# Estimating returning salmon stocks

## Stephen Gregory

# Why salmon?


© Katie Sumner

- Economic
  - Angling
  - Food source

- Social
  - "existence value"
  - "heritage value"

# Counting returning salmon



© Environment Agency

- Net or angler catches

# Counting returning salmon


© Environment Agency

- Net or angler catches

  – Temporally patchy sampling
  – Unknown / unrecorded effort
  – Fish damage / death

# Counting returning salmon

- Extrapolation from other life stages


© GWCT

# Counting returning salmon

- Extrapolation from other life stages

  - NASCO pre-fisheries abundance

  - Statistical & ecological assumptions

  - Standardised with uncertainty

© GWCT

# Counting returning salmon



© GWCT

- Automatic fish counters

# Counting returning salmon



© GWCT

- Automatic fish counters

  – Year-round monitoring

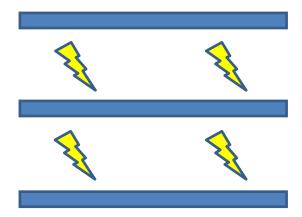  – Expensive to maintain

  – Patchy counts without uncertainty
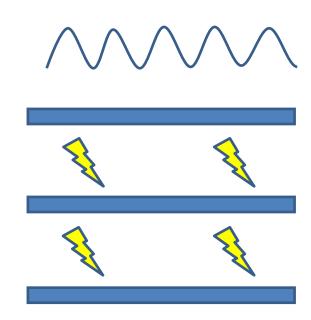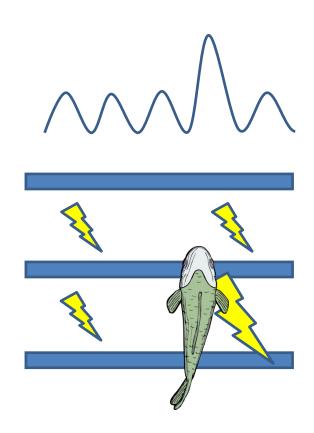
# Automatic fish counter

Resistivity counter

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Resistivity counter

- 3 electrodes

# Automatic fish counter

Resistivity counter

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- electric field

# Automatic fish counter

## Resistivity counter

- 3 electrodes
- electric field
- **waveform**

# Automatic fish counter

## Resistivity counter

- 3 electrodes
- electric field
- waveform
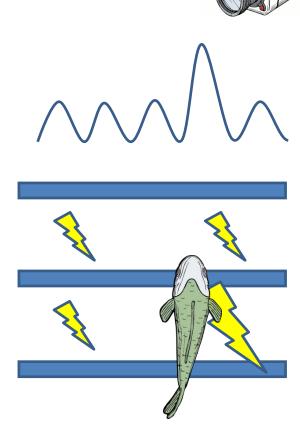
# Automatic fish counter

Video verification

# Automatic fish counter
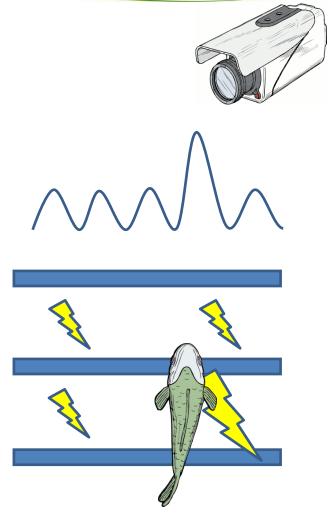
Video verification
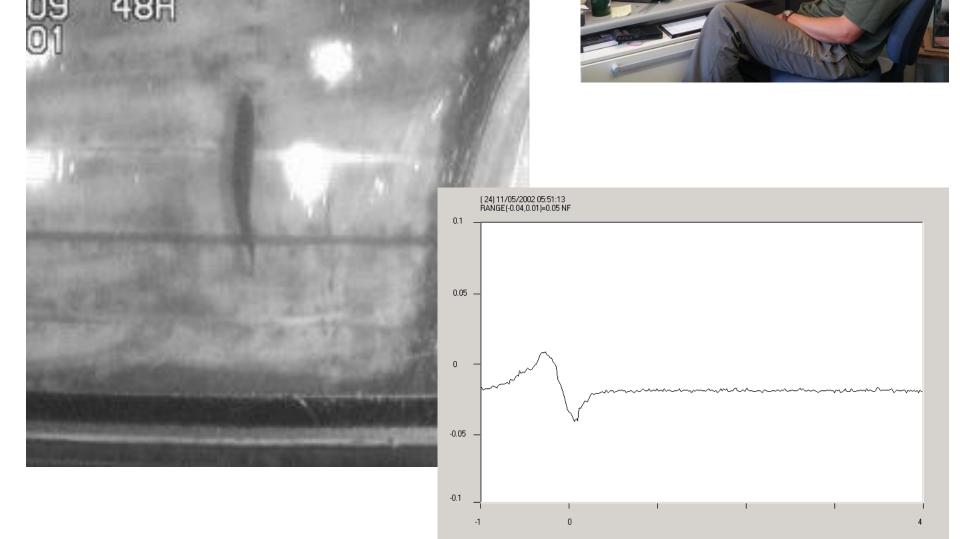
- 24h / 7d
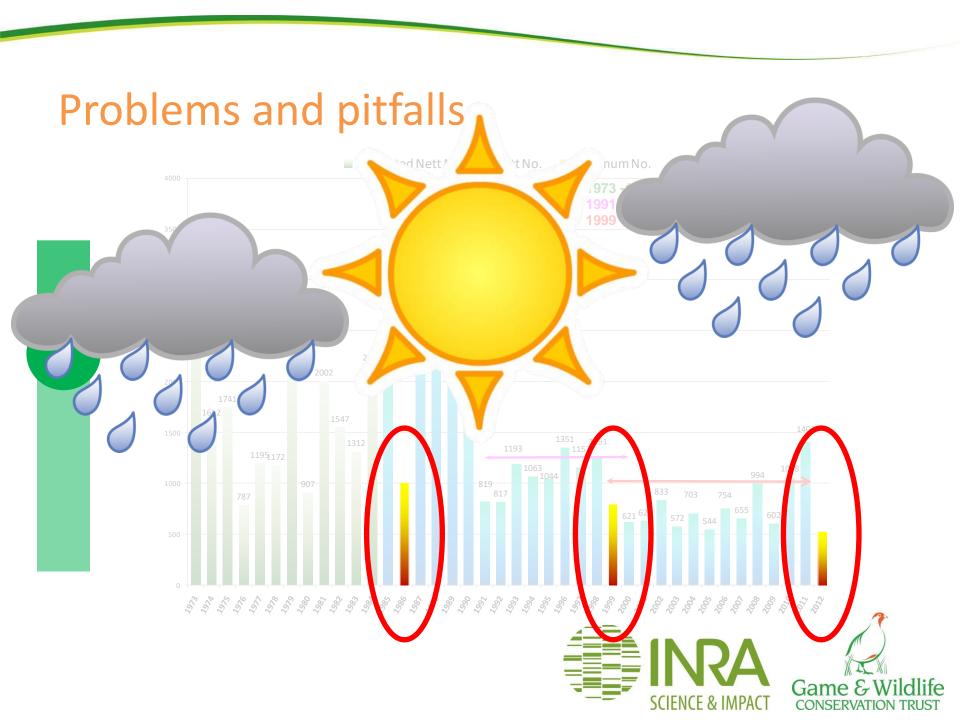- species-verification
- flow-sensitive

every waveform checked!

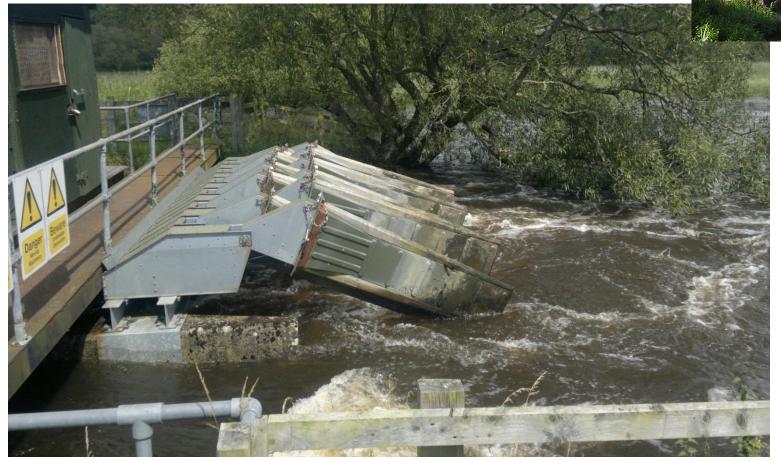# Automatic fish counter



( 24) 11/05/2002 05:51:13
RANGE(-0.04,0.01)=0.05 NF

# Problems and pitfalls



Legend: Estimated Nett No. | Nett No. | Minimum No.

1973 - 1990 average = 1950
1991 - 1998 average = 1087
1999 - 2011 average = 679
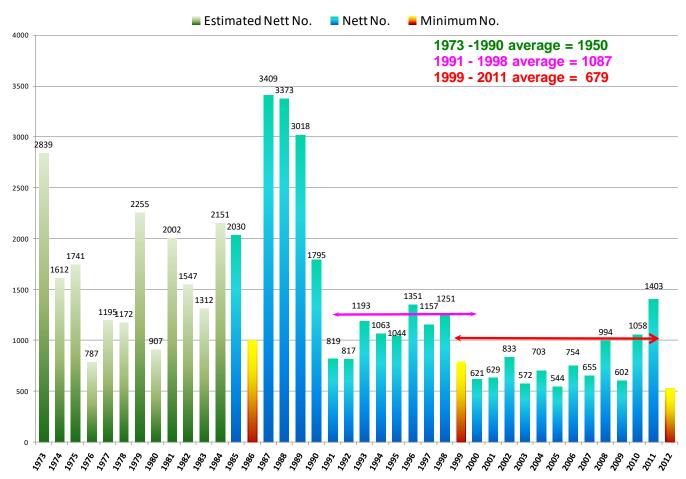
# Problems and pitfalls

# Problems and pitfalls

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# Objective

To develop a method to estimate the number of salmon (and its uncertainty) that ascend a river each year
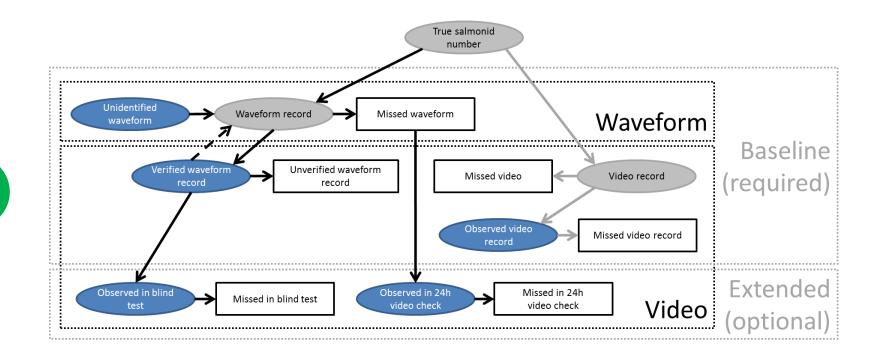
# Objective

To develop a method to estimate the number of salmon (and its uncertainty) that ascend a river each year

The method should:
- – cope with missing data
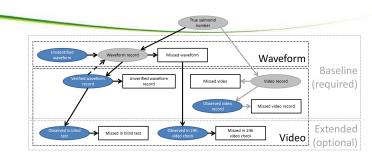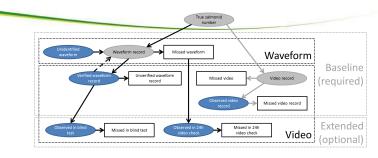- – admit covariates
- – be easily transferable

# An estimation framework

# An estimation framework



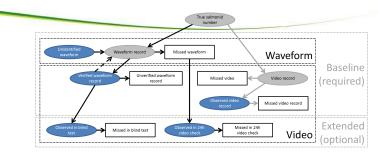- Estimates true number of salmon $S$

# An estimation framework



- Estimates true number of salmon $S$

- Uses video-verified waveforms but also
  - waveform only
  - video only
  - complete system failure

# An estimation framework



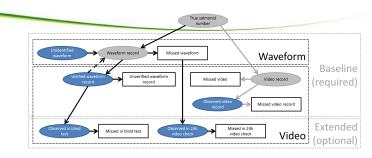- Estimates true number of salmon $S$

- Uses video-verified waveforms but also
  - waveform only
  - video only
  - complete system failure

- Hourly, daily, weekly, etc. estimates
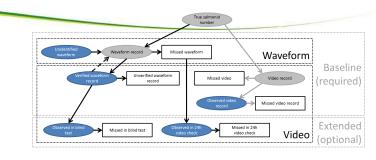
# Baseline model



- Modest data requirements
  - number of waveform
  - number of waveform verified as salmon
  - number of salmon on video when waveform off

# Baseline model



- ## Modest data requirements
  - number of waveform
  - number of waveform verified as salmon
  - number of salmon on video when waveform off

- ## Expertise on local salmon population
  - number of migration "peaks"
  - mean number of migrators outside peak(s)

# Transferability

- Counters are numerous and widespread

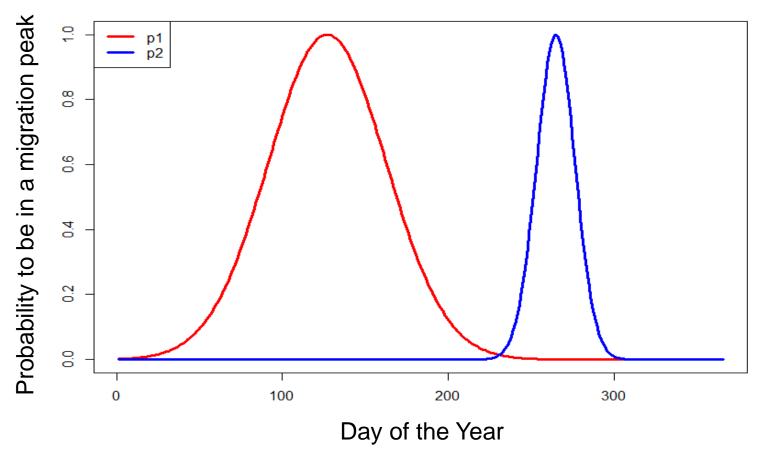  - 41 (England & Wales), 29 (Scotland), ?? (Ireland)

# Transferability

- Counters are numerous and widespread

  – 41 (England & Wales), 29 (Scotland), ?? (Ireland)

- Salmon populations are highly variable

  – Numbers of salmon

  – Migration timing

  – etc.

# Transferability

- Counters are numerous and widespread

  - 41 (England & Wales), 29 (Scotland), ?? (Ireland)

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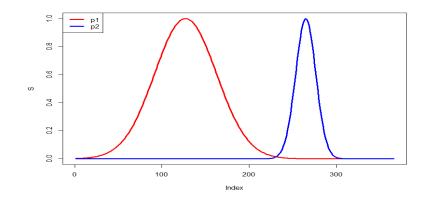
  - etc.

- Data is often poor quality
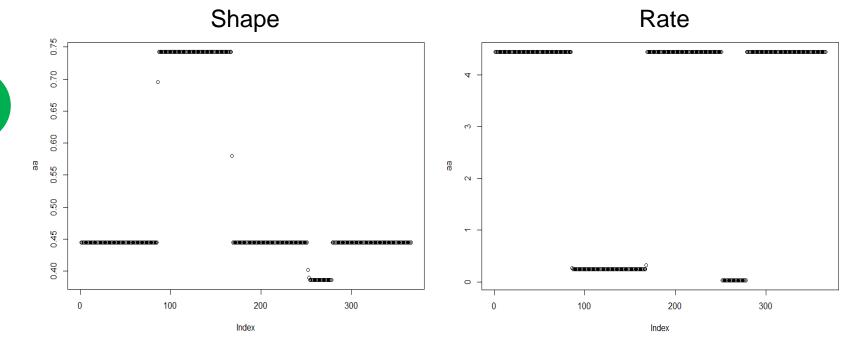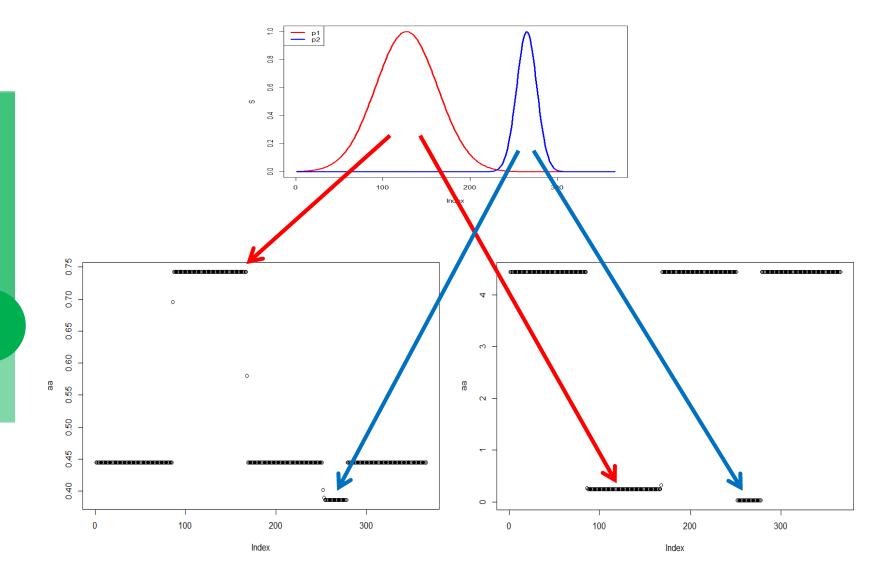
# Phenology informs $S$ estimation
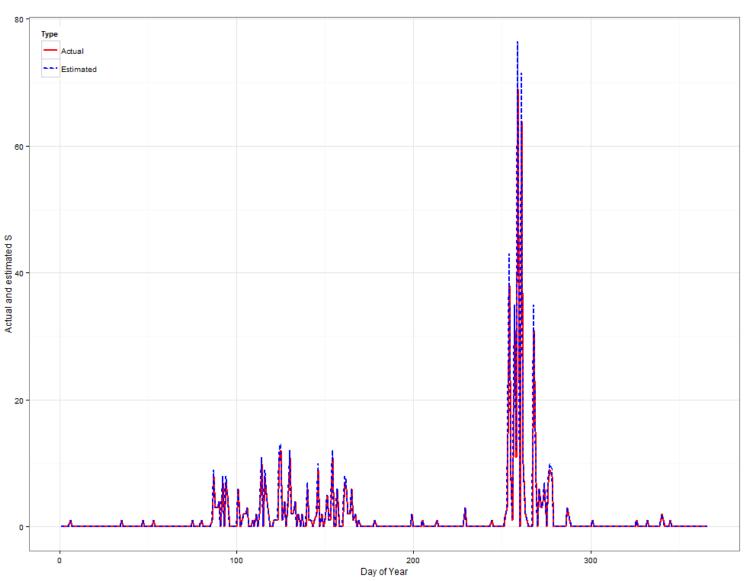
# Phenology informs $S$ estimation
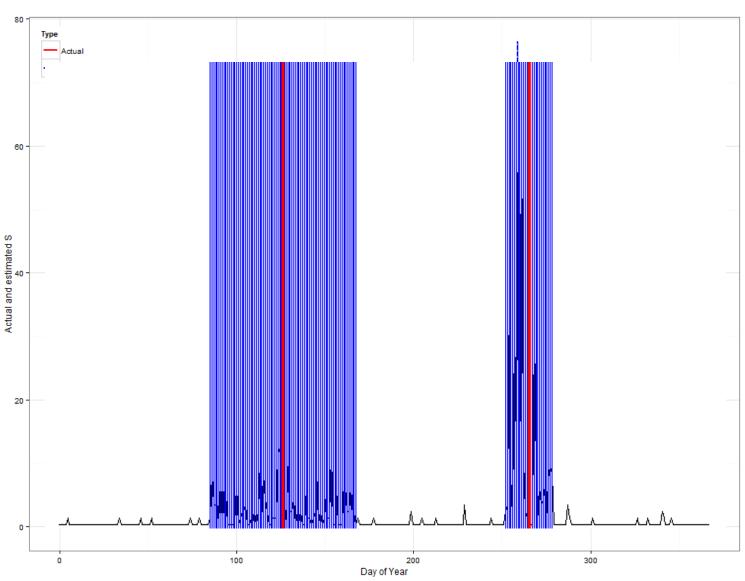


## Shape

## Rate

# Phenology informs $S$ estimation

# Preliminary tests

## Perfect conditions

# Preliminary tests

Imperfect conditions

# Preliminary tests
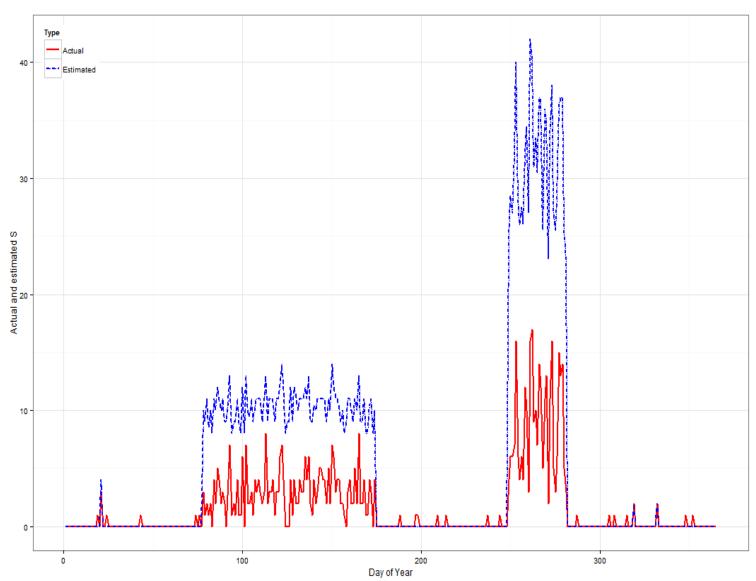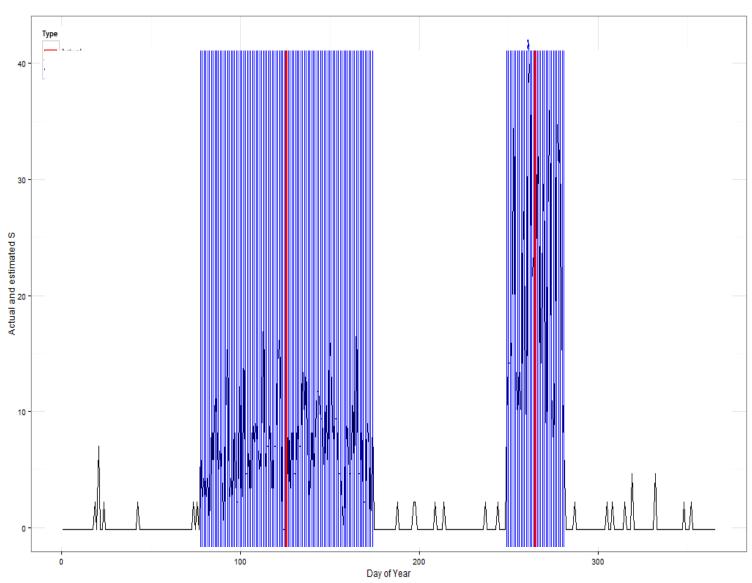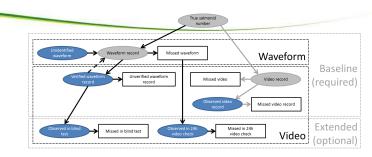
## Imperfect conditions

# Confused!

???

(@_@)

# Further work



- More simulation tests

- Extending to include "system tests"

  - 24h waveform check
  - Video observer test

# Application

∑ *June* 2016 *BayeSalmon*

- User workshop in 2016
  - Environment Agency
  - Natural Resources Wales
  - Scottish Natural Heritage
  - Scottish and Southern Electric
  - Inland Fisheries Ireland
  - others…

- Student projects

# Thank you

Bagliniere

Ibbotson

Gregory

Beaumont

Rivot

MorFish

Monitoring for Migratory Fish

Prevost

Jeannot

Roussel

Lauridsen

Nevoux

Scott

Roberts

www.morfish.org.uk

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