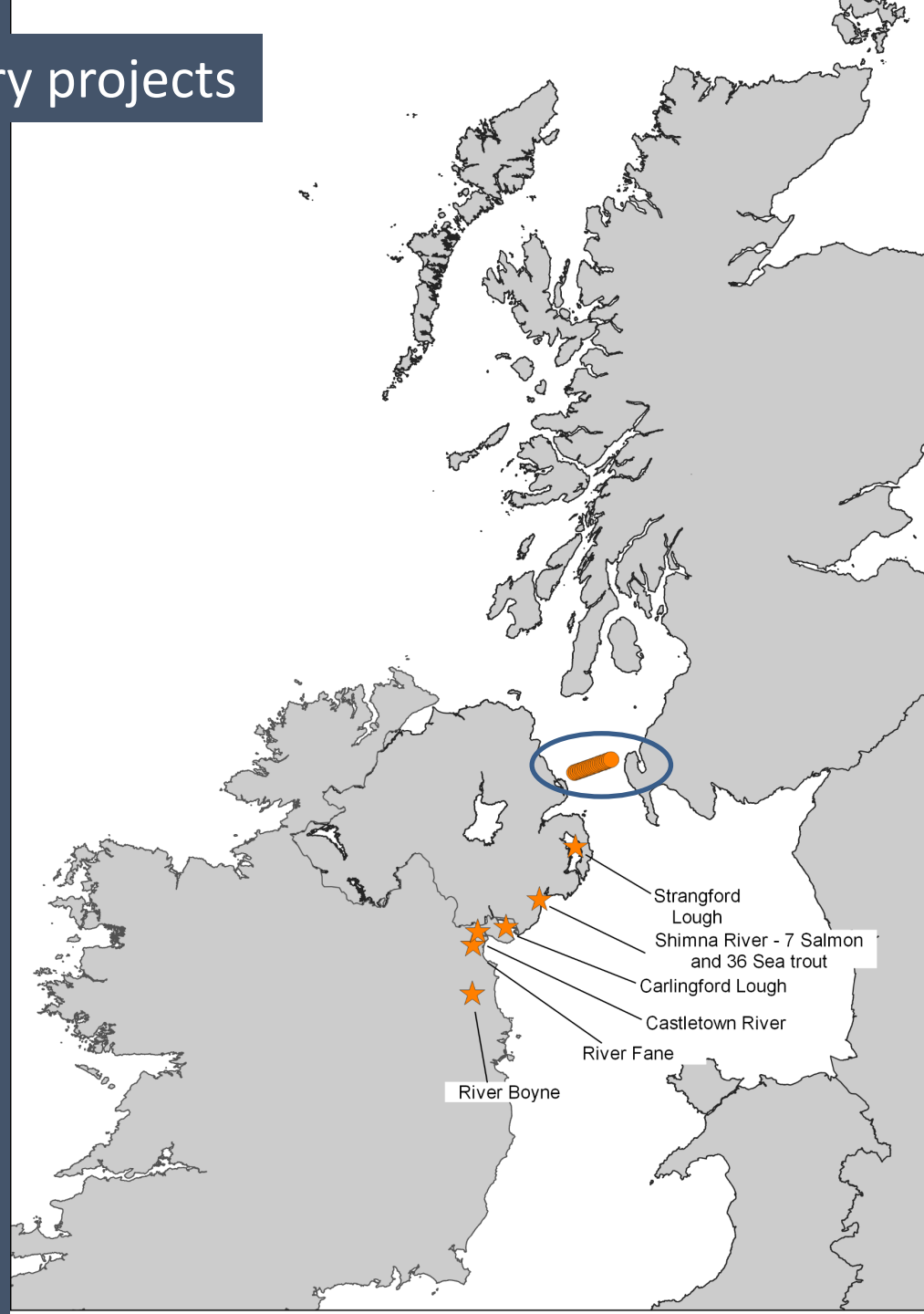
## COMPASS Project

Funded Interreg 5a

- Inland Fisheries Ireland
- AFBI
- 3 years

## In 2021

- 85 Salmon
- 800 fish 2017-20
- Ca 500 Sea trout
- Ca 340 salmon smolts
- 6 Rivers



## Marine Receivers:

- Coastal receivers Boyne to Larne
- Scotland to NI array - 2021



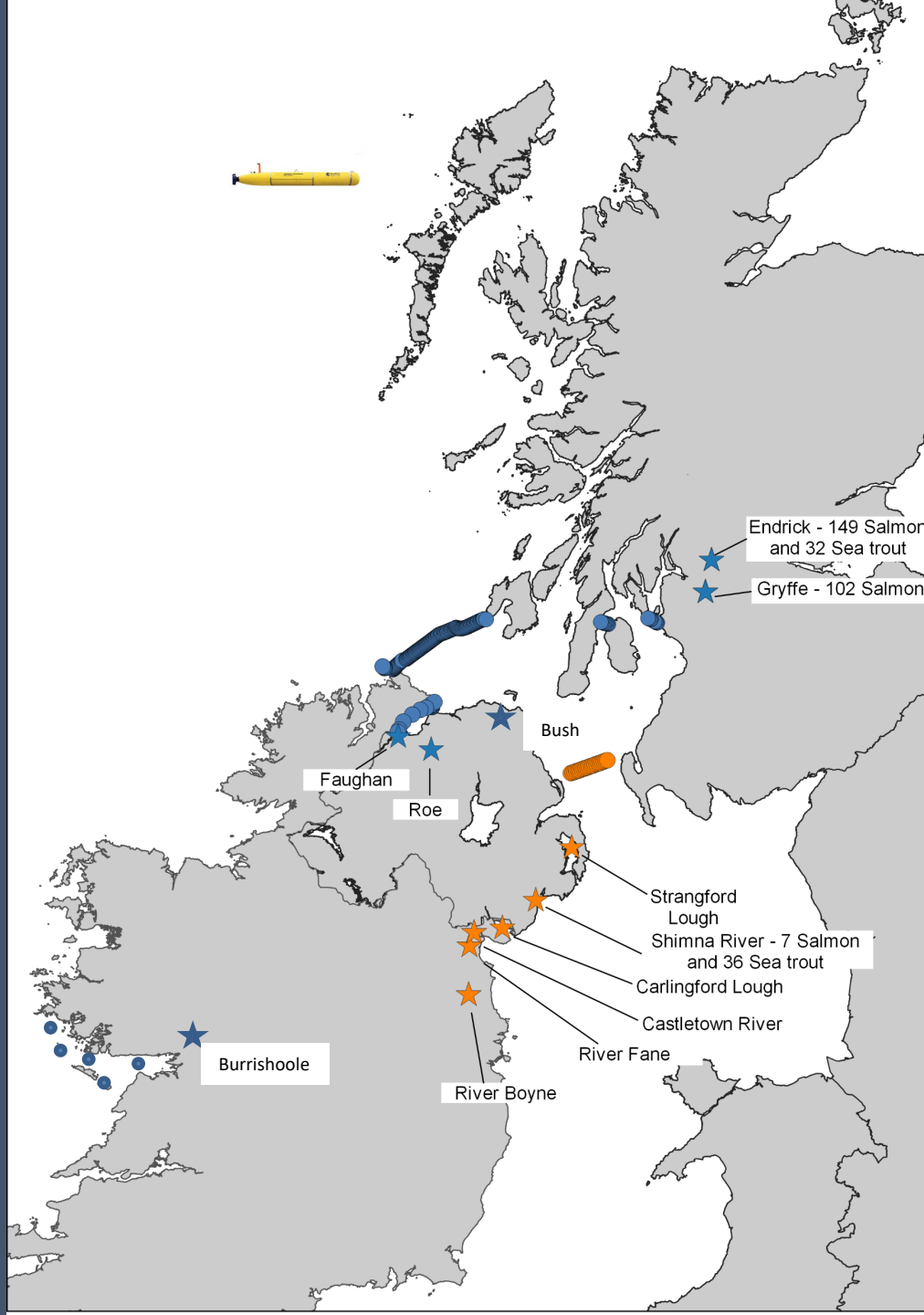
# SeaMonitor Project

Funded Interreg 5a, NatureScot

9 research grps – 3 years

2021

- Salmonids total: 512
- 6 rivers
- Bush - 80 salmon
- Burrishoole – 85 salmon
- Faughan (Foyle) -53 salmon
- Roe - 11 salmon
- Gryffe – 102 salmon
- Endrick – 149 salmon, 32 Sea trout



Marine Receivers:

Coastal receivers

- inner and outer Clyde
- Lough Foyle
- Coast around River Bush
- Clew Bay – west of Burrishoole

Ireland to Scotland:

- Malin Head to Islay

Wave glider:

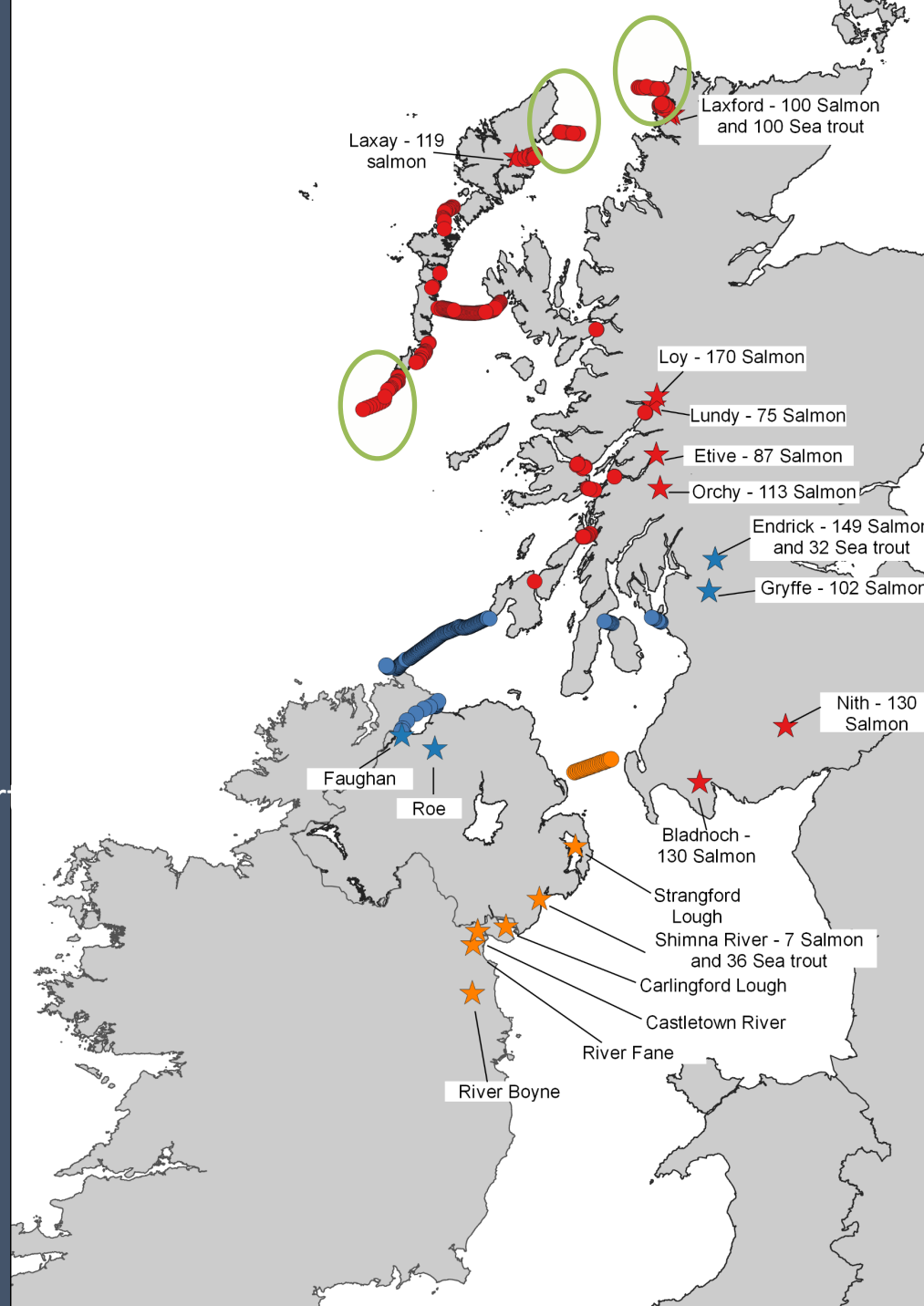
- Continental Shelf west of Hebrides
- Up to 200 km W of Harris

# West Coast Tracking Project

led by Atlantic Salmon Trust,  
Fisheries Management Scotland,  
Marine Scotland, Scottish Salmon,  
philanthropic donors  
3 Year project

## 2021

- Salmonids total: 1024
- 8 rivers
  
- Laxay - 119 salmon
- Laxford – 100 salmon. 100 sea trout
- Lay – 170 salmon
- Lundy – 75 salmon
- Etive – 87 salmon
- Orchy -113 salmon
- Nith - 130 salmon
- Bladnoch 130 salmon



## Marine Receivers:

### Coastal receivers

- North Sutherland spur
- Berneray spur
- Stornaway spur
- Between outer Hebridean islands
- Sound of Mull, Loch Linnhe, Firth of Lorn

### Mainland Scotland to Hebrides:

- Minch array: Skye to Uist



## Other projects

### Derwent River project

- (EA, Natural England)
- Derwent: 150 salmon, 15 sea trt

### AFBI Project

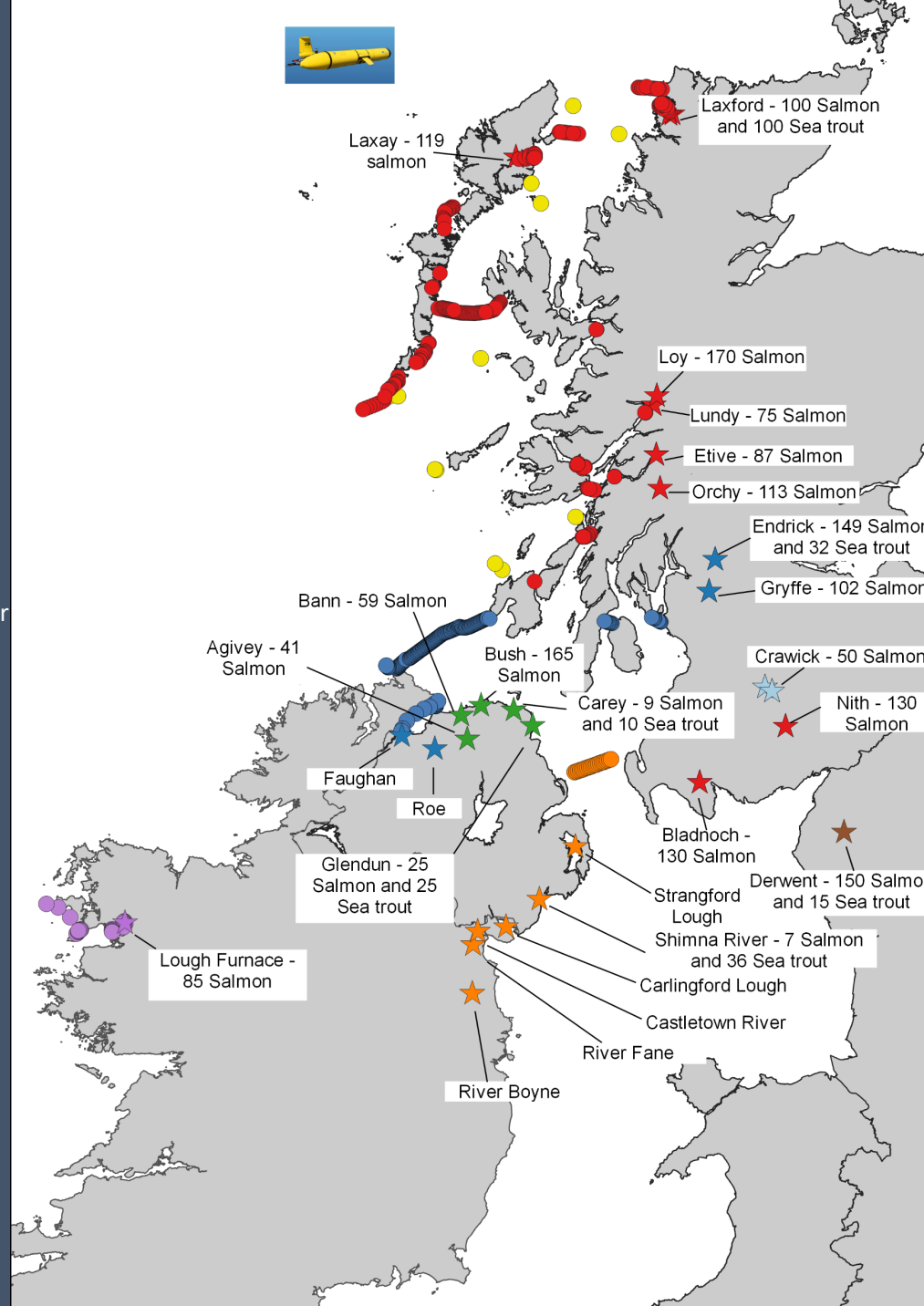
- Agivey - 41 salmon
- Bann - 59 salmon
- Bush - 85 salmon (in addition to SeaMonitor)
- Carey - 9 salmon
- Glendun - 25 salmon
- Shimna - 7 salmon

### Marine Institute

- Burrishoole 10 additional predator tags

### Nith DSFB

- Crawick Water - 50 salmon
- Additional salmonids = 451
- **Total salmonids = 2072**



### Marine Receivers:

- AST West coast project
- SeaMonitor
- Compass

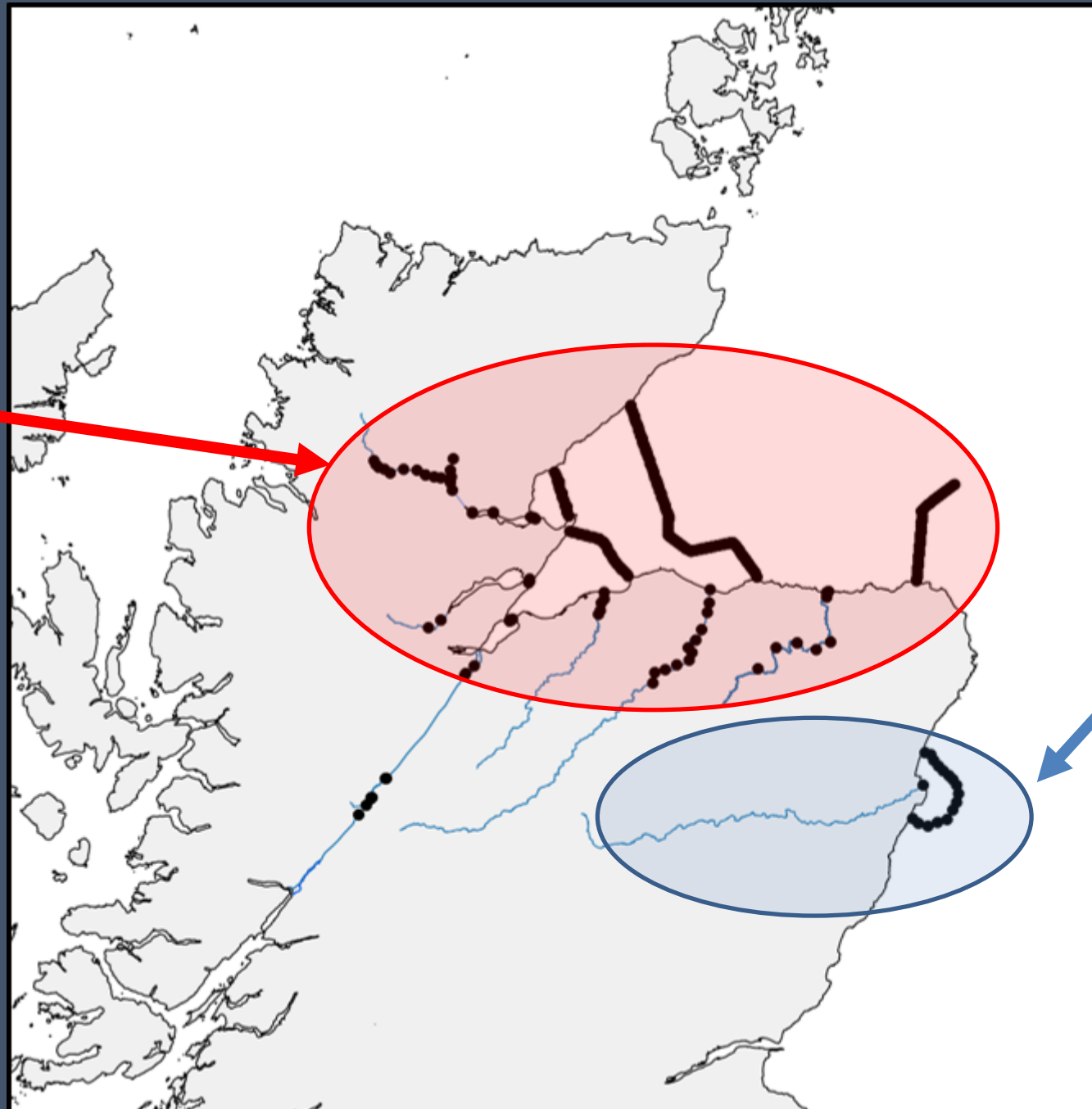
### Plus

- MARPAMM project
- MSS oceanographic monitoring devices
- Ca 10 (?)

**Total receivers in marine waters > 388**  
**Wave glider**

## AST East Coast project

- 3 year project
- 7 rivers
- Salmon N=700 (2021)



## Dee & Don Tracking Project

Marine Scotland  
River Dee Trust  
2021  
N=ca 100

- Salmon N= 340
- Sea trout n=50
- Over 3 years (2018-2021)

## Tracking effort in 2021:

- Salmon N= 2900
- >36 rivers
- Investment ca £1m tags
- Equipment ca £3m

much work continuing into 2022

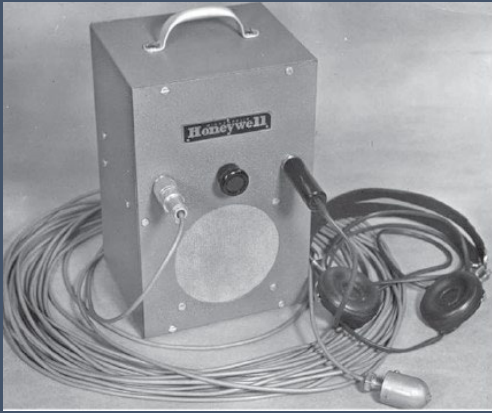
We will hear about many of these projects (and more) today



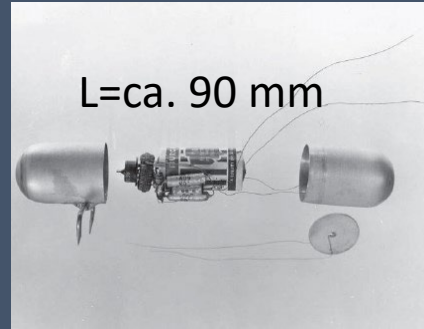




# Alternative study approach Acoustic telemetry



Mobile acoustic tag detection 1950s



One of the first acoustic telemetry tags for fish ca 1956



A fixed position acoustic listening station 1950s



Mobile acoustic tag detection 2020s



Acoustic telemetry tags for smolts (V7) 2022s

L=18 mm



A fixed position acoustic listening station 2020s



Methods – receivers not providing constant detection  
Affects the questions we can ask of the data

