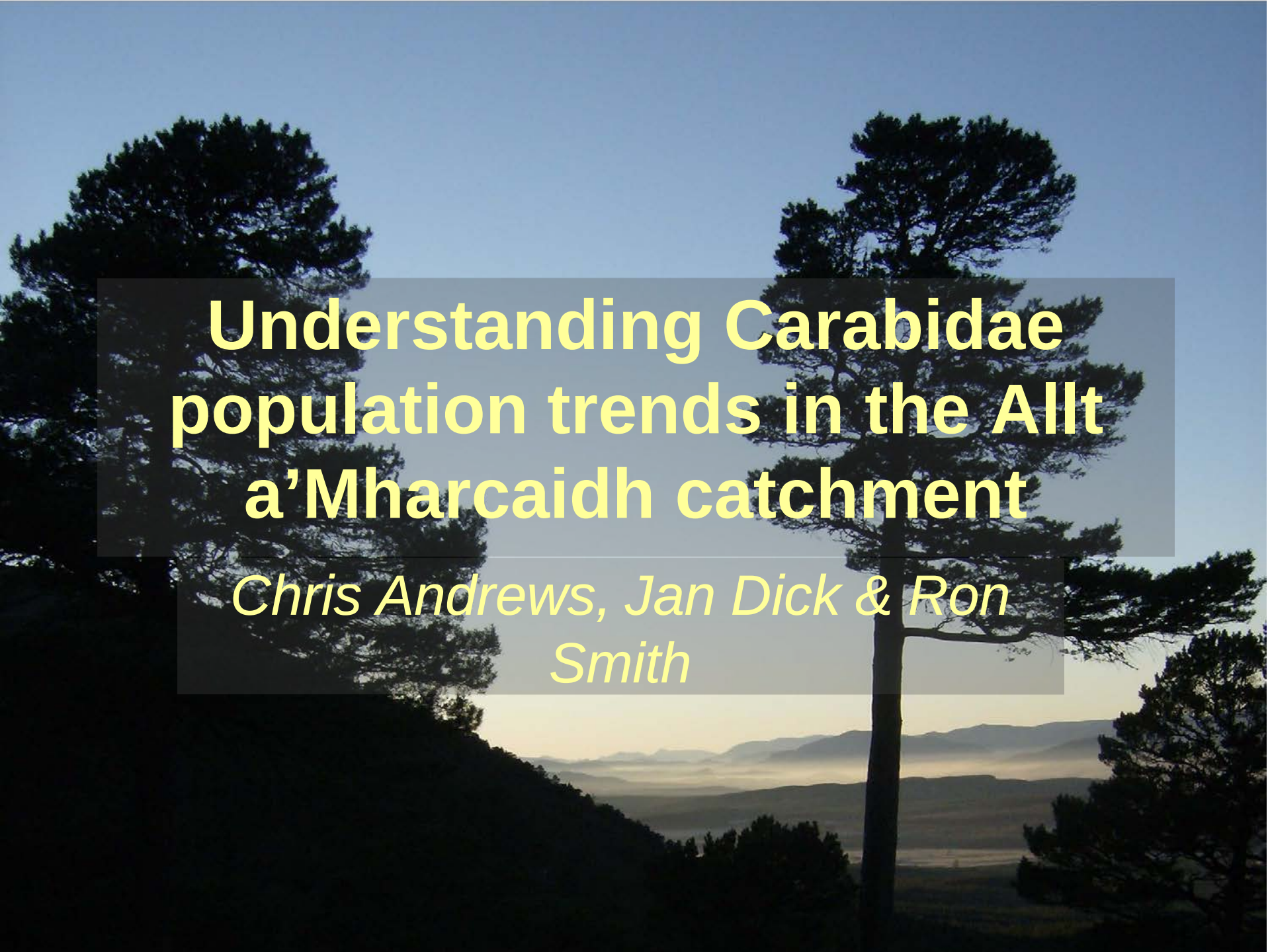


Understanding Carabidae population trends in the Allt a'Mharcaidh catchment

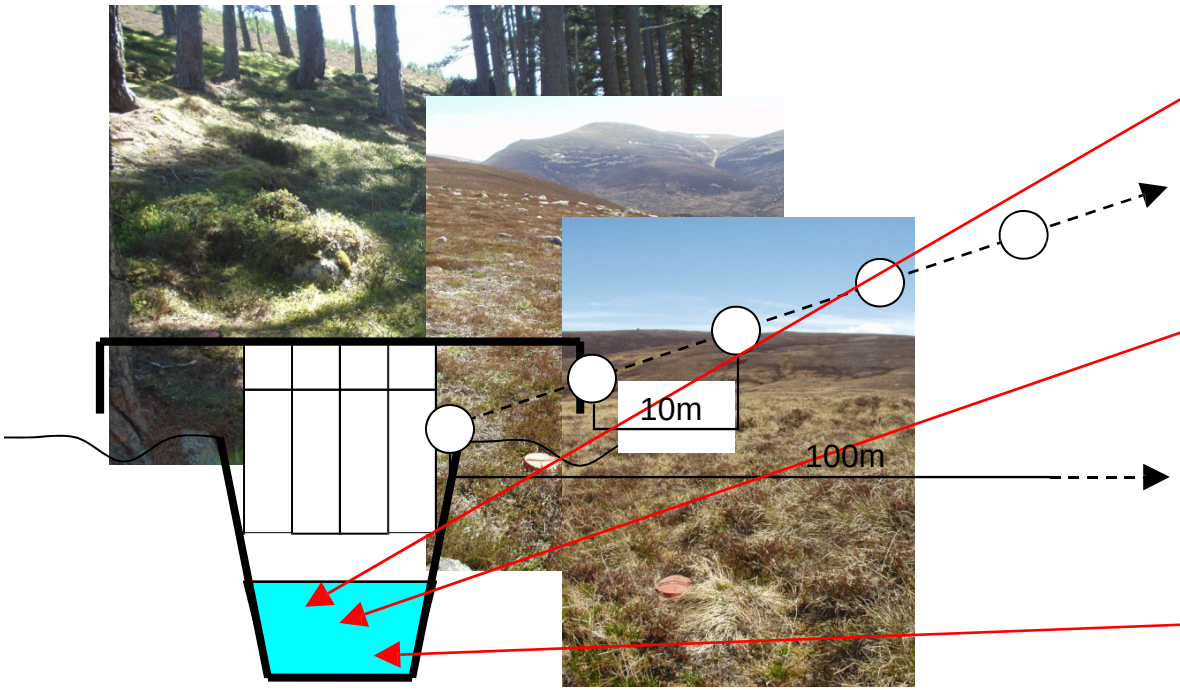
Chris Andrews, Jan Dick & Ron Smith

Introduction

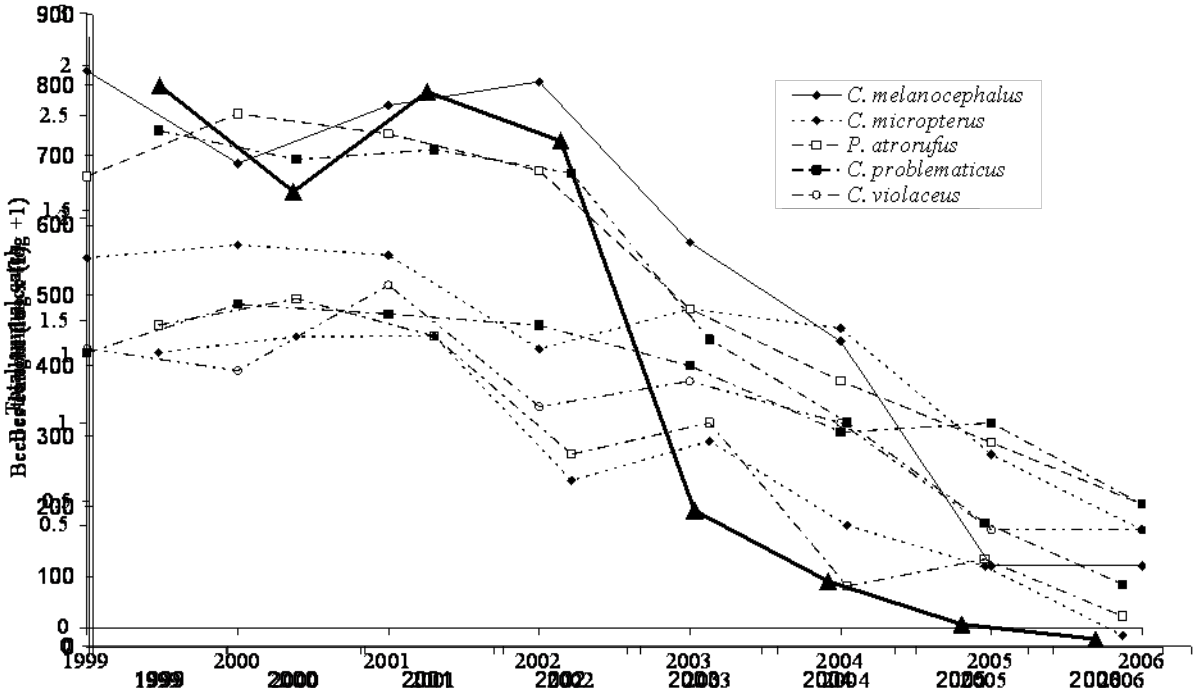
- Carabid ground beetles (Coleoptera, Carabidae L.) have been collected in the Allt a'Mharcaidh since 1999 as part of the Environmental Change Network (ECN) approach to monitoring changing climate and land use.
- Ground beetles widely used as bio-indicators

ECN Setup

- Transects placed in the prominent habitats, *Pinus sylvestris* woodland, *Calluna* dominated wind-clipped heath and raised bog.
- Transects consist of 10 traps spaced by 10m.
- Plastic pot (75mm), with rain guard, exclusion mesh, containing a killing solution of ethylene glycol (antifreeze)



ECN trends, 1999-2006



- Number of beetles collected dropped by over 98%
- No significant difference (p= 0.330) in decline between bog and wood habitats. Heath had significantly higher (p= <0.001) catches than both.
- All species showed a broad decline, no species of any morphological type displayed a favourable response over the years.

ECN trends, 1999-2006

- No evidence decline is related to changes in local climatic conditions (climate data from ECN weather station situated within 400m of all heath and bog transects).
  - •Broad decline across all species
  - •No significant changes in population assemblage
- No changes in local land management have taken place in a considerable time.

Variants	2000 Predicted mean	Confidence range	2007 predicted mean	Confidence range	P=	Direction of Change
Solar Radiation (W/m^2)	91.9	----	96.9	----	0.928	><
Soil temperature -10cm (°C)	5.2	4.8 - 5.5	5.7	5.4 - 6.1	0.081	><
Soil temperature -30cm (°C)	6.4	5.9 - 6.8	7.3	6.9 - 7.8	0.010	>
Relative humidity (%)	89.7	----	89.4	----	0.899	><
Wind speed (ms^{-1})	6.8	6.2 - 7.4	7.9	7.2 - 8.6	0.024	>
Frost days	110.6	----	113.8	----	0.135	><
Air Temperature (Dry) (°C)	4.7	4.1 - 5.3	5.9	5.2 - 6.5	0.025	>

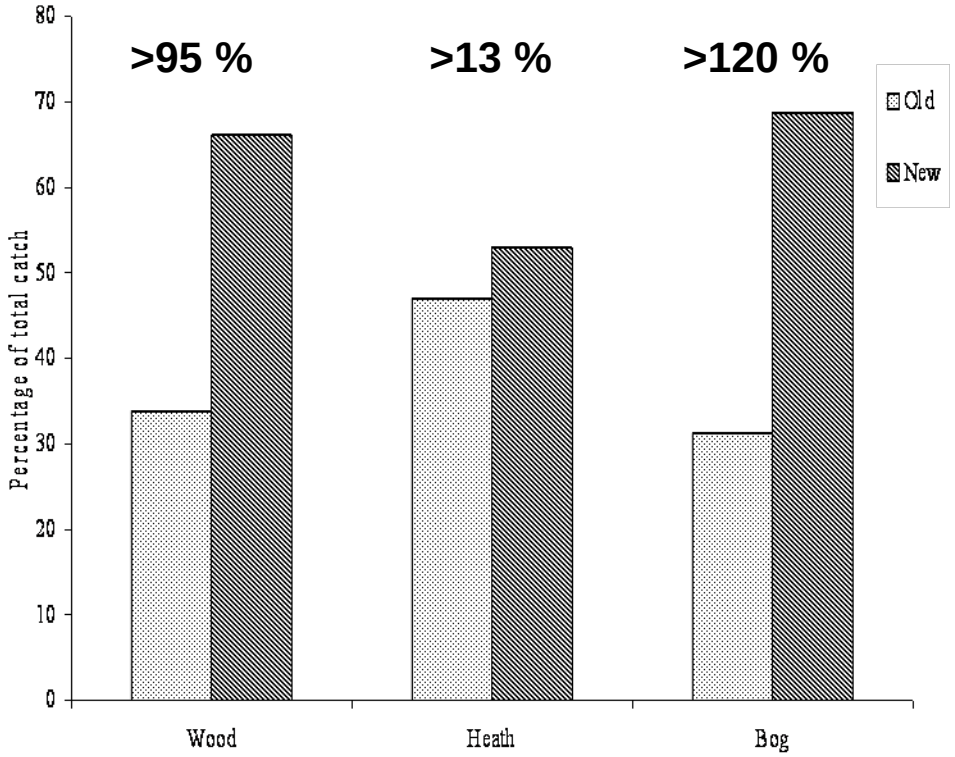
*Results prompted an investigation into a more direct anthropogenic disturbance – **over trapping**.*

2007 Experiments

- We added new replicate transects a minimum of 100m from ECN transects in each habitat assuming the following rationale:
    - Significantly higher numbers in new transects suggests depletion has occurred in original transects
    - A higher occurrence of macropterous species in original transects would suggest the possibility of immigration (occupation of a vacant niche).

- In the heathland we set up a series of transects at increasing distances (100, 200 & 400m) from the ECN transect.
    - Occurrence of depletion at the ECN transect would be characterised by increasing catches at further distances.

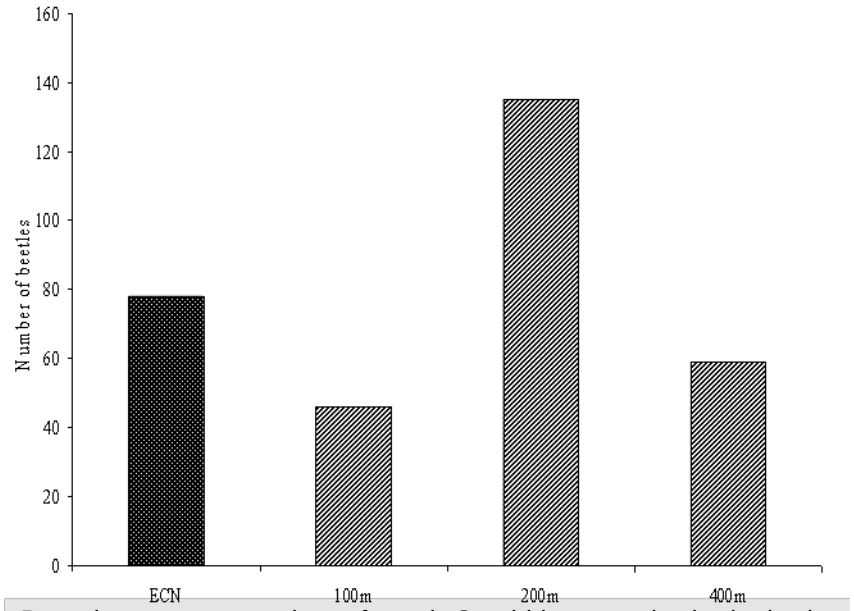
Results from replicate transects



Number of beetles caught in old and new transects (2007), expressed as a percentage of the entire catch for each of wood, heath and bog habitats. Percentage change from old to new transect is displayed above.

- Accumulated GLM analysis shows catch rate of new transects to be significantly higher (p= <0.001) than original ECN transects.
- Catch double (or more) in new transects at wood and bog habitats respectively.

Results from distance experiment



Bar chart representation of total Carabidae caught in both the original ECN heathland transect, and at duplicated transects positioned 100m, 200m and 400m from ECN line.

- Catch at 200m accounted for 43% of total beetles caught, and was significantly higher (p= 0.016) than that at 100m and 400m
- However, number of beetles was not found to be positively associated with increasing distance from the ECN transect (p= 0.570).
- No correlation between distance and two important physiological traits of dispersal, wing type (p= 0.809) and size (p= 0.900).

Key findings

- No relationship to climate or land use change
    - Further supported by broad general decline in all species (no winners as could be expected in changing ecosystem)
- Habitat repetition showed clear signs of depletion in the original transects, but not supported in the distance experiment.
- No evidence of ‘new’ populations occupying the old transects.

Conclusions

- Mixed results require some caution, but over-trapping can not be ruled out as one of the factors in the decline of Carabidae beetles in the Allt a'Mharcaidh.

- Data collected is unlikely to be representative of the entire catchment, and depletion should be taken into account when assessing data sets.
    - Can be tested with extra transects in the wider catchment

- Future long-term studies using ground beetles as bio-indicators should space traps at greater intervals to reduce depletion.