Failure to recognise within-species diversity can lead to a conservation dead-end

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Arctic Biodiversity Congress 2018 - Rovaniemi, Finland

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Species	W&C Act	UK BAP	HD Annex	Cons Regs Schedule	Bern Conv Appendix	Bonn Conv Appendix	CITES	IUCN 2015
Lampetra fluviatilis (L.)		Y	II, V	3	III			LC
Lampetra planeri (Bloch)			II		III			LC
Petromyzon marinus L.		Y	II		III			LC
Acipenser sturio L.	Sch. 5	Y	II, IV	2	III	I, II	I	CR
Anguilla anguilla (L.)		Y				II	II	CR
Alosa alosa (L.)	Sch. 5	Y	II, V	3	III			LC
Alosa fallax (Lacepede)	Sch. 5	Y	II, V	3	III			LC
Barbus barbus (L.)			V	3				LC
Cobitis taenia L.		Y	II		III			LC
Osmerus eperlanus (L.)		Y						LC
Coregonus albula (L.)	Sch. 5	Y	V	3	III			LC
Coregonus lavaretus (L.)	Sch. 5	Y	V	3	III			VU
Salmo salar L.		Y	II, V	3	III			LC
Salmo trutta L.		Y						LC
Salvelinus alpinus (L.)		Y						LC
Thymallus thymallus (L.)			V	3	III			LC
Cottus gobio L.			II					LC

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	Within-species diversity
Convention on Biological Diversity	Strategic Plan for Biodiversity 2011-2020 (Aichi Biodiversity Targets) - Thematic programme of work includes biodiversity in inland waters; - Target 13 states that strategies should be developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity. The importance of within-species variation is explicitly mentioned in its definition on Biological Diversity but rarely appears thereafter.
Bern Convention	Article 3 – No explicit mention of sub-species or within-species diversity. States that particular attention should be paid to endangered and vulnerable species, especially endemic ones.
Bonn Convention	Appendix II – recognises sub-species, and populations of vulnerable species which are present in certain locations.
European Biodiversity Strategy and the Habitats Directive	EU 2020 Biodiversity Strategy – Target 6 (Help avert global biodiversity loss) makes no mention of within-species diversity. Habitats Directive – Freshwater fish cited at genus or species level only, with some reference to populations in some geographical areas.

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Convention on Biological Diversity

IUCN

RED LIST

THE IUCN RED LIST OF THREATENED SPECIES™

Extinct | Threatened | Least Concern

EX | EW | CR | EN | VU | NT | LC

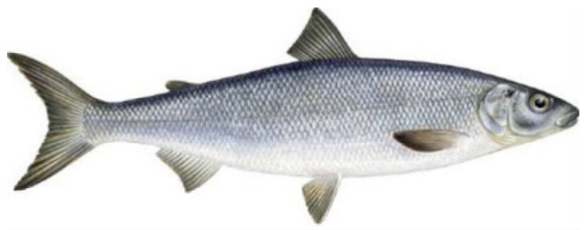
Extinct in the wild | Near Threatened

- Increased the number of European ’species’ from 270 species to 546.

- Increased the number of <u>endemic species</u> on the IUCN Red List and European Red List.

21

1



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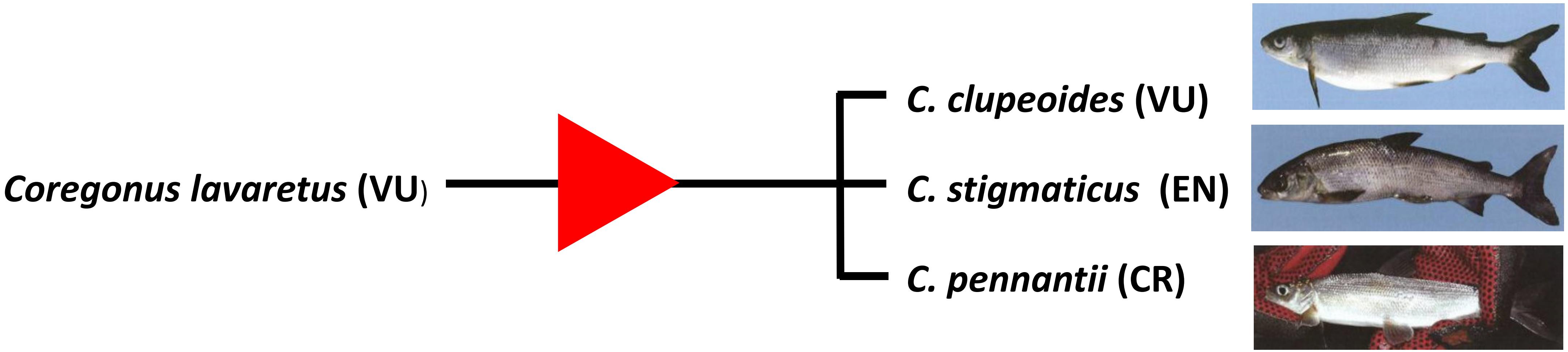

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Coregonus	Population	Authority
acronius	British whitefish	Schindler 1957
cepedii	Lomond	Valenciennes 1848
clupeoides	Lomond, Eck, Haweswater, Red Tarn, Ullswater, Llyn Tegid	Lacepede 1803, Gunther 1866, Day 1884, Tate 1908.
fera	British whitefish	Yarrell 1836
lacepedei	Lomond	Parnell, 1838
lavaretus	Lomond, Eck, Brotherswater, Haweswater, Red Tarn, Ullswater, Llyn Tegid	Linnaeus 1757, Pennant 1776, Turton, 1807, Fleming 1828, Jardine 1830, Jenyns 1835, Steinmann 1950, Svardson 1957, Gasowska 1965, Maitland 2004.
macrophthalmus	Haweswater, Llyn Tegid	Drottrens 1959
microcephalus	Lomond	Parnell 1838
oxyrhynchus	Haweswater, Ullswater, Llyn Tegid	Svardson 1957
pennantii	Llyn Tegid	Valenciennes 1848, Tate 1911
stigmaticus	Brotherswater, Haweswater, Red Tarn, Ullswater	Tate 1911
wartmanni	British whitefish, Lomond, Ullswater	Yarrell 1836, Drottrens 1959

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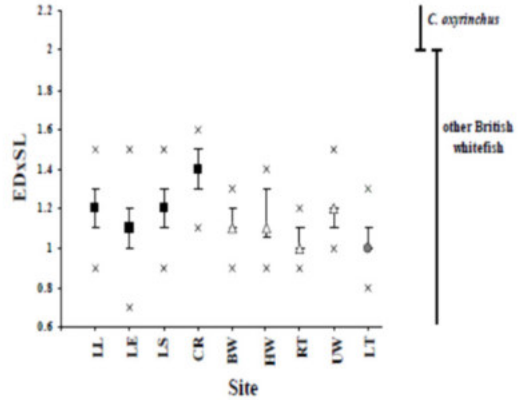
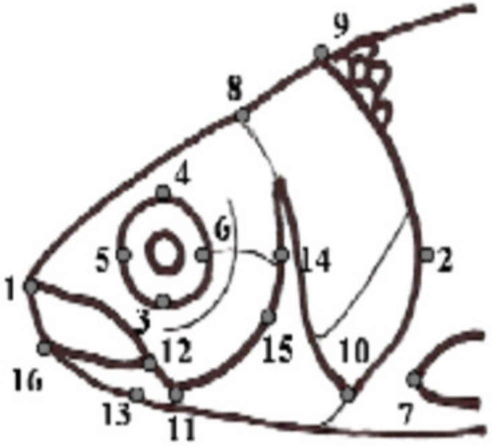
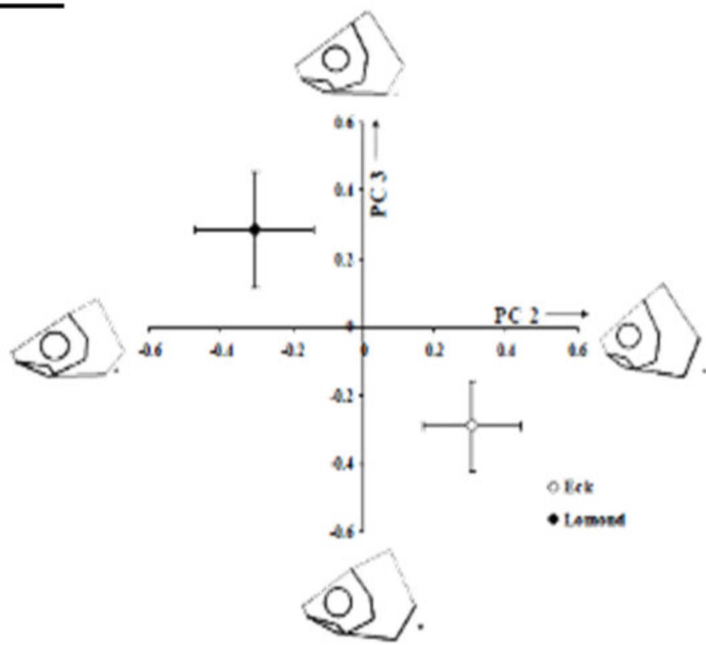
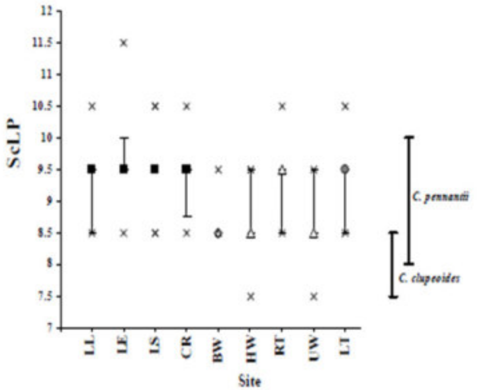
Q1. Does the the taxonomic key of Kottelat & Freyhof 2007 adequately descriminate between putitative Coregonid taxa?





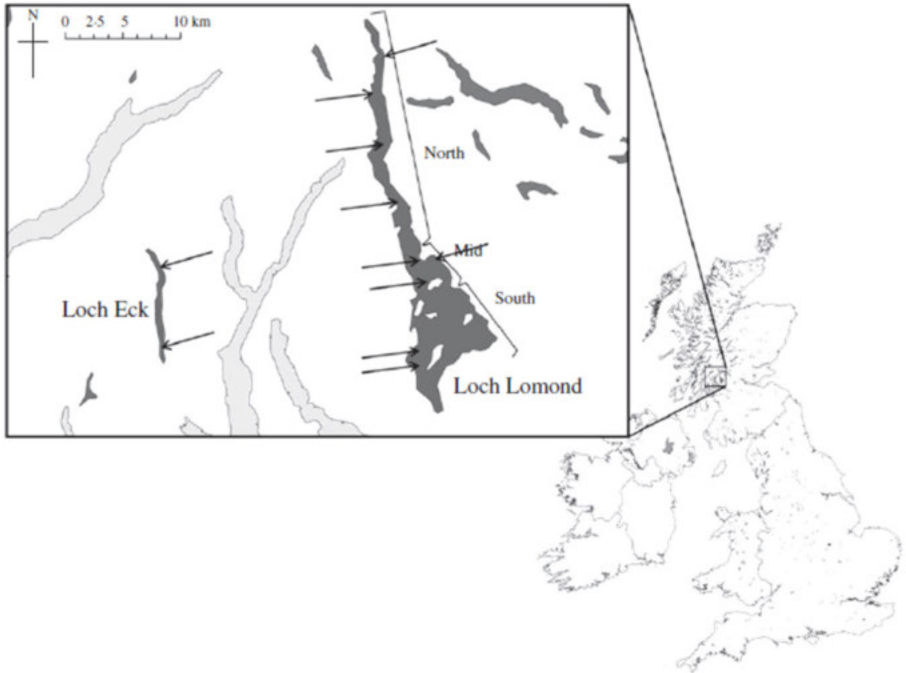


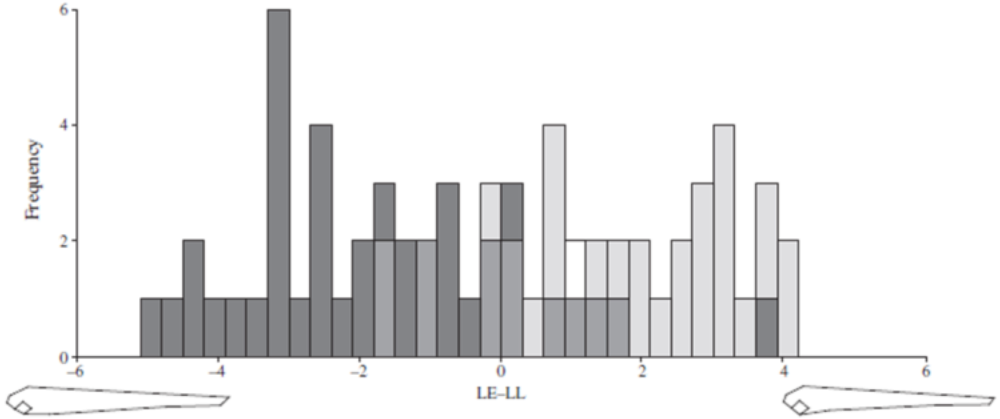


Result: Using 577 fish from nine populations around the UK, the successful classification of into one of the three 'species' was low – 27%.

Etheridge, E.C., Adams, C.E., Bean, C.W., Durie, N.C., Gowans, A.R.D., Harrod, C., Lyle, A. A., Maitland, P.S. & Winfield, I.J. (2012). Are phenotypic traits used for differentiating among *a prior Coregonus* taxa? *Journal of Fish Biology,* **80**: 387-407.

Q2. What level of phenotypic and genetic structuring within and between lakes in *C. lavaretus* in Scotland?





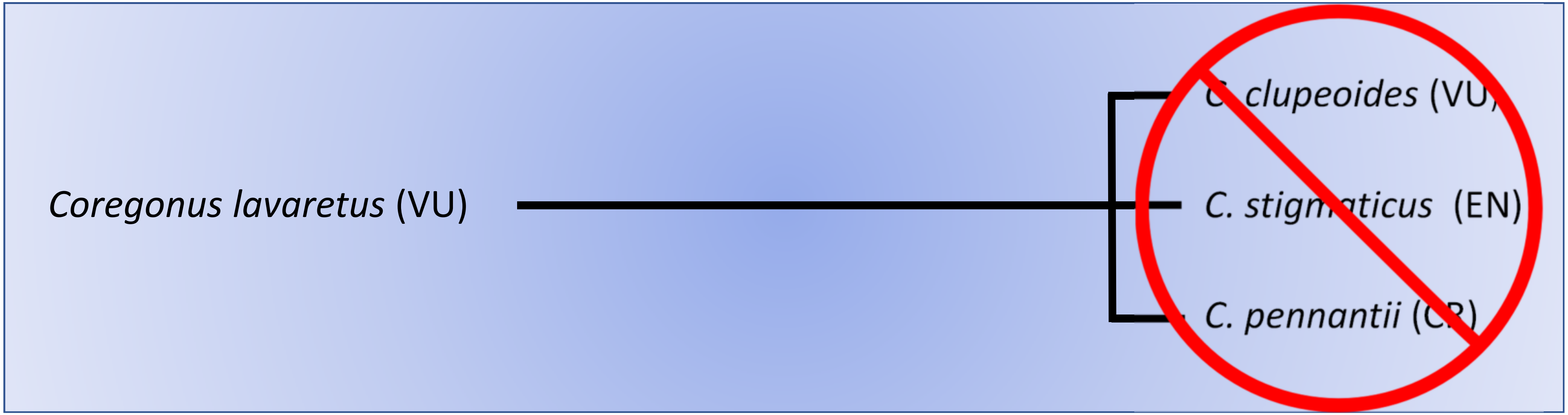
Lake	Location	Code	n	H_e	F_{IS}	P_{HWE}	N_{AR}	N_{PAR}	N_e
Lomond	North	LLN	18	0·462	0·059	>0·05	4·1 ± 0·7	0·4 ± 0·3	–
	Mid	LLM	20	0·450	−0·071	>0·05	3·6 ± 0·6	0·3 ± 0·1	–
	South	LLS	21	0·491	0·027	>0·05	3·9 ± 0·5	0·4 ± 0·2	–
Lomond	Pooled N+M+S		59	0·471	0·011	<0·001	–	–	–
Lomond	Pooled M+S	LLO	41	0·480	−0·028	>0·05	4·7 ± 0·6	1·2 ± 0·3	54 (45–72)
Eck		ECK	44	0·422	0·016	>0·05	3·8 ± 0·5	0·4 ± 0·1	52 (43–70)

Result: Study showed between-lake genetic structuring, and discovered weak, but detectable within-lake genetic structuring in one site (Lomond). Common Garden experiments showed clear, at least partly, inherited, phenotypic differences in trophic morphology.

Adams, C.E., Bean, C.W., Down, A., Dodd, J.A., Etheridge, E.C. Gowans, A.R.D., Hooker, O., Knudsen, R., Lyle, A. A., Maitland, P.S., Winfield I.J. & Præbel K. (2016) Inter and intra-population phenotypic and genotypic structuring in the European whitefish, *Coregonus lavaretus,* a rare freshwater fish in Scotland. *Journal of Fish Biology,* **88**: 580-594.

Conclusion:

C. lavaretus is best described as 'a single, highly variable species' and the original taxonomy should prevail.



New Guidelines for the selection of fish populations for conservation in the UK

First written in **1981**

*Examples of **ecotypic or genetically distinctive fish populations** which are worthy of conservation are:*
- populations of charr in North Wales, the Lake District and southern Scotland, and also certain genetically distinct 'races' elsewhere in Scotland;
- possible post-glacial relict races of brown trout in northern Scotland;
spine-deficient three-spined stickleback (an aberrant form which may be a genotype or an ecotype) in the Outer Hebrides.

These were re-written in **2018** as:

Bean, C.W., Mainstone, C.P., Hall, R.A., Hatton-Ellis, T.W., Lee, A.S.L. and Boon, P.J. 2018. Guidelines for the Selection of Biological SSSIs. Part 2: Detailed Guidelines for Habitats and Species Groups. Chapter 19 Freshwater Fish. Joint Nature Conservation Committee, Peterborough.
http://jncc.defra.gov.uk/pdf/SSSI_chapter19Freshwaterfish_2018.pdf

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Unique **phenotypes and genotypes** should be given high priority

Multiple **phenotypes or genotypes (sympatric or allopatric polymorphisms)** at a site should be given higher priority

A population that is a good exemplar of a particular form, **genetic group, or ecological type (an ecotype)** should be given higher priority

The population should be pristine, i.e. no evidence of artificial genetic mixing, introductions or stocking

Where there is good reason to suspect the presence of **important evolutionary selection pressure scientific evidence should be gathered …**

Populations that are **geographically isolated** should generally be given higher priority, since this would **sustain and drive phenotypic and genetic differentiation**

Where the protection of the population and its supporting habitat would also protect an evolutionary process should be given higher priority

The role of habitats, environmental and ecological processes in driving within-species diversity is intrinsic to conservation.

So ……. are we at a dead end?

- **Within-species diversity is not adequately recognised within legislative instruments used to drive international conservation.**

- **National Biodiversity Strategies and Action Plans (CBD Article 6) also fail to reflect within-species diversity.**

- **CBD Aichi Target 13 recognises the need *to minimise genetic erosion and safeguard genetic diversity*, but specific guidance is lacking in relation to the protection of within-species diversity and supporting environmental and ecological processes.**

- **The 'splitting approach' adopted by the IUCN Red List at least recognises that high diversity exists within 'Species', but is less clear about how within-species diversity and evolutionary processes can be protected.**

- **Within-species diversity and the role of the supporting environment is becoming increasingly recognised in some countries, but this is not mainstream.**

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The IUCN Red List will continue to lack explicit considerations of genetic diversity, and consequently may not account for the potential adaptation of species to future environmental change.

[Rivers *et al*. (2014). Do species conservation assessments capture genetic diversity? Global Ecology and Conservation, **2**: 81-87.]

Delonix regia

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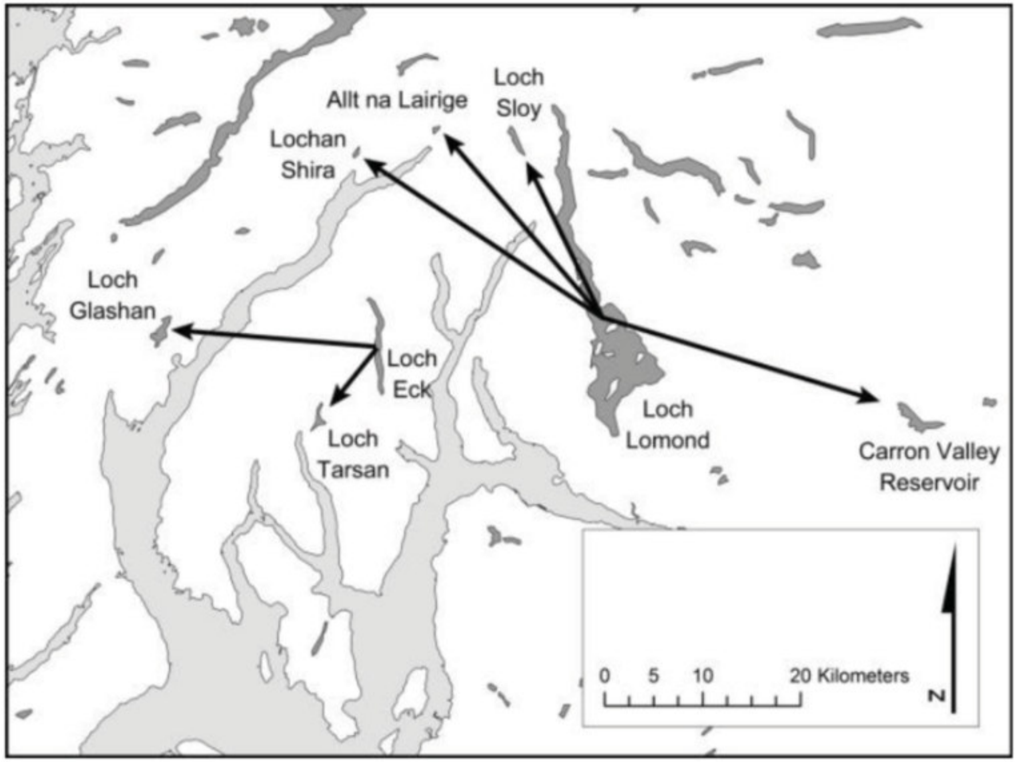
Failure is a detour, not a dead-end street © Zig Zigler



AQUATIC CONSERVATION: MARINE AND FRESHWATER ECOSYSTEMS

Aquatic Conserv: Mar. Freshw. Ecosyst. **20**: 274–281 (2010)

Published online 22 March 2010 in Wiley InterScience
(www.interscience.wiley.com). DOI: 10.1002/aqc.1101

Morphological and ecological responses to a conservation translocation of powan (*Coregonus lavaretus*) in Scotland

E. C. ETHERIDGE[a,†], C. W. BEAN[b], P. S. MAITLAND[a] and C. E. ADAMS[a,*]

[a]*Scottish Centre for Ecology and the Natural Environment, Faculty of Biomedical and Life Sciences, Glasgow University, Rowardennan, Glasgow, G63 0AW, UK*

[b]*Scottish Natural Heritage, Caspian House, Clydebank Business Park, Clydebank, Glasgow, G81 2NR, UK*

Significant differences in head morphology, size and growth were observed between founder and refuge populations.

Changes probably due to a combination of founder effects, intense selection and phenotypic plasticity – and took place over a 20 year period.