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Post-catch survivability of discarded Norway lobsters (*Nephrops norvegicus*): Further investigations within the large-scale fleet operation

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Reformed Common Fisheries Policy (CFP)

- The aim of the reformed CFP is the exploitation of living marine biological resources at levels which contribute to long-term sustainable environmental, economic and social conditions.
- Reinforced strategies within CFP include the **introduction of measures to reduce discards**.
- However, even with the implementation of new reduction measures, the reformed CFP has approved **an obligation to land all catch (LANDING OBLIGATION)**, including discards from species which are subject to catch limits or quotas, except for some specific exemptions.
- One of the **landing exemptions** is for those species deemed to have a **high post-catch survivability**.

Norway lobster (*Nephrops norvegicus*)

- In the case of post-trawl discarded Norway lobsters (*Nephrops norvegicus*) it is assumed that the survivability of this species post-discarding is 25%.
- Recent studies by the Swedish University Agricultural Sciences and Cefas have reported **survival estimates of around 60-75% using different selective measures.**
- The differences in operational practice and environmental conditions between fisheries can restrict the extrapolation of discard survival estimates from one fishery to another.
- Therefore, to be able to potentially support an exemption from the landing obligation, **fishery specific trials are needed** to estimate levels of survival of *Nephrops* discarded by Scottish trawlers.



after: IPIMAR database (2002)

OBJECTIVES

1- To conduct **tank-based *Nephrops* post-trawl survival trials** using a **representative vessel** operating:

1a) In the West Coast, Minches taking into account seasonal variation.

1b) In the East Coast, Firth of Forth in the summer season.



2- To **collect relevant data (environmental, fishing practices and damage) from the wider fleet** to elucidate if the vessels used in tank-based survival trials were comparable/representative of the wider fleet for West (Minches) and East (Firth of Forth) fisheries. SFF collaboration.



**Generate survival estimates for post-trawl
discarded *Nephrops***

OBJECTIVES

3- To conduct **behavioural observations on post-trawl discard *Nephrops*** recover under natural conditions on the seabed and interact with potential predators using fixed and mobile underwater camera systems.



4- Evaluate which potential **environmental/on-board factors are associated to post-discard survival.**



Generate a **set of recommendations**
for best practice to minimise post-
discard mortality on *Nephrops* discards

PROTOCOL TANK-BASED SURVIVAL TRIALS

- 1- Record of environmental parameters and fishing practices on the day.
- 2- Record of catch composition (target and non-target species). Record also of amount and size composition of discarded *Nephrops*.
- 3- A sub-sample of 20 discards (T=0) were sampled: visual indexes recorded (damage, vigour and reflex indexes) and samples taken for biochemical analysis (stress-related parameters).
- 4- Another 100 discarded *Nephrops* are placed in tube-set boxes after recording visual indexes and placed in an on-board tank with seawater. Record taken of discards *Nephrops* dead at the time of catch.
- 5- Animals transported in containers to SAMS aquaria. Survival recorded for up to 13 days. Damage at time of death or end of trial recorded again.

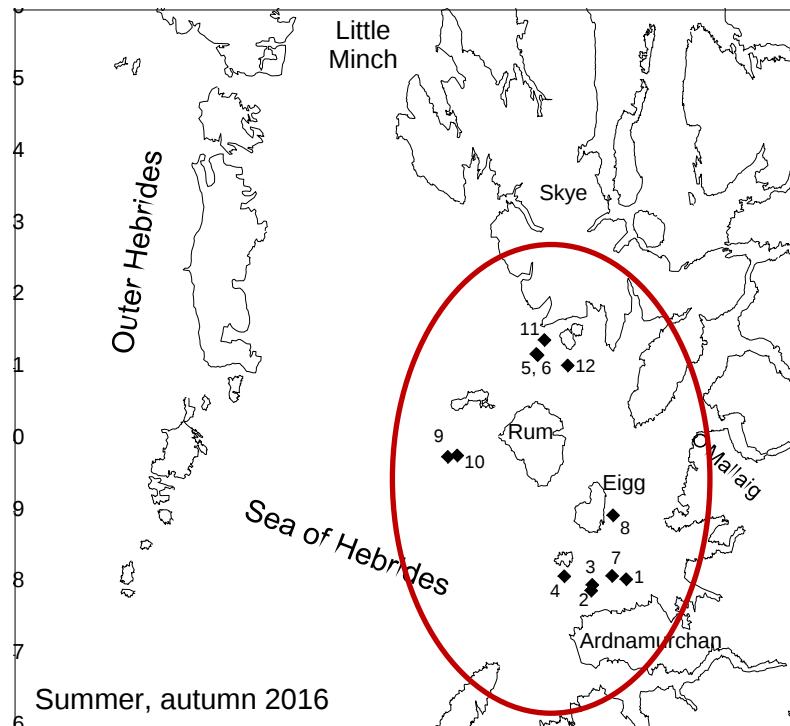


WEST COAST (MINCHES) TANK-BASED SURVIVAL TRIALS



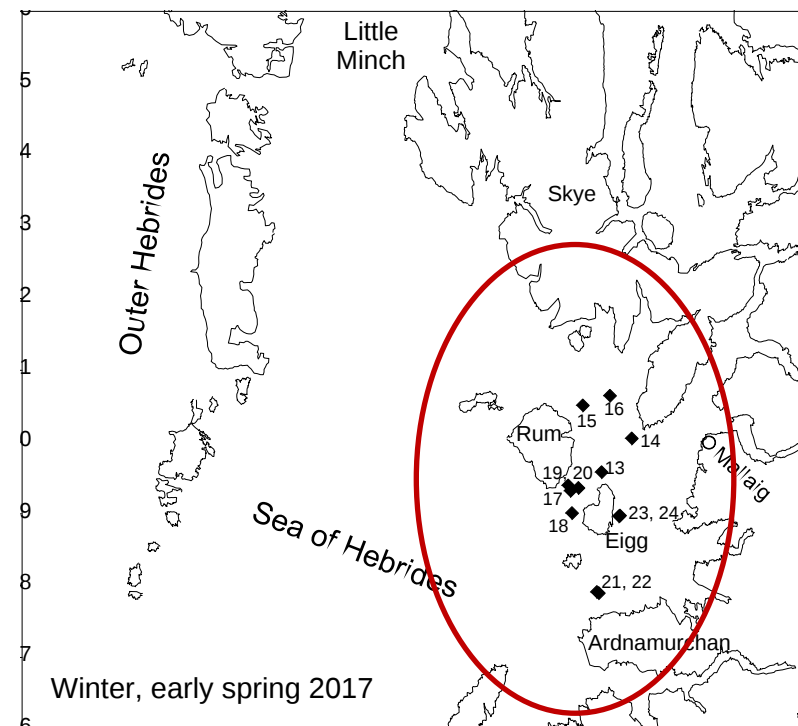
Commercial fishing vessel 'Ocean Trust' (>15m) (Mallaig)
Twin-rig/nets 10 m wide rock-hoppers fitted with 200 mm square mesh escape panels

Summer



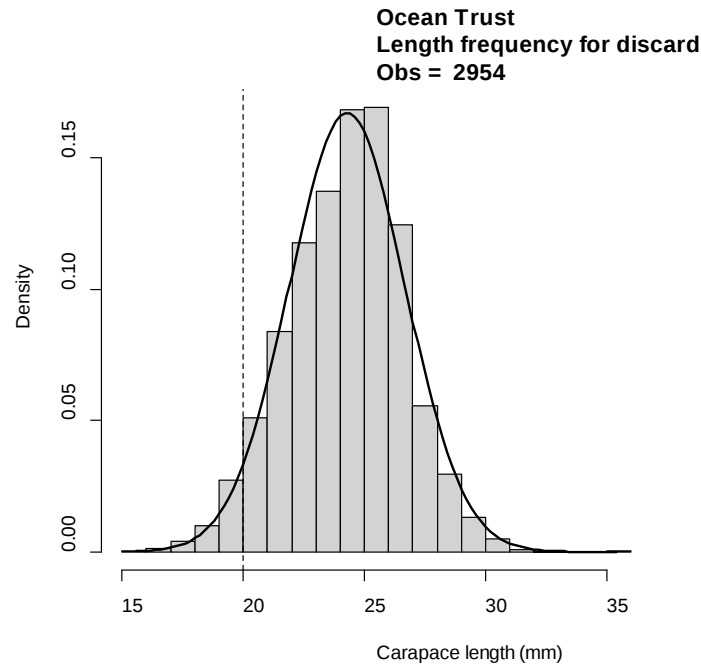
- 6 tank-based survival trials TR1 net
- 6 tank-based survival trials TR2 net

Winter



- 6 tank-based survival trials TR1 net
- 6 tank-based survival trials TR2 net

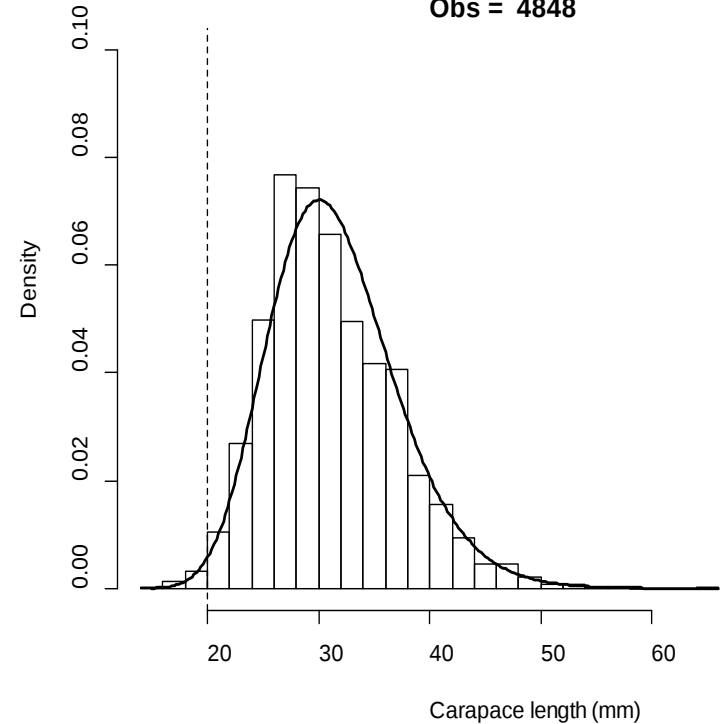
WEST COAST (MINCHES)



Mean Carapace lengths of discarded *Nephrops* was 24.3 +/- 1.98 mm CL



Around 97% of the discarded *Nephrops* were >MCRS (Division VIa is 20 mm CL)



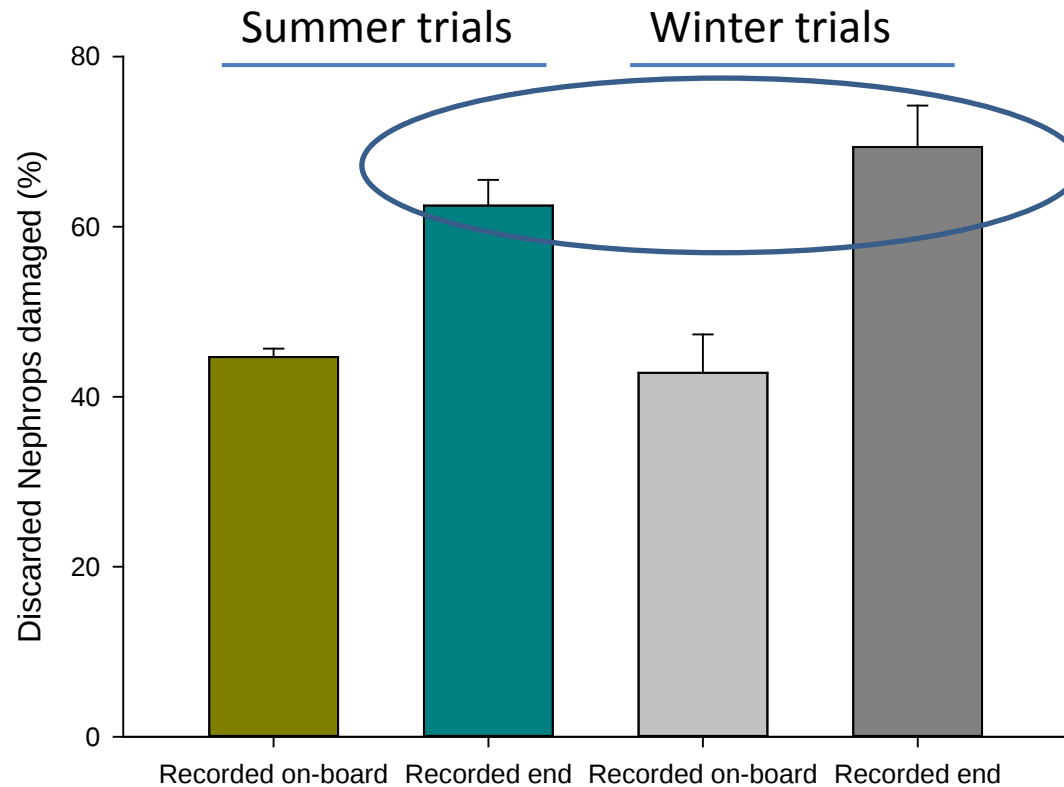
Around 2.6% (+/-0.5%) of *Nephrops* catch was discarded.



The total number of *Nephrops* discarded per tow was in average around 626 individuals.

WEST COAST (MINCHES): DAMAGE

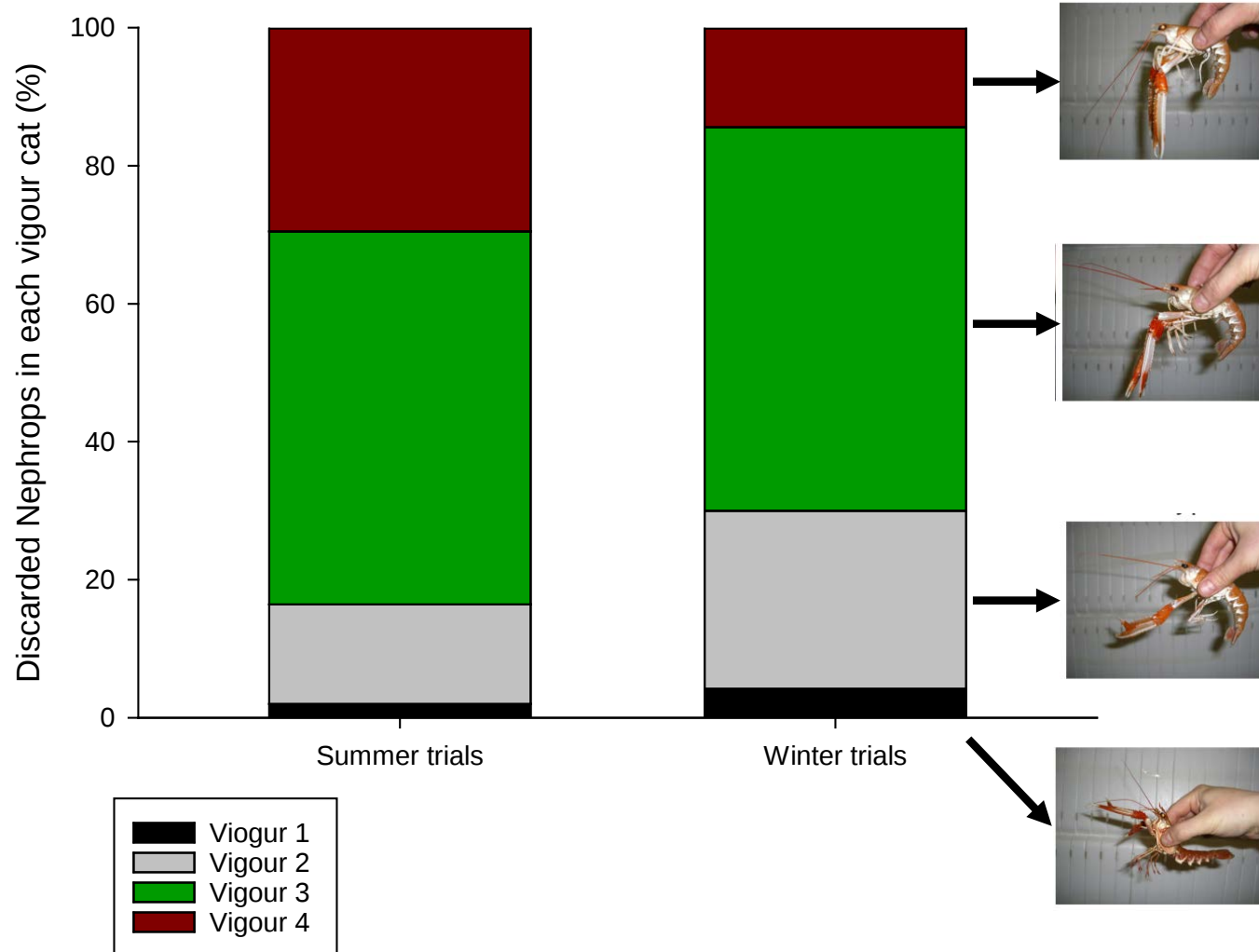
Around 88% ($\pm 2.4\%$) of discarded *Nephrops* were alive during sorting



The average percentage of discard fraction *Nephrops* across both seasons with damage when scored in the aquarium was $63.4 \pm 4.4\%$

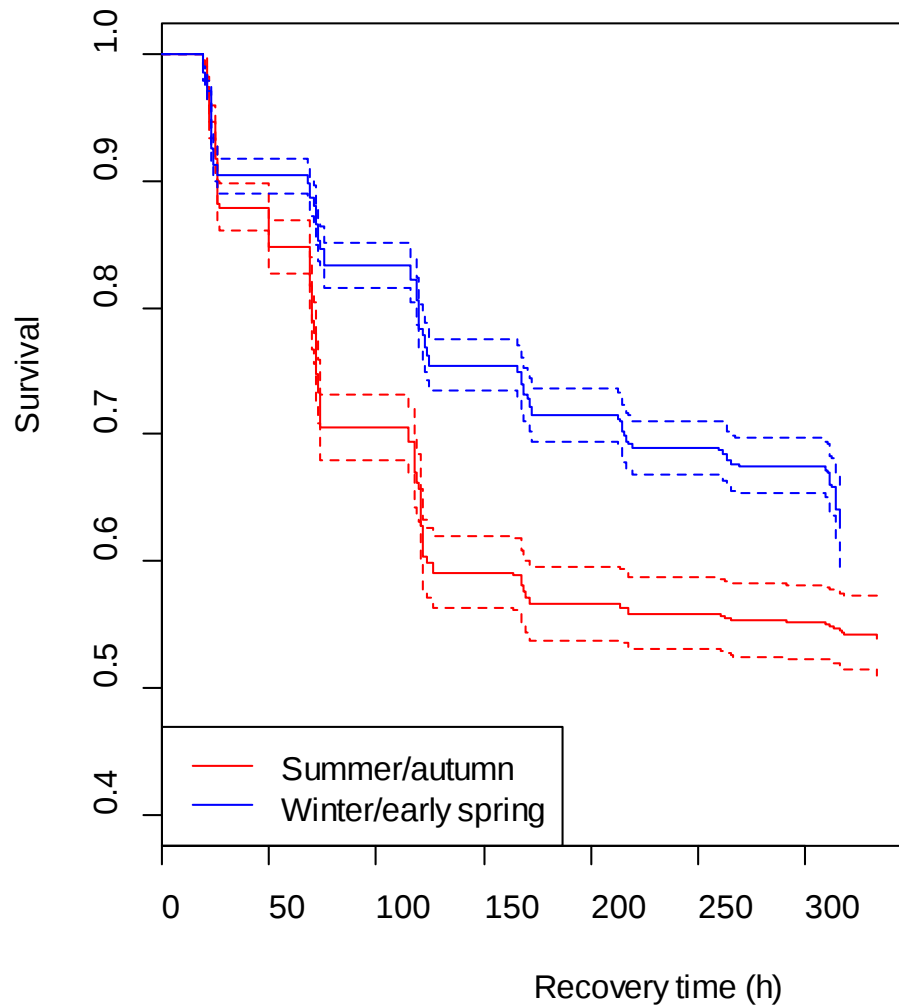
WEST COAST (MINCHES): VIGOUR AFTER CAPTURE

After trawling the majority of discarded *Nephrops* were in vigour category 3



TANK-BASED SURVIVAL ESTIMATES WEST COAST (MINCHES)

Survival was significantly affected by season with lower survival recorded in the summer.



Final estimates (corrected to considering discards *Nephrops* dead at time of capture) were:

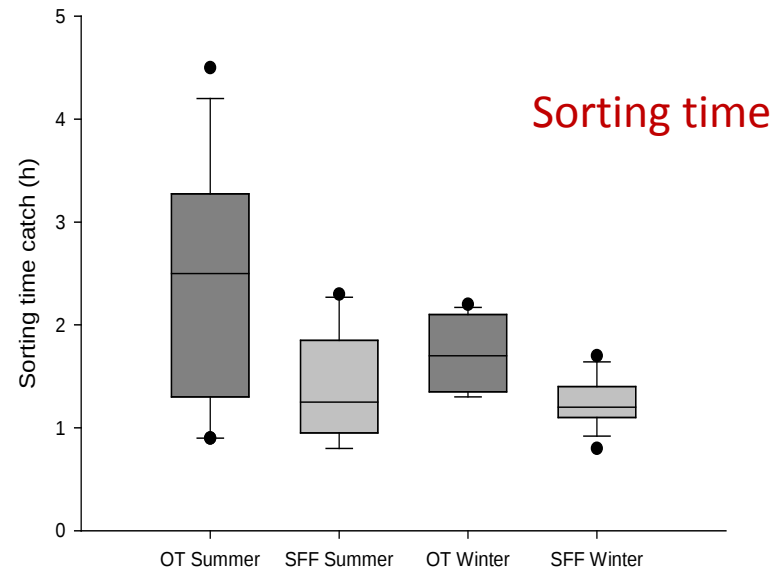
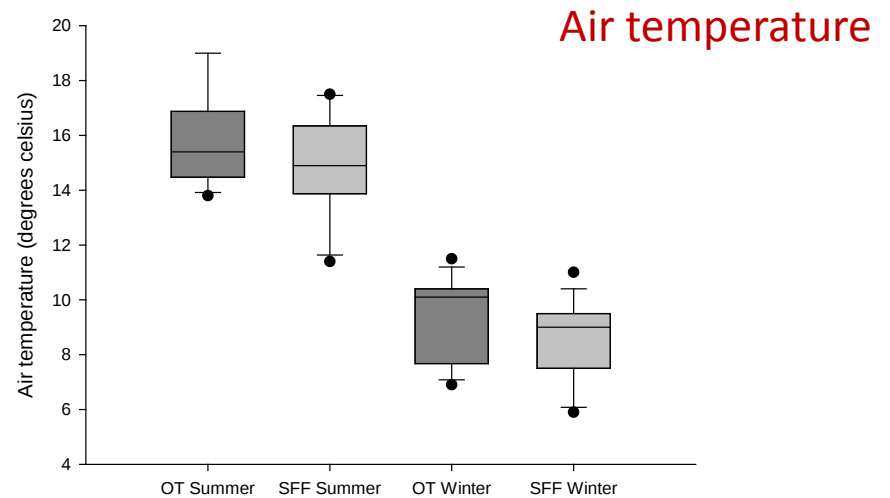
- 45.7% (43.4-48.3%) in summer
- 56.3% (53.5-59.4%) in winter

OVERALL SURVIVAL ESTIMATE MINCHES:

52.7% (50.9-54.6%) across both seasons

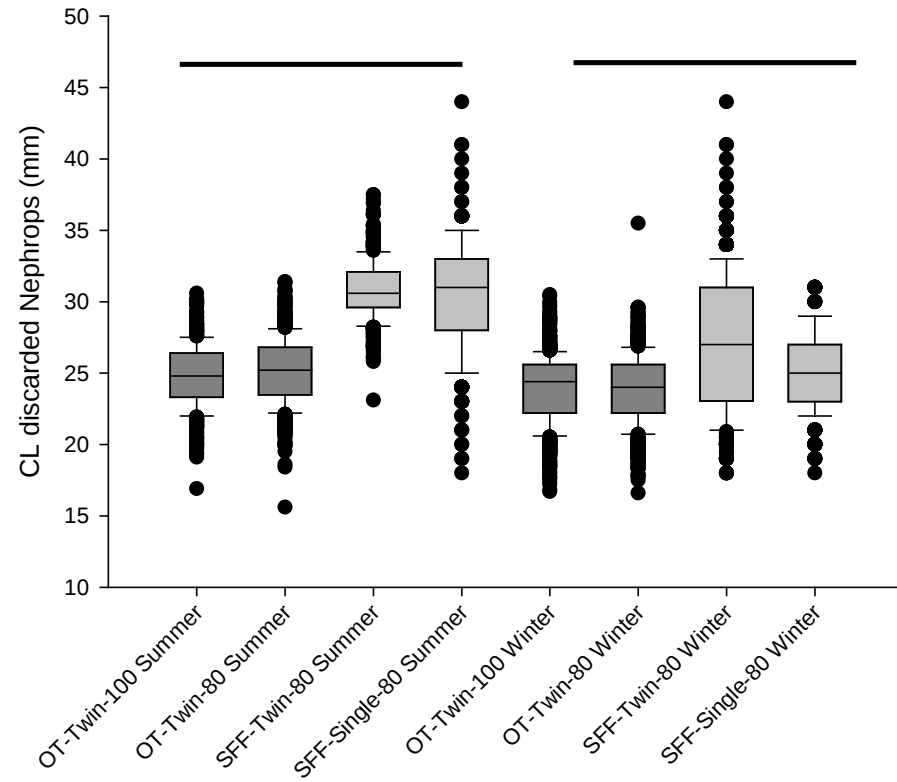
HOW EXTRAPOLLABLE ARE THESE RESULTS TO WIDER FLEET?

- For the Scottish west coast (Minches) the environmental conditions, fishing practices and damage to discarded *Nephrops* from 'Ocean Trust' were compared seasonally with the wider fleet (3 single-rig vessels and 3 twin-rig vessels, TR2; **10 tows for comparison in the summer and 14 in the winter**).
- In general terms, 'Ocean Trust' data were in range with the wider fleet information indicating that the discard survival estimates are representative of the wider fleet operating on the west coast.

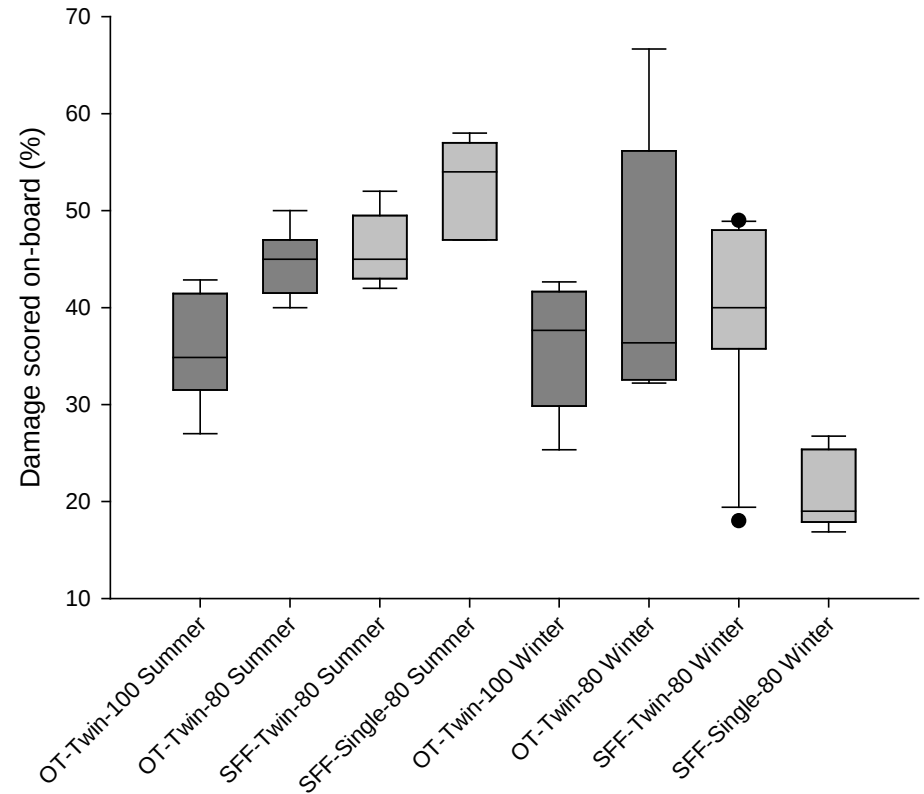


HOW EXTRAPOLLABLE ARE THESE RESULTS TO WIDER FLEET?

CL discarded *Nephrops*



Percentage of damaged discarded *Nephrops*



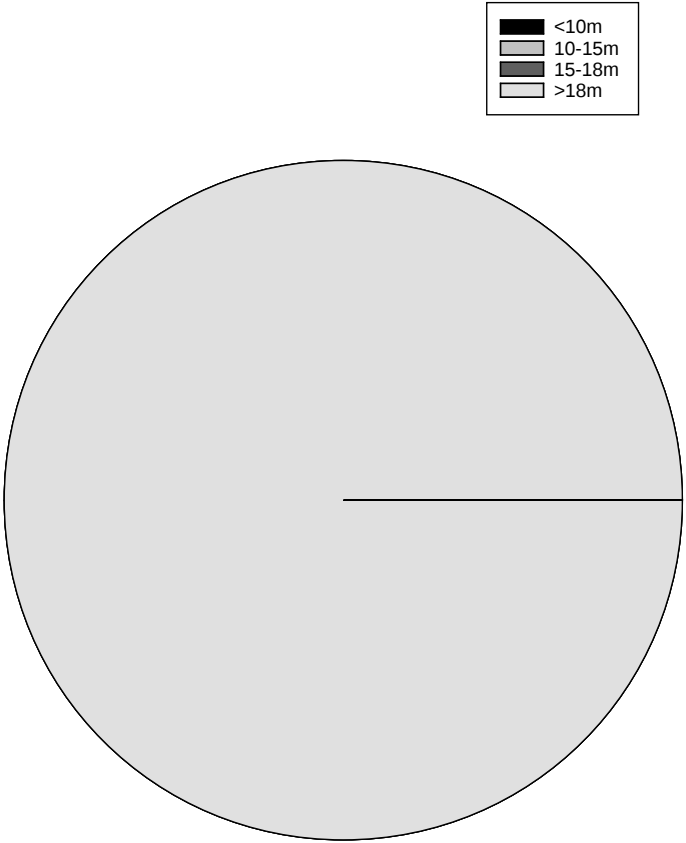
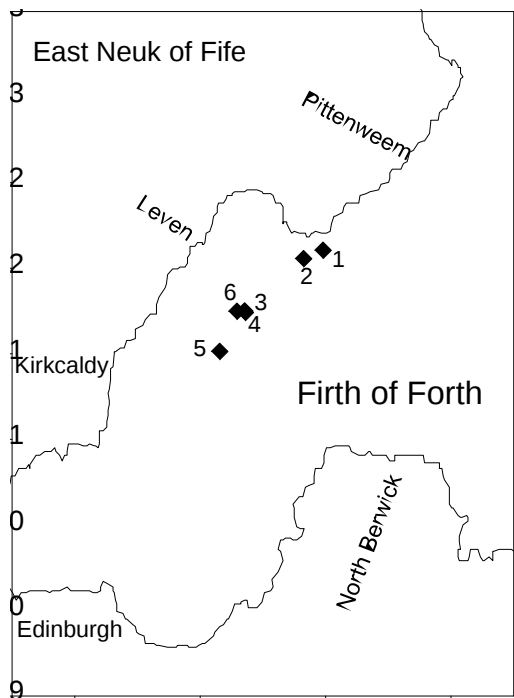
EAST COAST (FIRTH OF FORTH) TANK-BASED SURVIVAL TRIALS



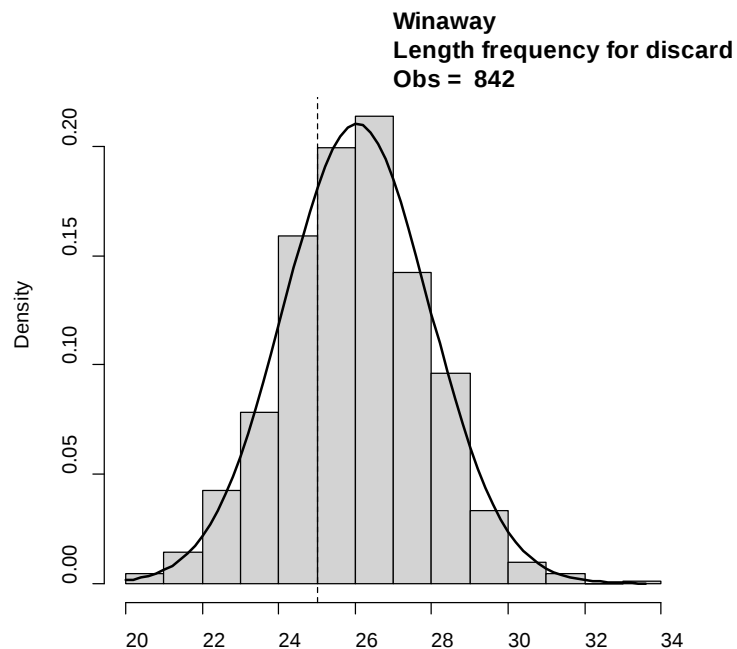
Commercial fishing vessel ‘Winaway’ (11.4 m) (Pittenweem)
Twin-rig/nets 6 m wide rock-hoppers fitted with 200 mm square mesh escape panels and 80 mm TR2 cod end nets

Selection of vessel not easy....

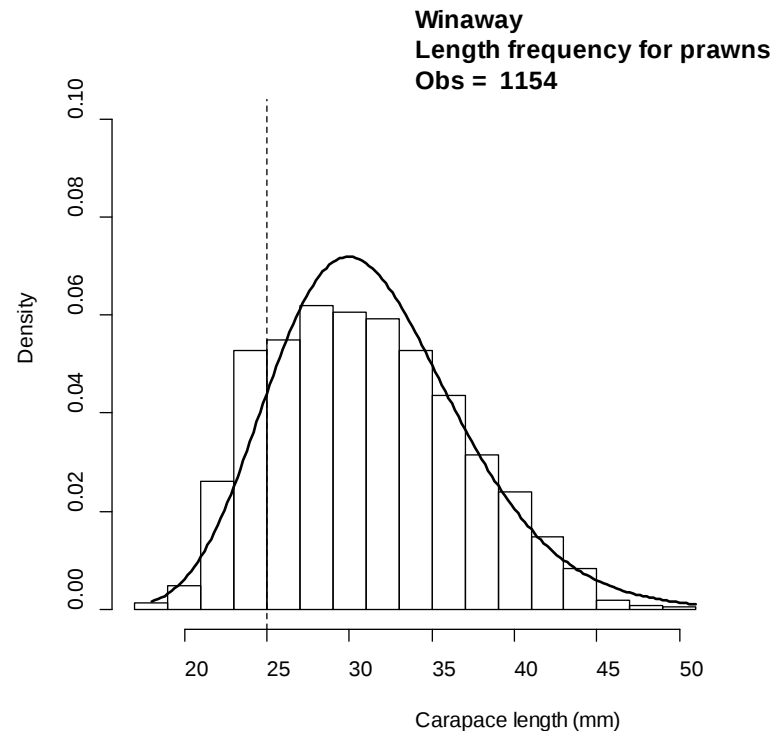
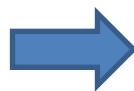
Summer: 6 tank-based survival trials TR2 net



EAST COAST (FIRTH OF FORTH)



Mean Carapace lengths of discarded *Nephrops* was 26.0 +/- 1.9 mm CL



Around 71% of the discarded *Nephrops* were >MCRS (Division IVa is 25 mm CL)

Around 6.7% (+/-1.6%) of *Nephrops* catch was discarded.

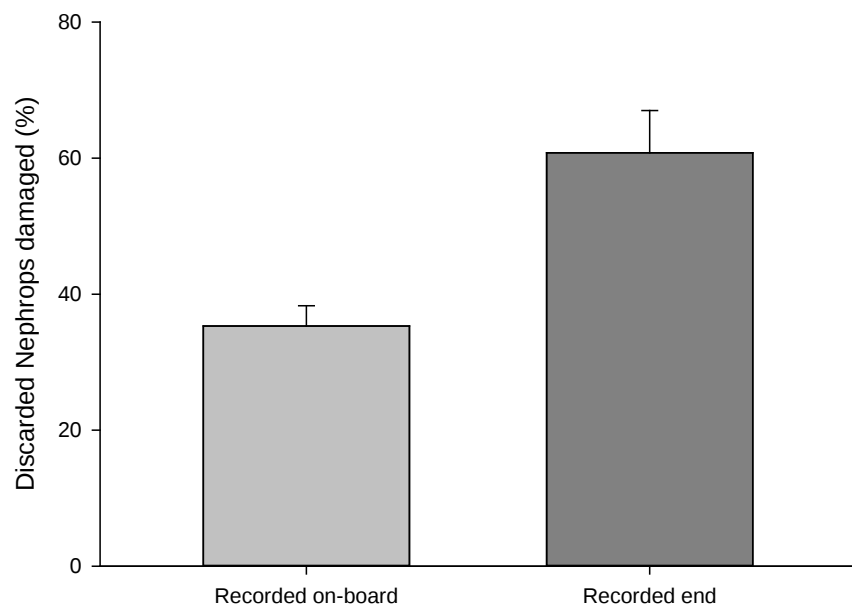


The total number of *Nephrops* discarded per tow was in average around 763 individuals.

EAST COAST (FIRTH OF FORTH)

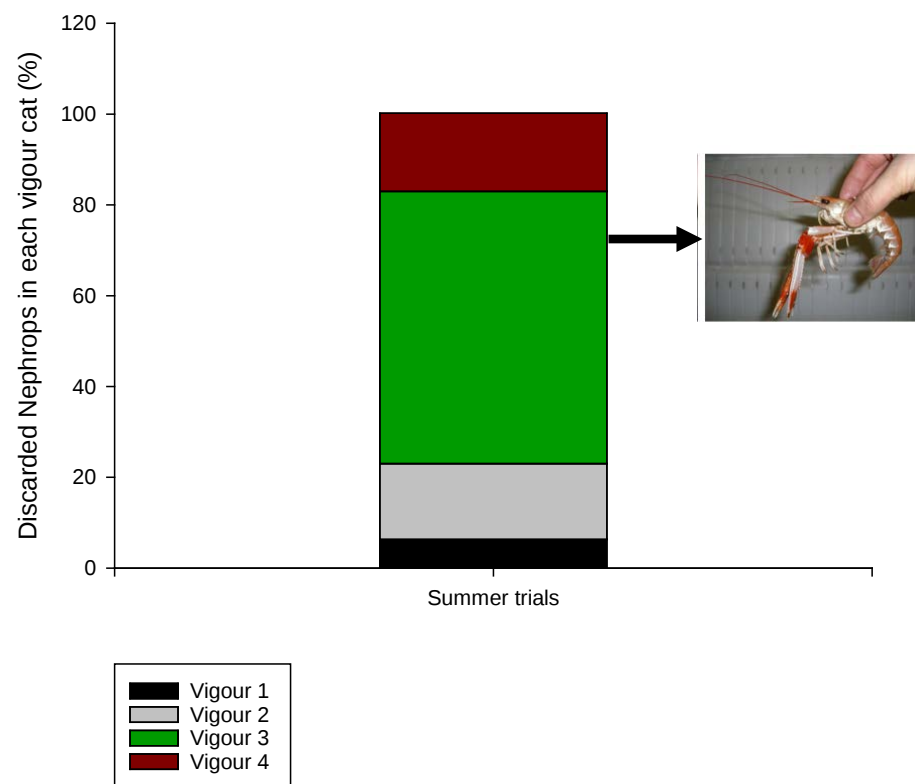
Damage

The average percentage of discard fraction *Nephrops* with damage when scored in the aquarium was 60.8 ± 6.2 (mean $\pm$ 95% CI)

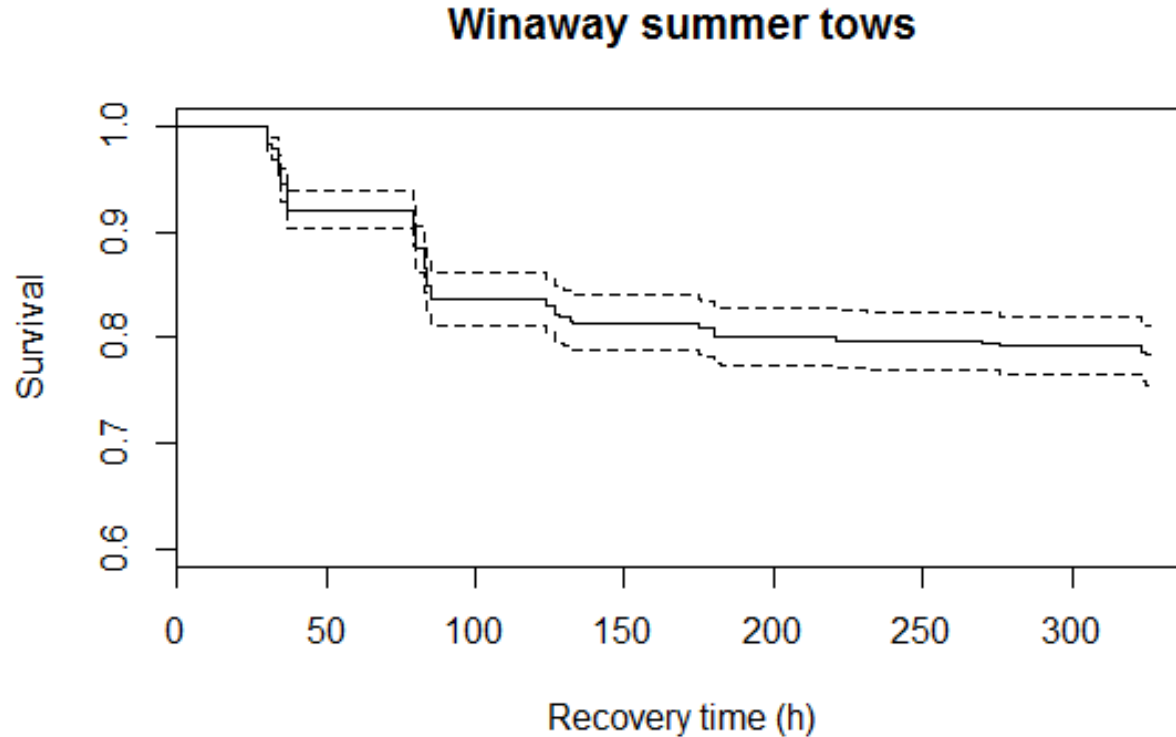


Vigour Index

At the time of sampling the majority of discard fraction *Nephrops* were in vigour category 3



TANK-BASED SURVIVAL ESTIMATES EAST COAST (FIRTH OF FORTH)



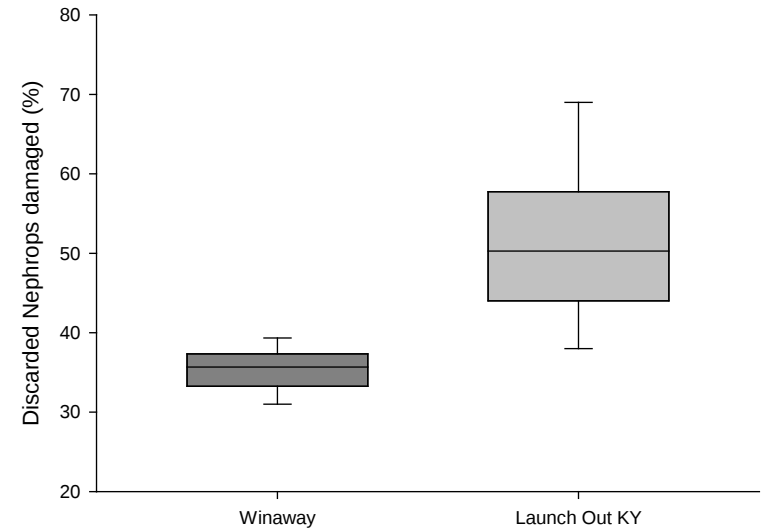
Final estimates (corrected to considering discards *Nephrops* dead at time of capture) were:

- 74.5% (71.8-77.1%) in summer

HOW EXTRAPOLLABLE ARE THESE RESULTS TO WIDER FLEET?

- For the Scottish east coast (Firth of Forth) environmental conditions, fishing practices and damage on discarded *Nephrops* from 'Winaway' were compared with available data from one other vessel (6 tows).
- There were substantial differences in the estimates of discard rates, occurrence of injuries and immediate mortalities between the two vessels, which also fished in different locations.
- **The survival estimates obtained in the recovery trials are likely to be most representative of smaller (<15m) vessels, such as the 'Winaway', operating in the inner Firth of Forth and less representative of larger vessels fishing further offshore.**

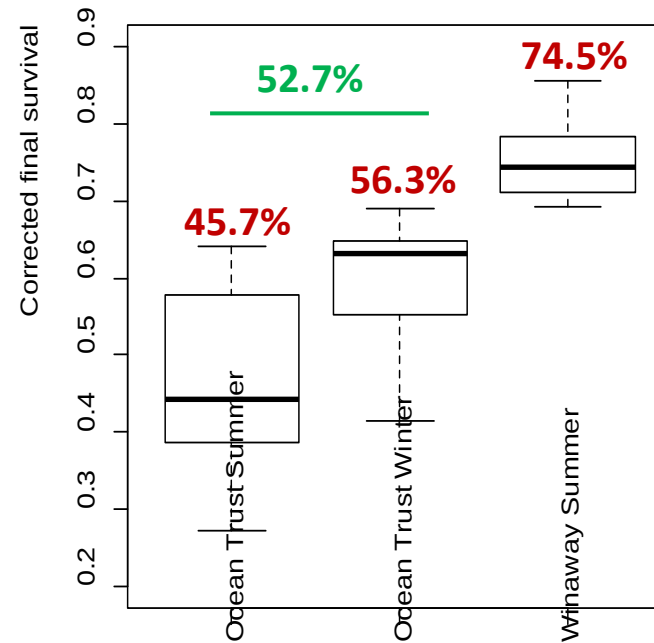
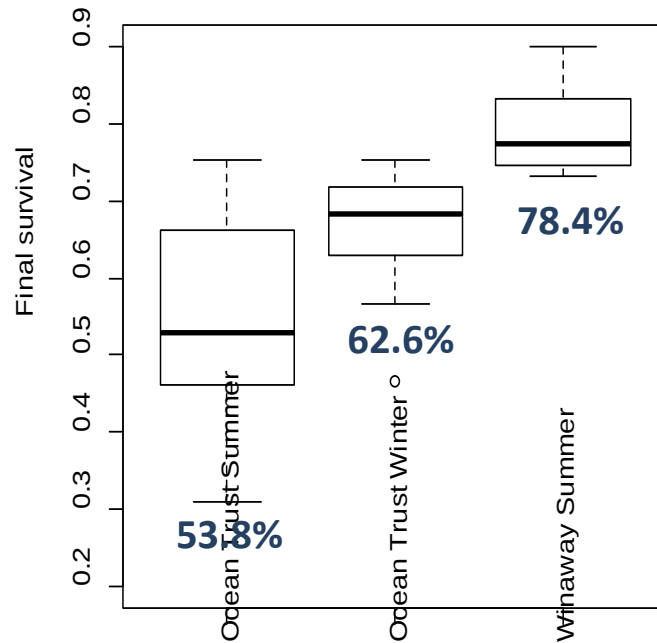
Damage scored on-board



% Discard *Nephrops* alive while sorting

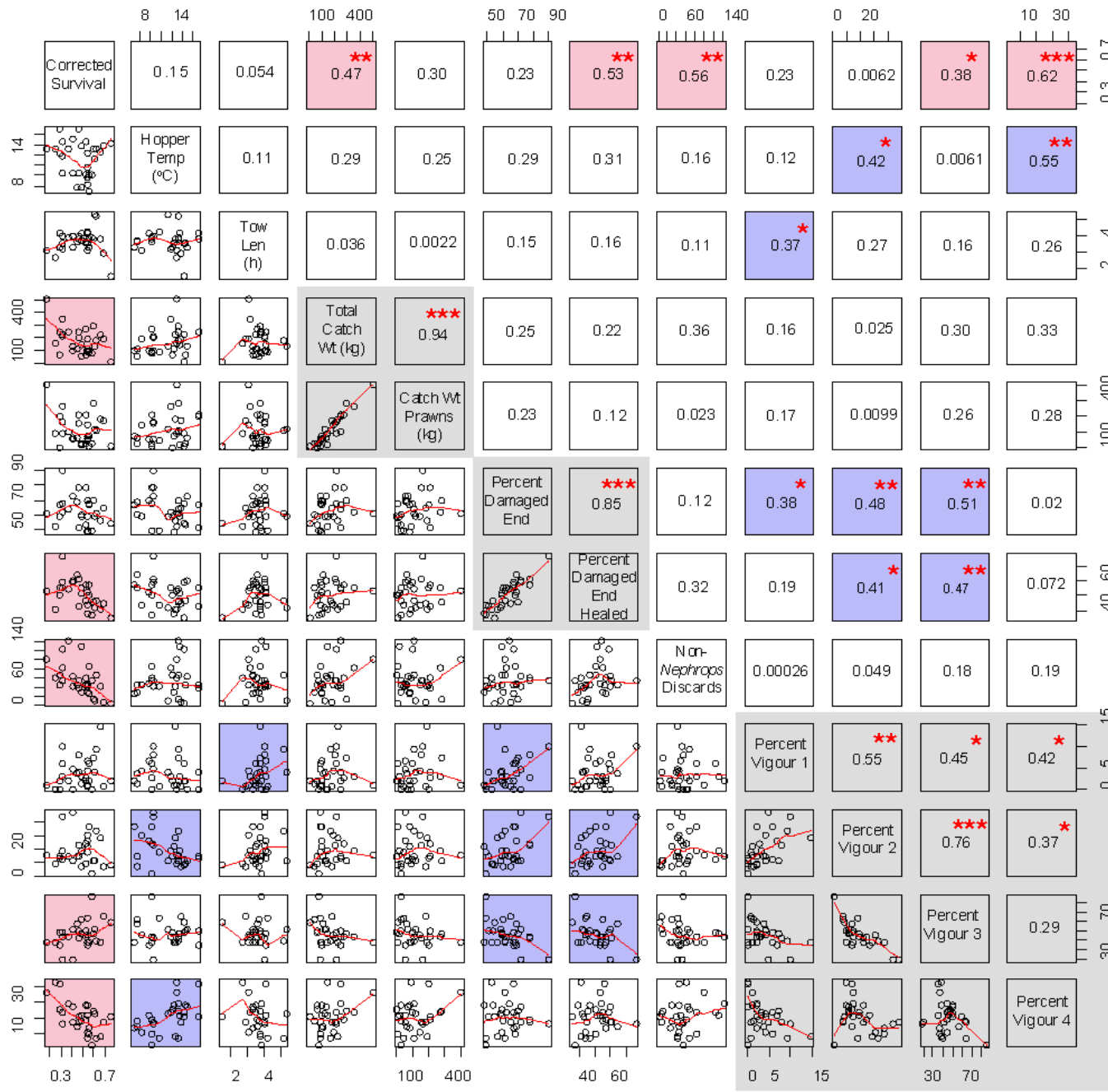


SUMMARY TANK-BASED SURVIVAL ESTIMATES



- These estimates were obtained using the captive observation method as recommended by ICES WKMEDS (Methods for Estimating Discard Survival).
- The holding tanks caused negligible deaths during the monitoring period (control samples showed mortalities of 3% Ocean Trust trials and 0% Winaway trials) providing confidence in the survival estimates.

Which variables associated with survival of discarded *Nephrops*?

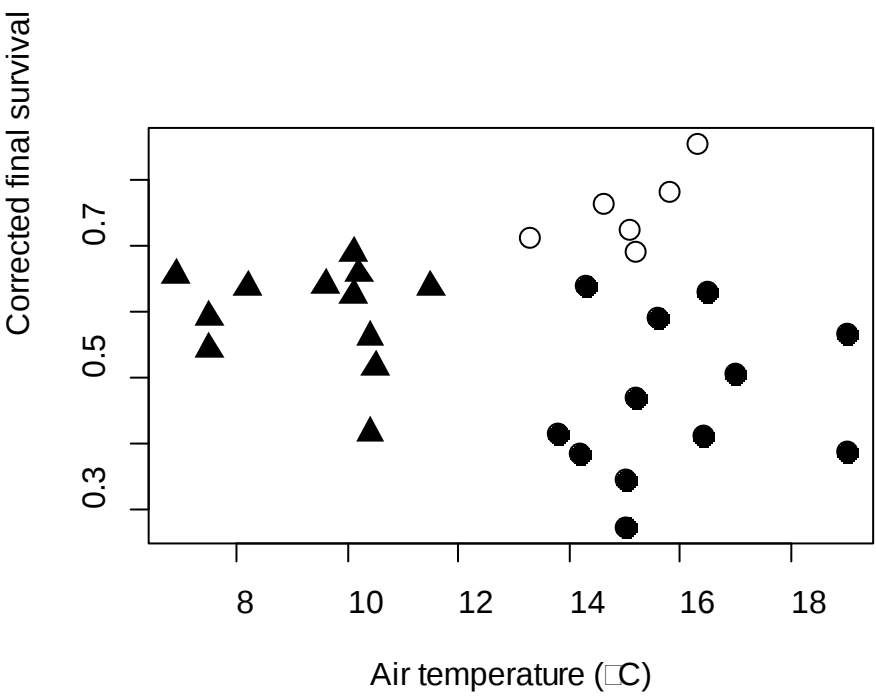
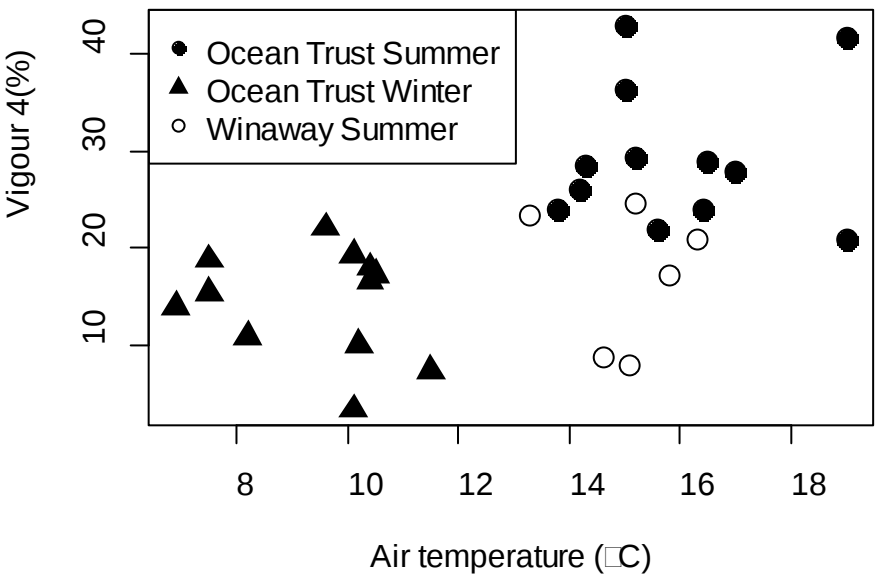
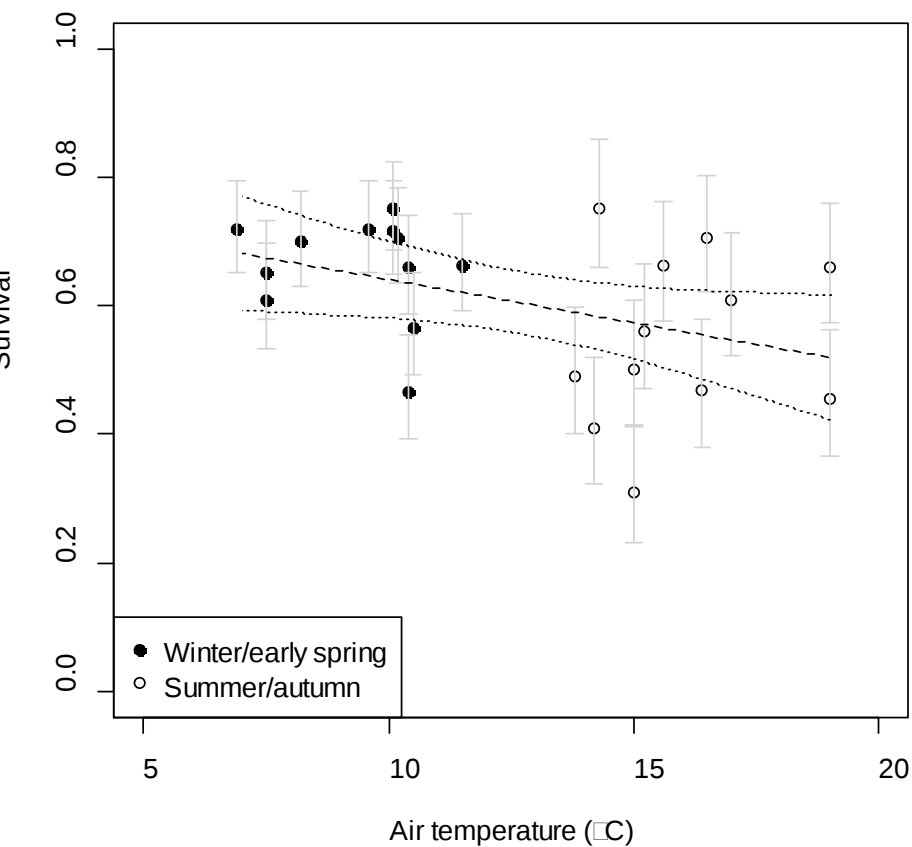


FACTORS ASSOCIATED WITH SURVIVAL OF DISCARDED NEPHROPS

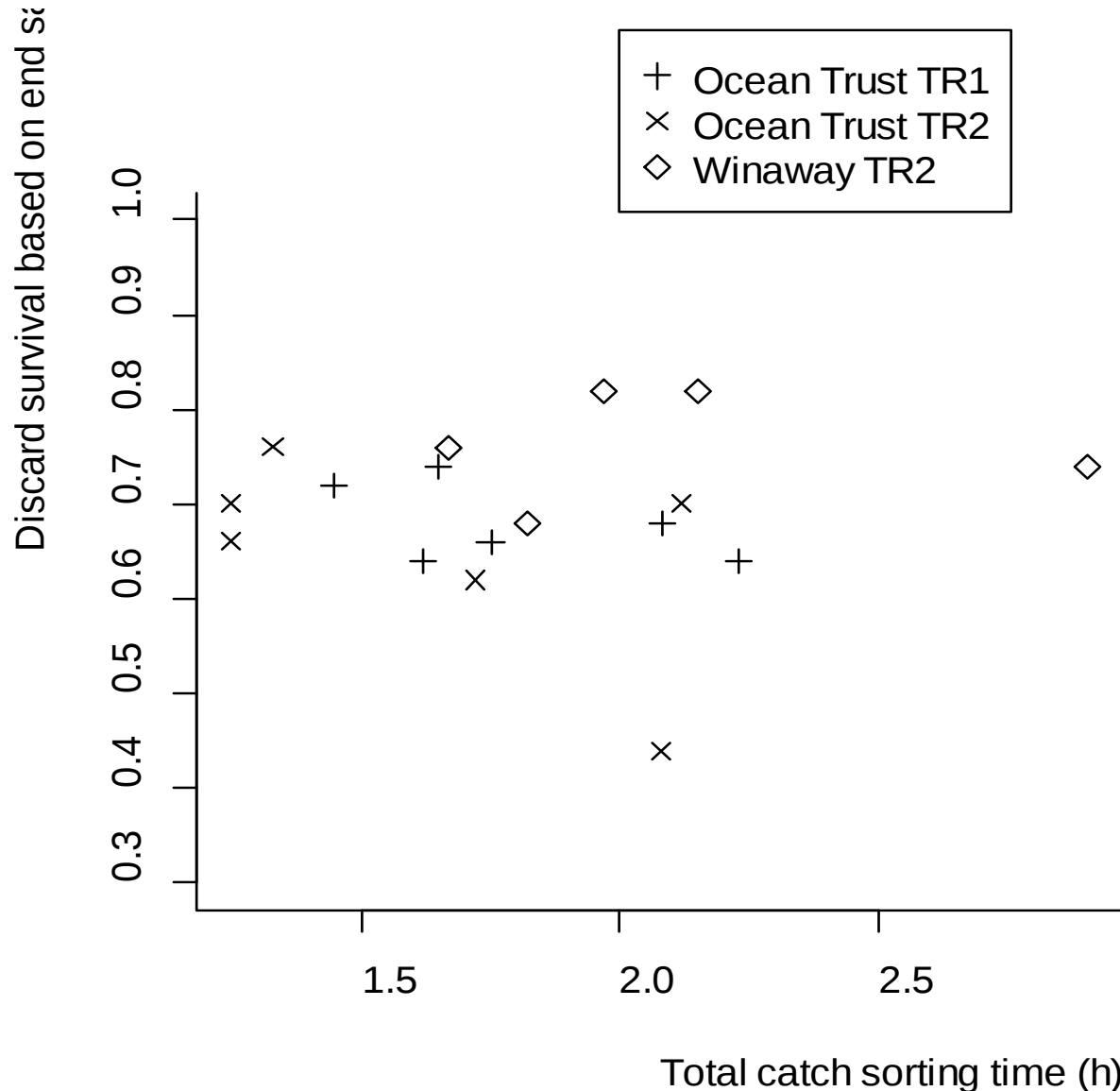
VIGOUR AND AIR TEMP

- Lower survival observed in catches where discards *Nephrops* were recorded with poorest vigour index at time of catch

Final survival versus air temp
 $Surv = 0.7755 - 0.0135 \times Air\ temp$



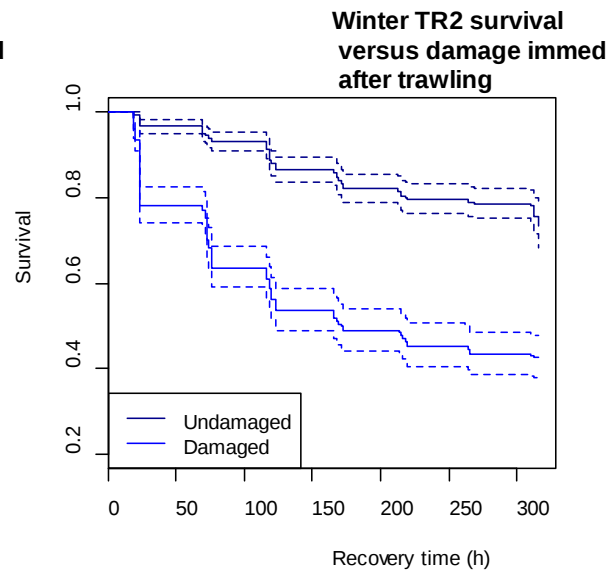
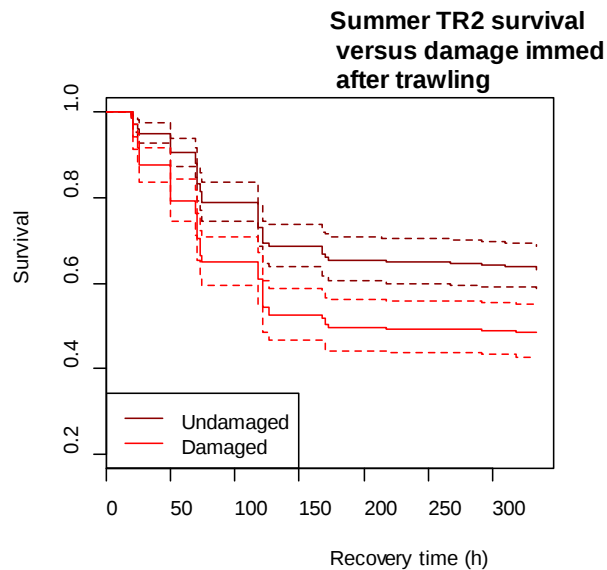
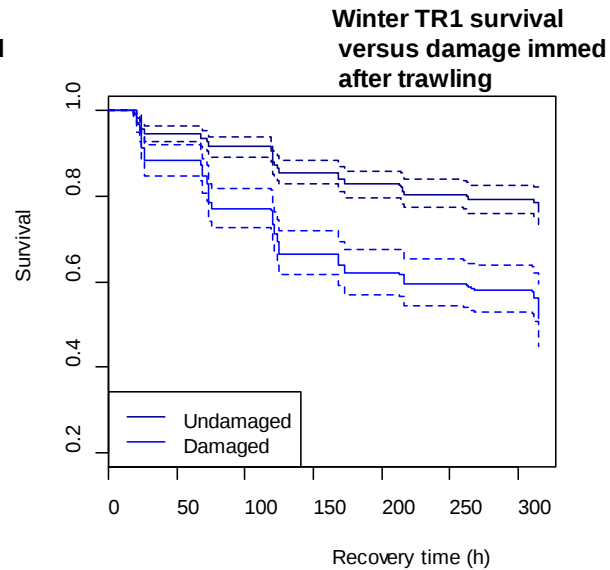
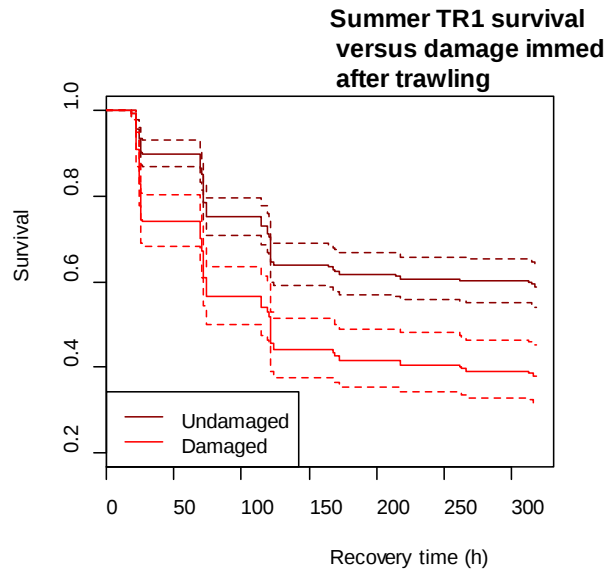
FACTORS ASSOCIATED WITH SURVIVAL OF DISCARDED *NEPHROPS*



SORTING TIME

- Sorting time (≤ 3 h) did not affect significantly *Nephrops* discard survival.
- However, it is possible (no data available) that longer sorting times will negatively affect survival.

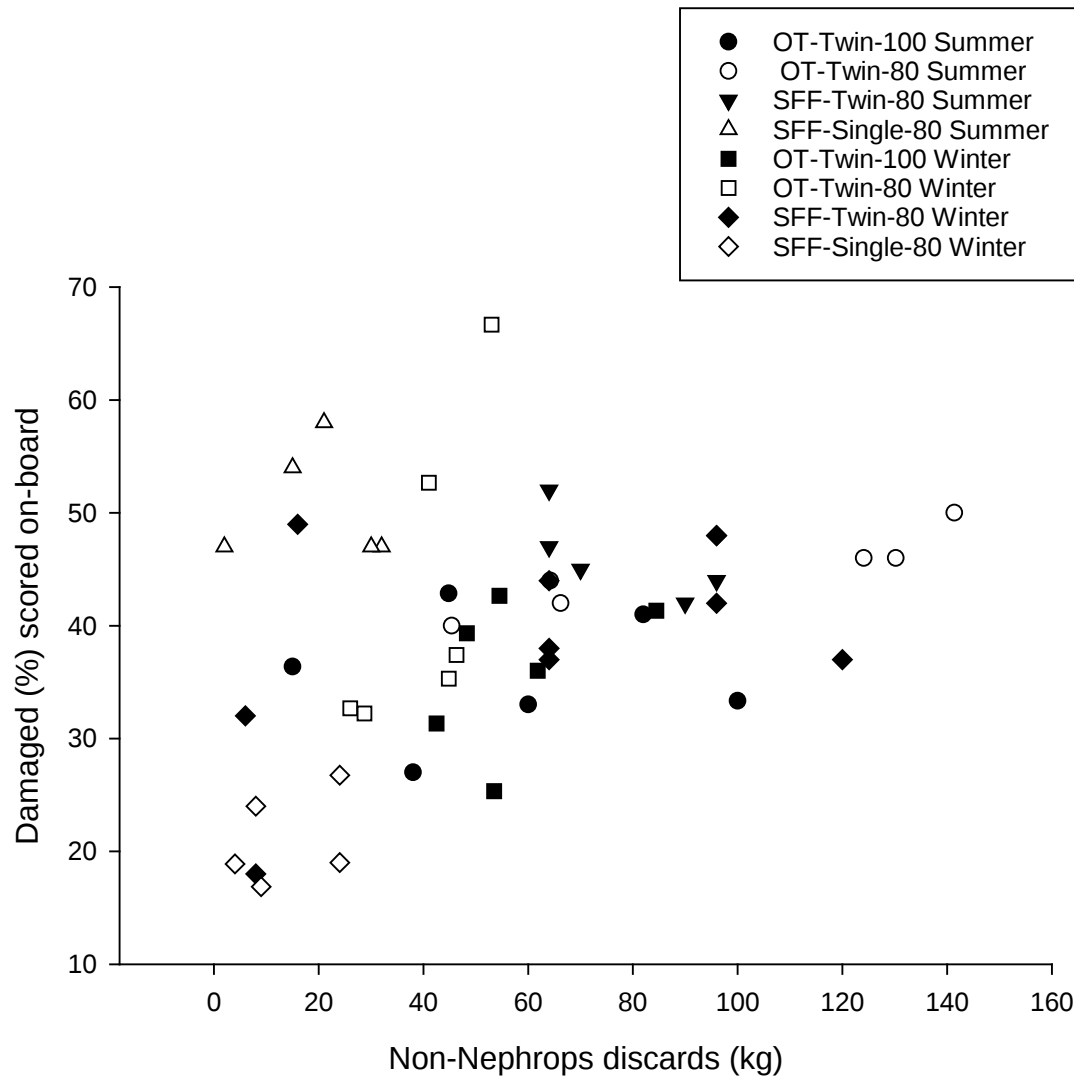
FACTORS ASSOCIATED WITH SURVIVAL OF DISCARDED NEPHROPS



DAMAGE

- Damage had a negative effect on survival of discarded *Nephrops*.

FACTORS ASSOCIATED WITH SURVIVAL OF DISCARDED *NEPHROPS*



DAMAGE

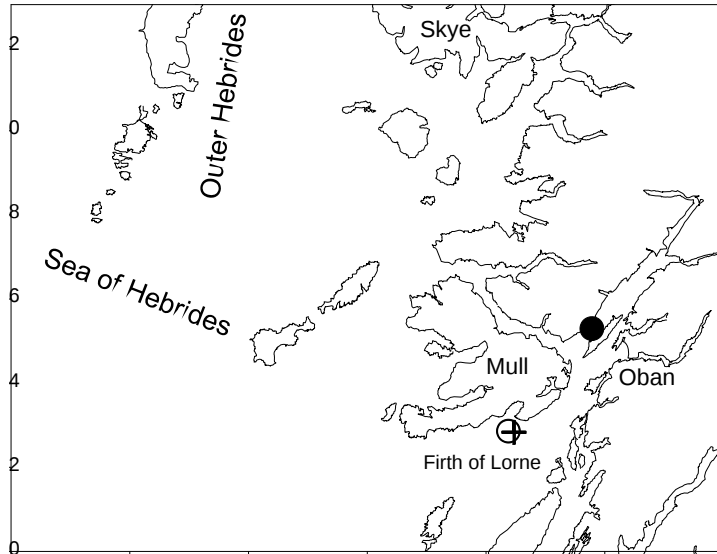
- Damage had a negative effect on survival of discarded *Nephrops*.
- Damage increased in catches where non-*Nephrops* discards were highest.

FACTORS ASSOCIATED WITH SURVIVAL OF DISCARDED *NEPHROPS*

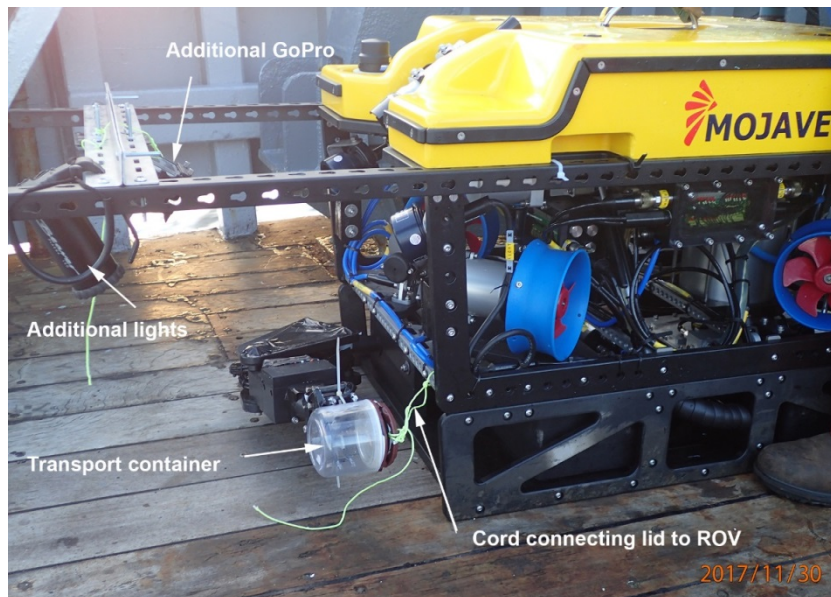
HANDLING OF CATCH AND HOPPER DESIGN?

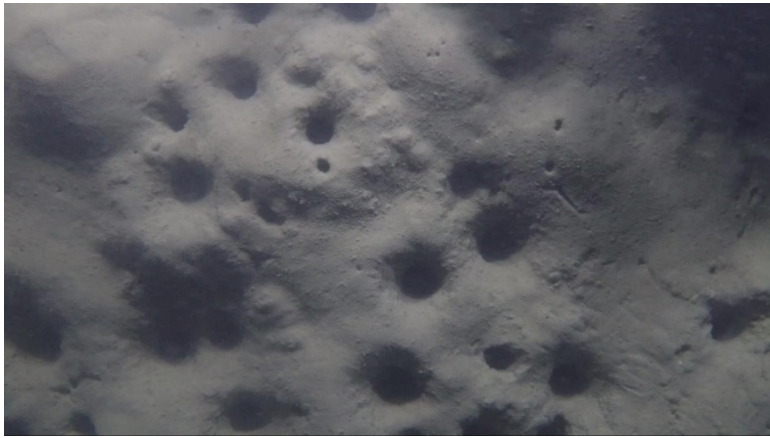


Behavioural observations on discarded *Nephrops*



- 15 dives were completed at between 70-115 m water depth observing the responses of 23 discard-sized *Nephrops* released on the seabed.
- Observations performed in Mar and Nov 2017.





- If available *Nephrops* generally entered a burrow within a few minutes.
- Only *Nephrops* which had been exposed to air for more than 2.5 to 3 h remained moribund on the seabed when released and even these animals revived and began exploring their surroundings within 10 mins.



- Their behaviour once recovered therefore seemed normal i.e. moving about with claws raised in defensive postures or entering burrows.



- Apart from a few small gadoid fish no other potential predators were seen at the release sites and there were thus no interactions between released *Nephrops* and potential predators.

RECOMMENDATIONS BASED ON TANK-BASED SURVIVAL TRIALS

- **Cool air temperatures in the hopper:**
 - A fine seawater mist spray could be installed in the catch sorting hoppers at minimal cost.
 - Closing the hatch over the sorting hopper or covering the hopper once the nets are emptied is also recommended.
- **Handling strategies that minimise damage** (i.e. not walking on top of the catch and reducing the use of metal rakes to handle the catch).
 - There is circumstantial evidence to suggest that a sloping floor in the hopper might help reduce damage to the catch.
- **Reduction of non-*Nephrops* catch:** This study suggests that survival might be improved by use of more selective fishing gear by reducing the proportion of non-*Nephrops* catch.
- **Behavioural observations:** *Nephrops* should be discarded over suitable grounds to improve their chances of finding burrows to shelter.

Conclusions

- **Survival estimates now available** for West coast (Minches-overall 52.7%) and East coast (Firth of Forth-summer 74.5%) following the captive observation method as recommended by ICES WKMEDS.
- In the **West coast (Minches)**, data from vessel used was in range with the fleet indicating that the **discard survival estimates are representative** of the wider fleet.
- In the **East coast (Firth of Forth)** there were substantial differences and therefore survival estimates are **likely to be most representative of smaller (<15 m) vessels**.
- **Lower survival was associated** with the physiological condition of *Nephrops* at the point of release i.e. proportion in the **poorest vigour category**, with the proportion of *Nephrops* with signs of **physical damage**, and with higher **weights of non-*Nephrops* catch**.
- Recommendations provided are likely to improve survival but the absolute and relative benefits of each were not tested in this research.

Complete report and videos now available at:
<http://www.fiscot.org/media/1404/fis015-report.pdf>

Thanks to

- Skippers and crew of the fishing vessels 'Ocean Trust' and 'Winaway'
- SFF for their continued support and for collecting data on wider fleet operation
- West of Scotland Fish Producers Association and Fishermen's Mutual Association
- Northern Lighthouse Board for facilitating the use of 'Pole Star' for behavioural studies;
- The skipper and crew of SAMS research vessel 'Calanus' for their help with behaviour trials;
- Mr John Beaton for piloting the Mojave ROV;
- Ronan Fisher for his support during field work



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