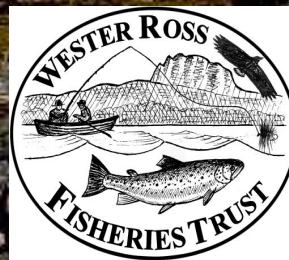


# Improving habitats for salmon and trout production in Wester Ross

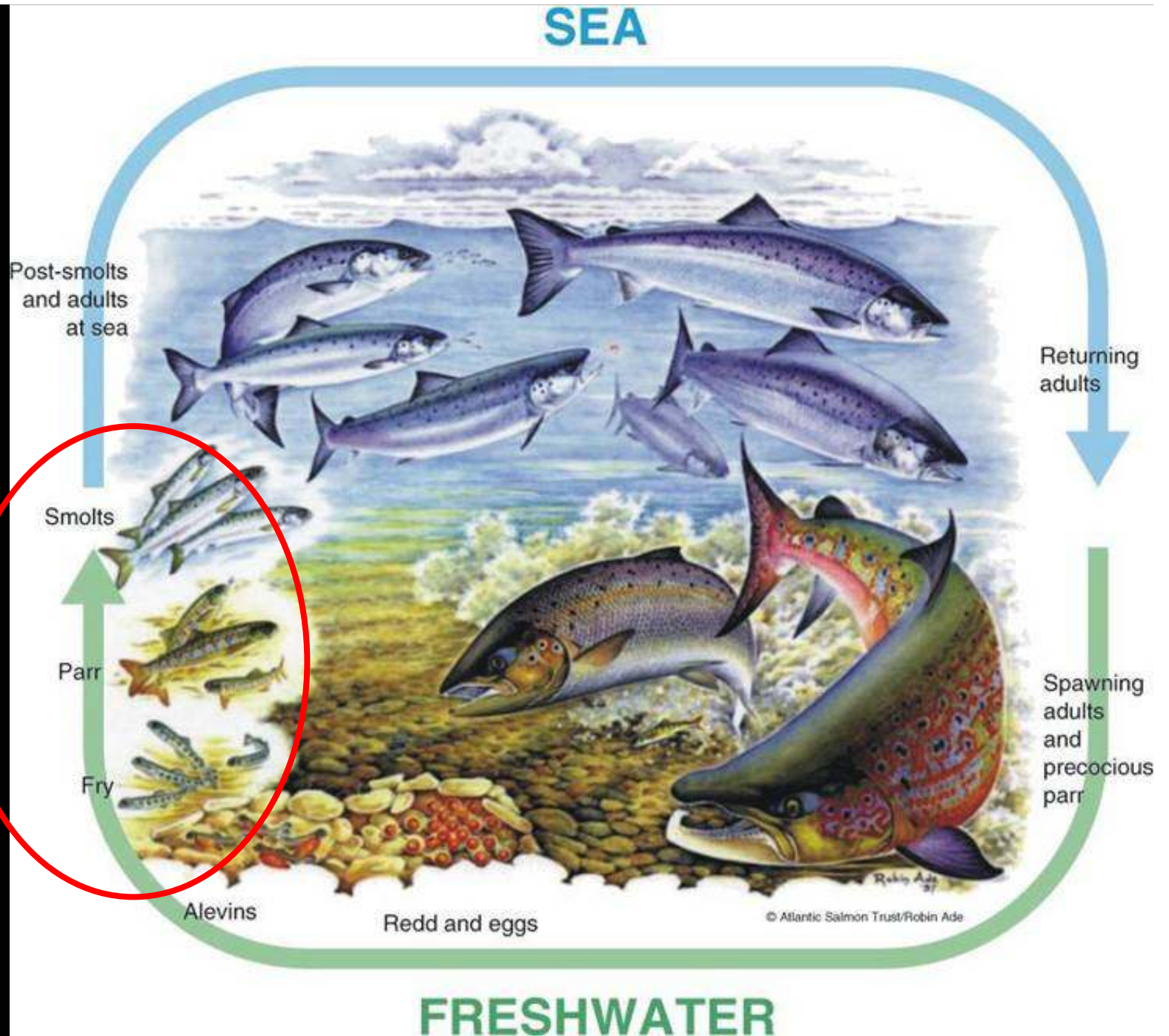
Workshop 26<sup>th</sup> January 2009



# SUMMARY

- How does 'habitat' affect the production of salmon and trout in Wester Ross?
- Are there opportunities for improving habitat for salmon and trout production in Wester Ross?
- Can the SRDP provide funding packages that are attractive enough to landowners to motivate them to take action?

What limits juvenile salmon production in Wester Ross?




**First find out if  
there are any  
salmon . . .**



**WRFT electro-fishing survey**

*By John Macpherson*

A photograph showing a yellow bucket filled with small fish, likely trout or salmon, resting on a wooden surface. A ruler is placed on the wood above the bucket to provide a scale. The fish are of various sizes and are scattered throughout the bucket. The text "Count and measure the catch. . ." is overlaid in the upper right corner.

Count and  
measure the  
catch. . .

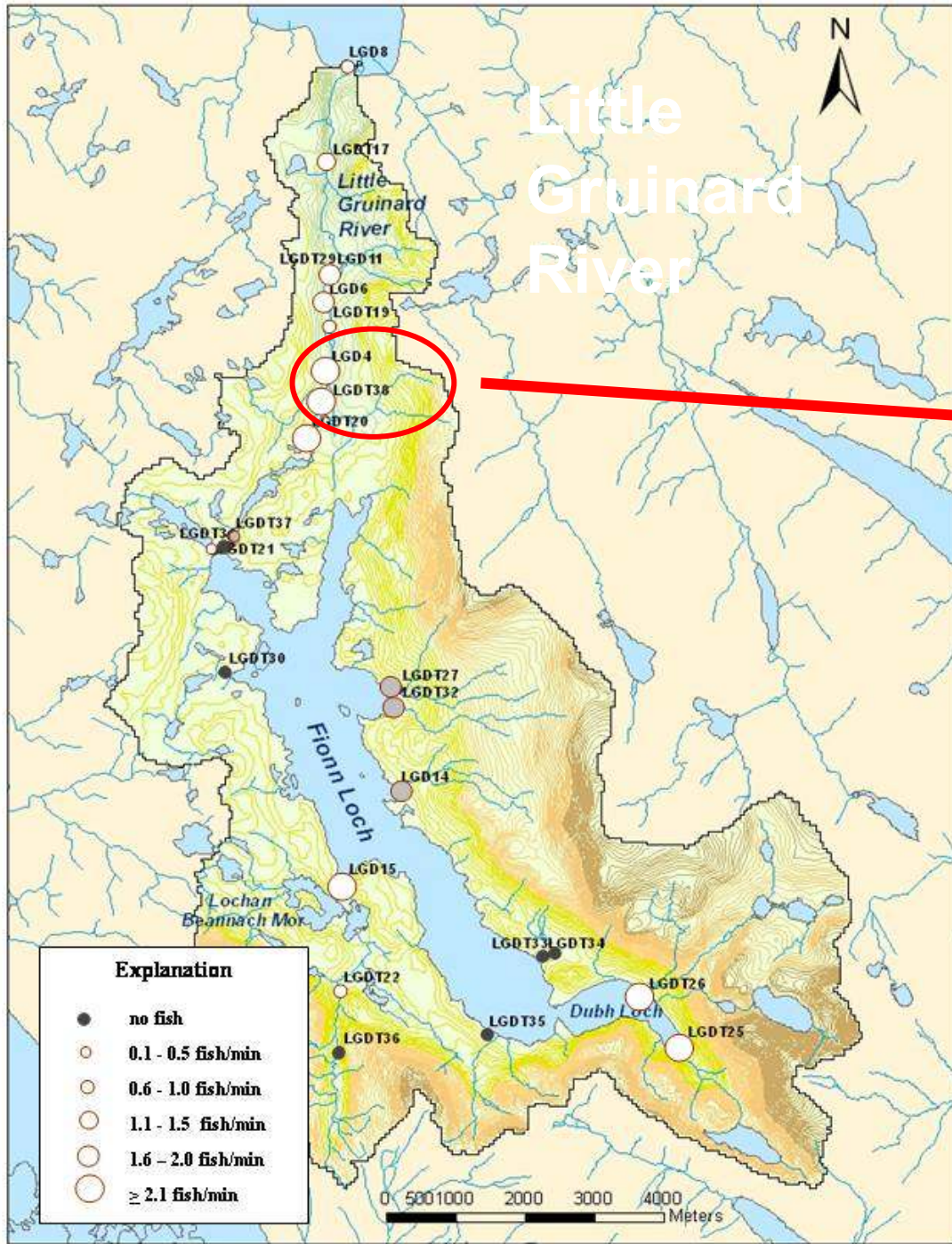
Which sites are most productive?

**Lower Flats of  
Little Gruinard**

**E-fish survey 23 August 2006**

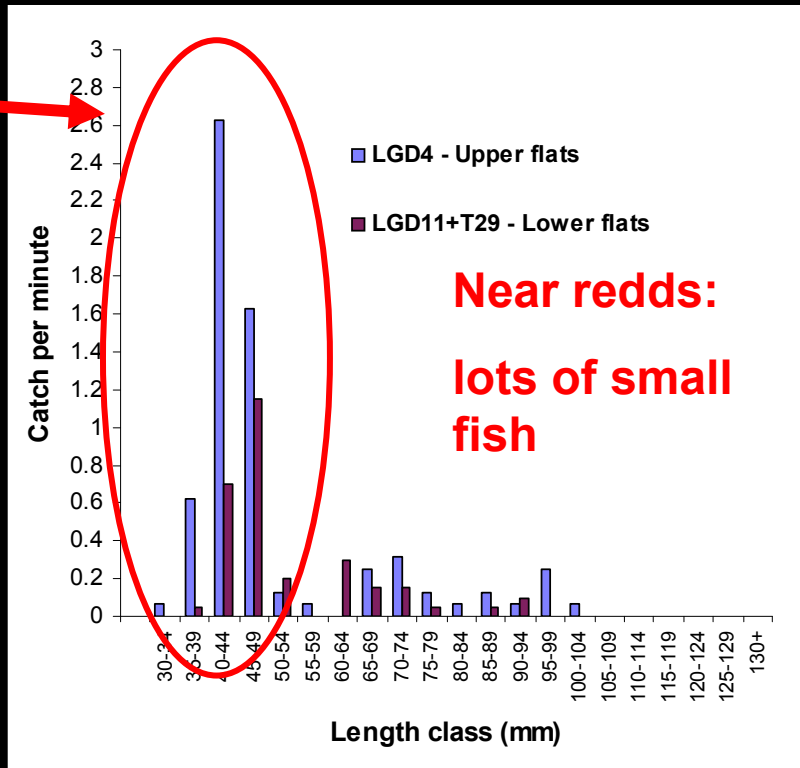
**Small fry . . . . . and small parr**





## Juvenile salmon abundance

### Little Gruinard River in 2006

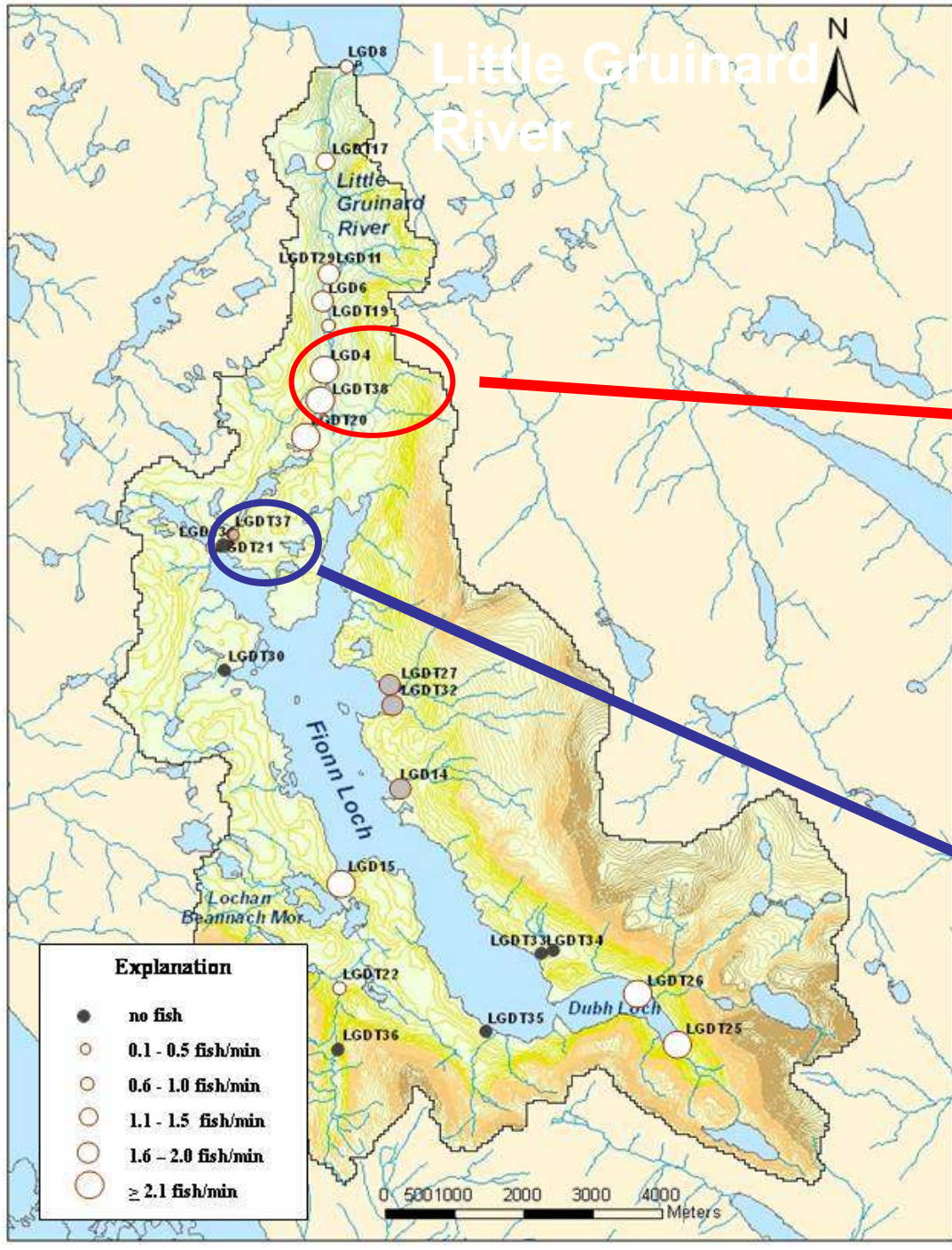


**Stepping stones (below Fionn Loch)**

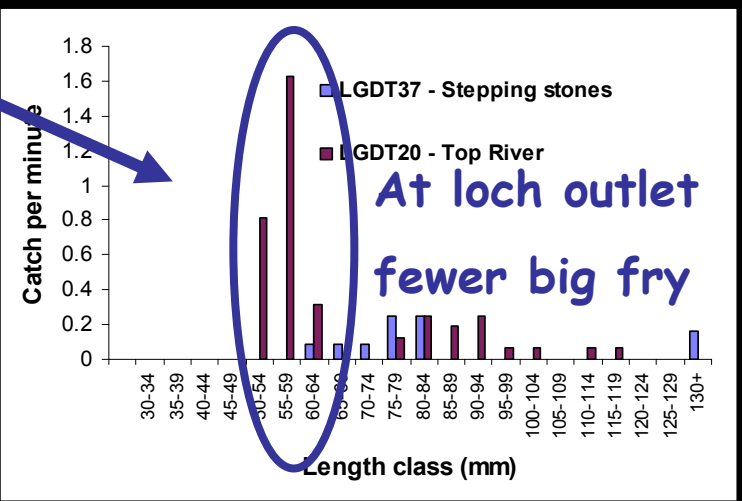
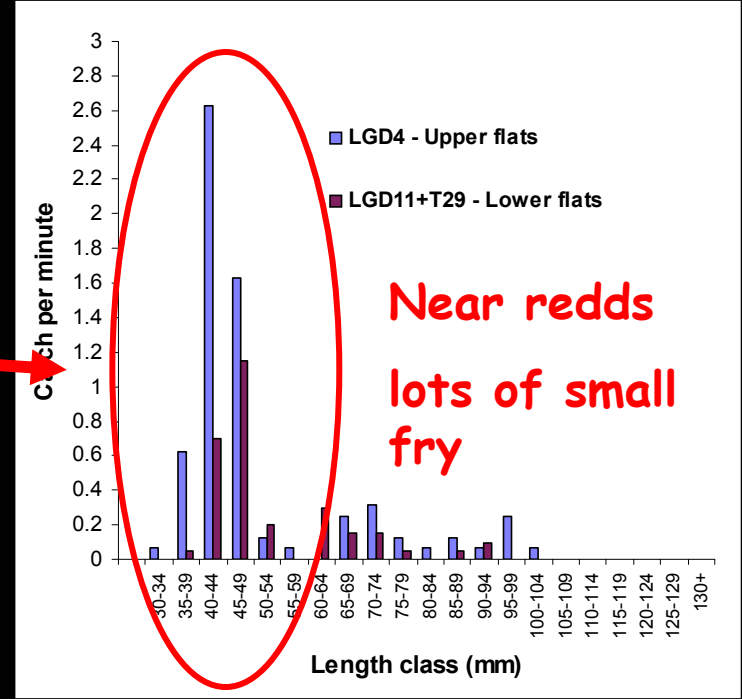


**Big one year old parr**





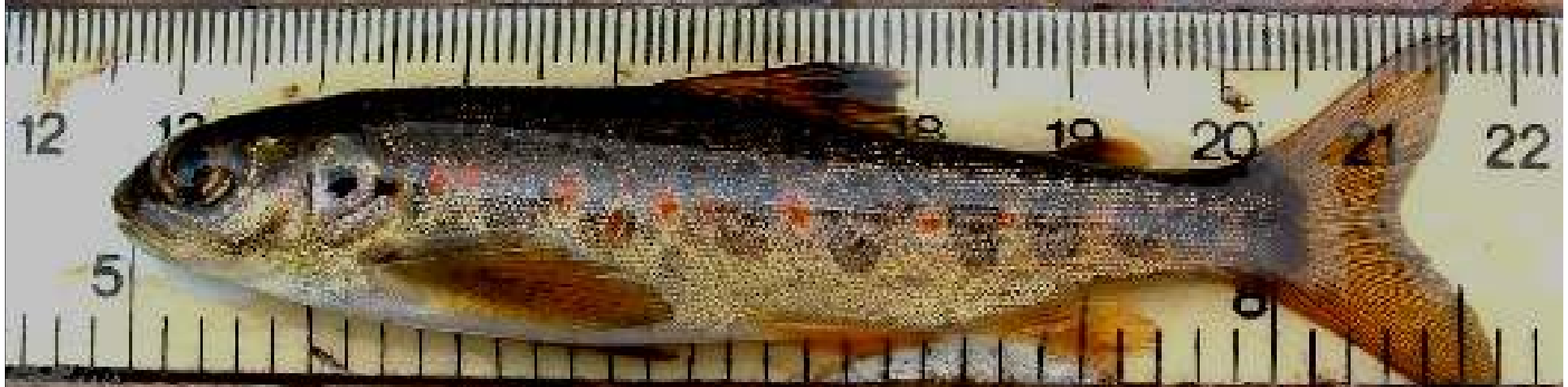
## Juvenile salmon 2006



- *Where juvenile salmon densities are high, growth tends to be slower.*
- *Where juvenile salmon densities are low, growth tends to be faster.*



**The rate of growth of juvenile salmon varies greatly.**



**18 month old salmon parr from the River Coulin (130m ASL)**



**6 month old salmon fry from the Cuaig River (15m ASL)**

**Why is there such variation in growth rates?**



*photo by Nick Bengel*





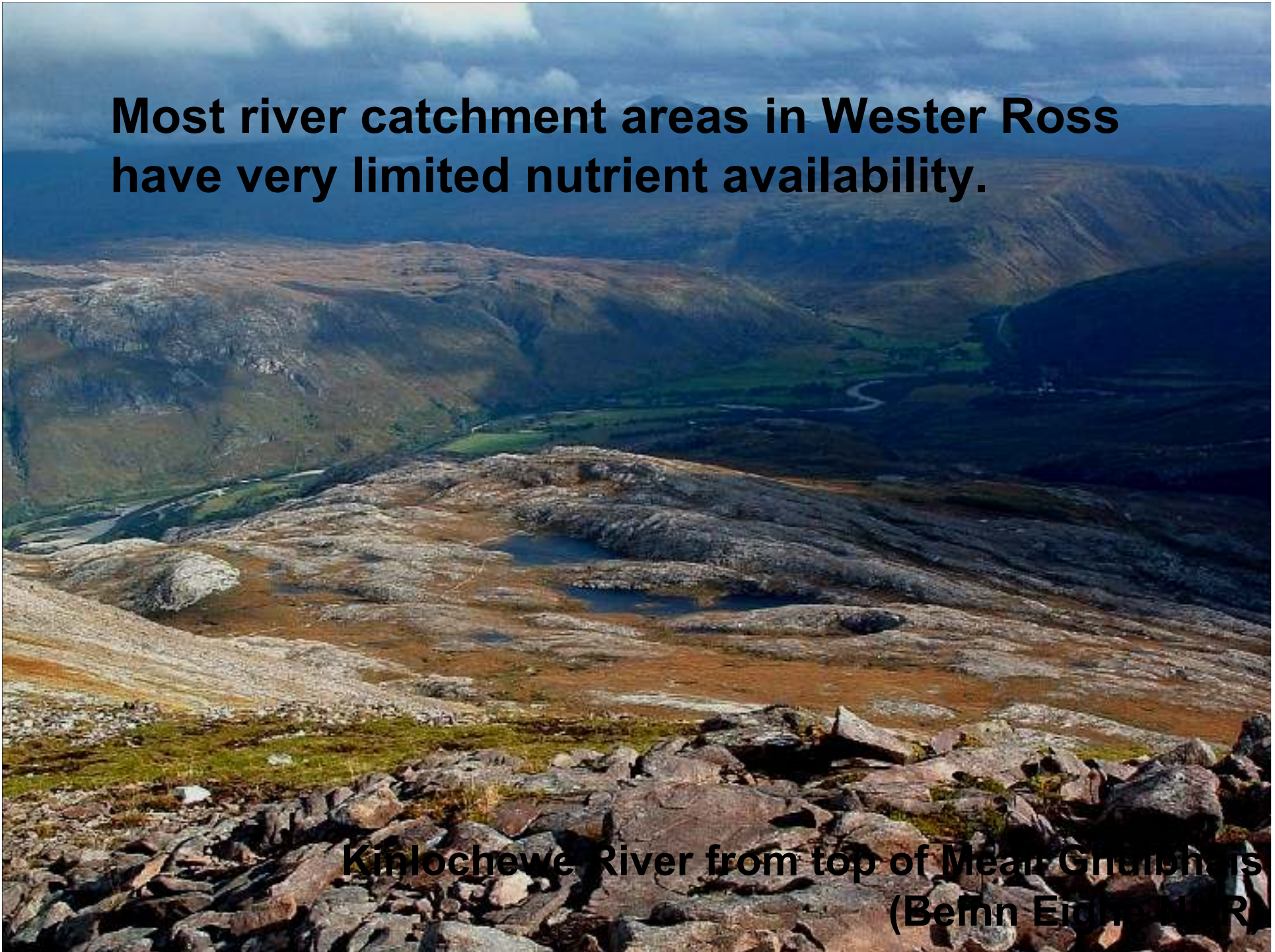
**Growth and  
production of  
juvenile salmon  
depends upon  
food availability**



**Stonefly and Mayfly larvae**

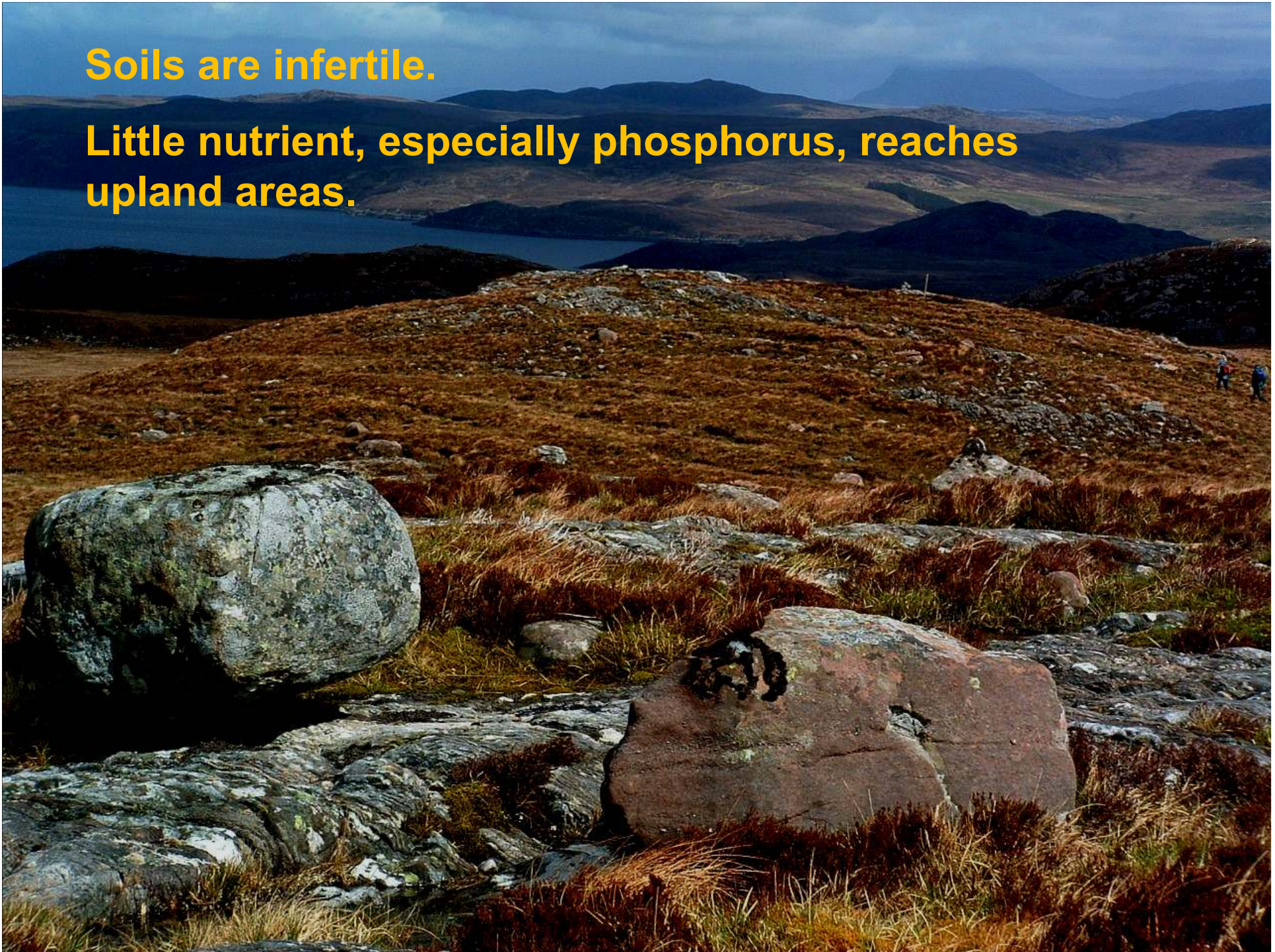
**Most river catchment areas in Wester Ross  
have very limited nutrient availability.**

**Kinlochewe River from top of Meall Ghnùphais  
(Beinn Eòin, W.R.)**



**Soils are infertile.**

**Little nutrient, especially phosphorus, reaches upland areas.**





Hills above Coulin – mostly bare rock



# Extreme spates erode stream banks, removing fertile riparian soils



*Photo by James Butler*

**River Ling, 2000**

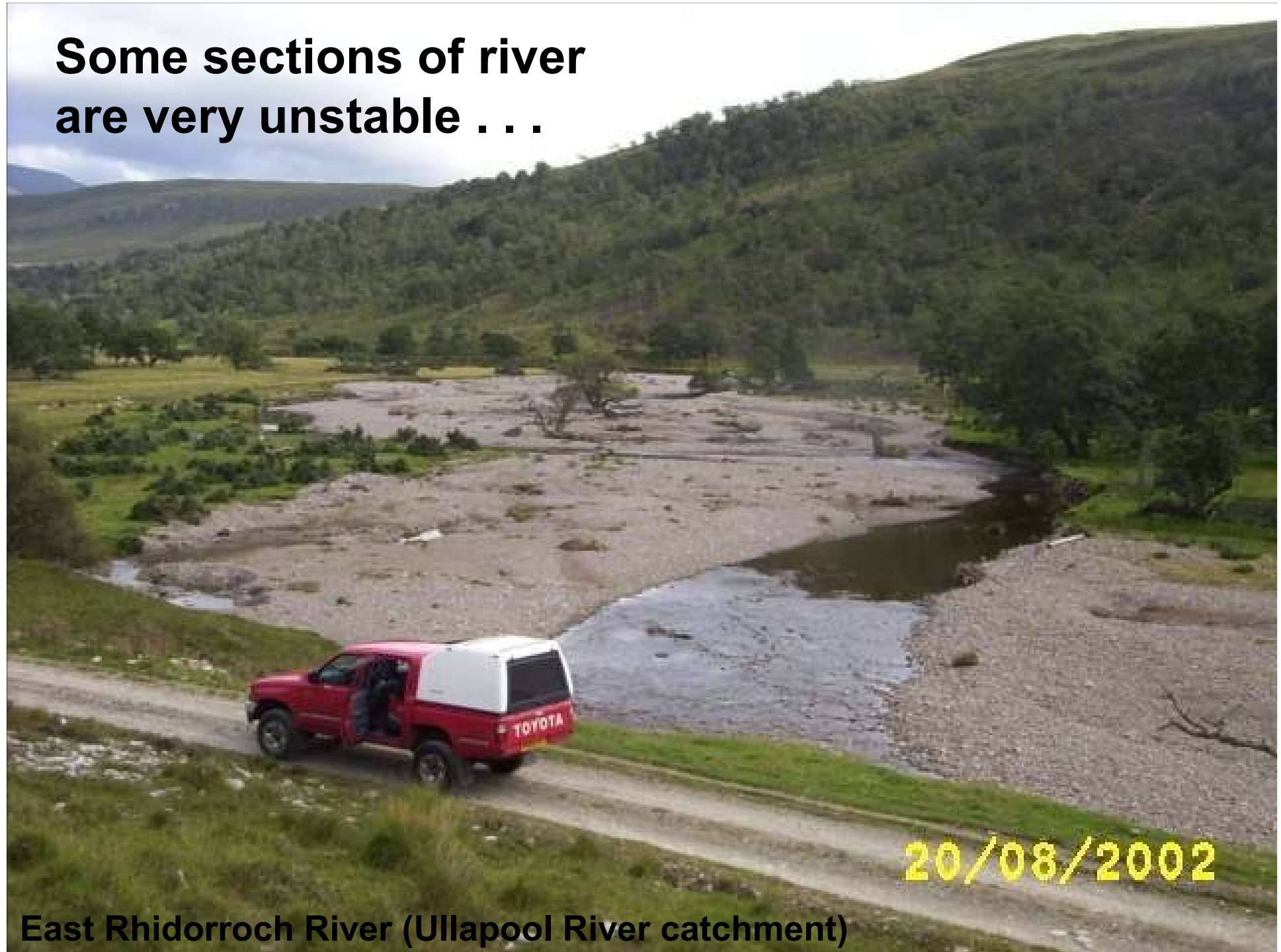
**The Achanasheen – Kyle railway line was washed away in July 2007 because soils were unable to absorb rain water fast enough.**



**Headwaters of River Carron**



**Some sections of river  
are very unstable . . .**



**20/08/2002**

**East Rhidorroch River (Ullapool River catchment)**

**August 2006**



**December 2005**



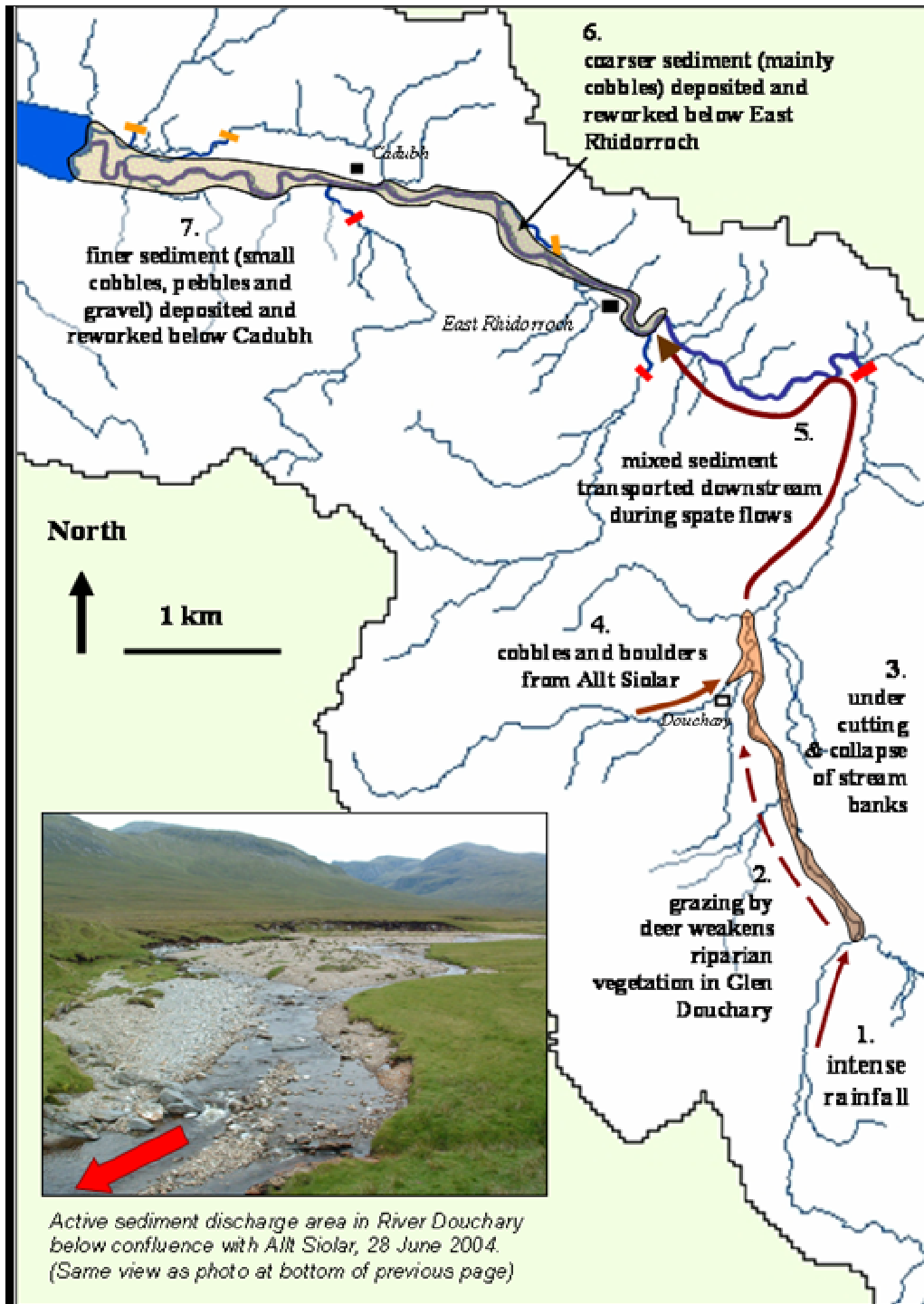
**August 2007**







# Problems originate in the upper river catchments



**Extreme spates may wash out eggs, juvenile fish, insect life and other nutritious organic matter.**



**Taagan burn below Beinn Eighe NNR**

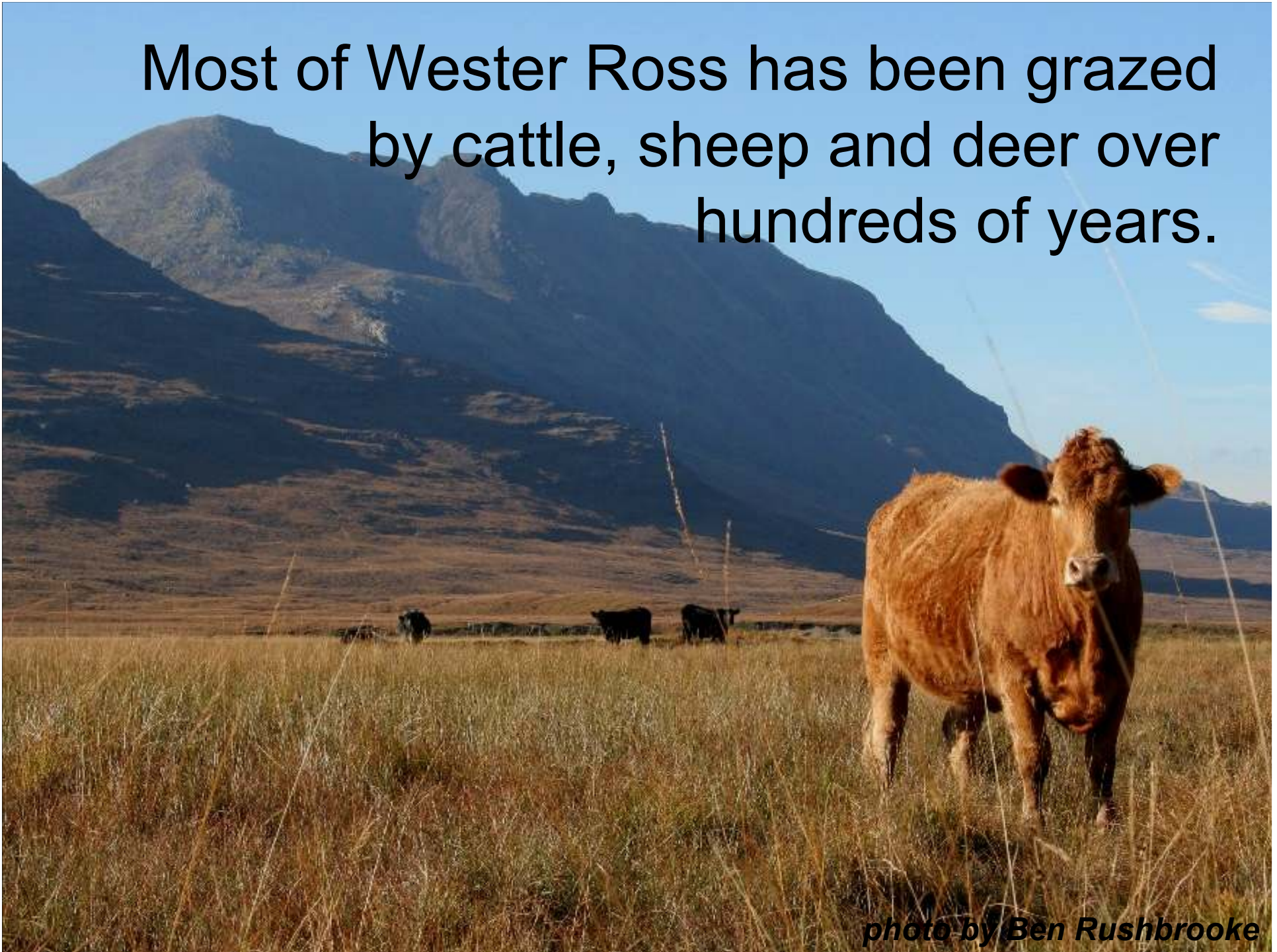


**Have fertility levels changed  
as a result of land use and  
wildlife management  
practices?**



Most of Wester Ross has been grazed  
by cattle, sheep and deer over  
hundreds of years.

*photo by Ben Rushbrooke*



**Grazing beneath old alder trees.**



*photo by Ben Rushbrooke*







**Most juvenile salmon grow slowly in the headwaters streams**





**. . . but not all:**

**Sheneval bothy at the foot of An Teallach is popular with hill walkers (and salmon poachers!) . . .**

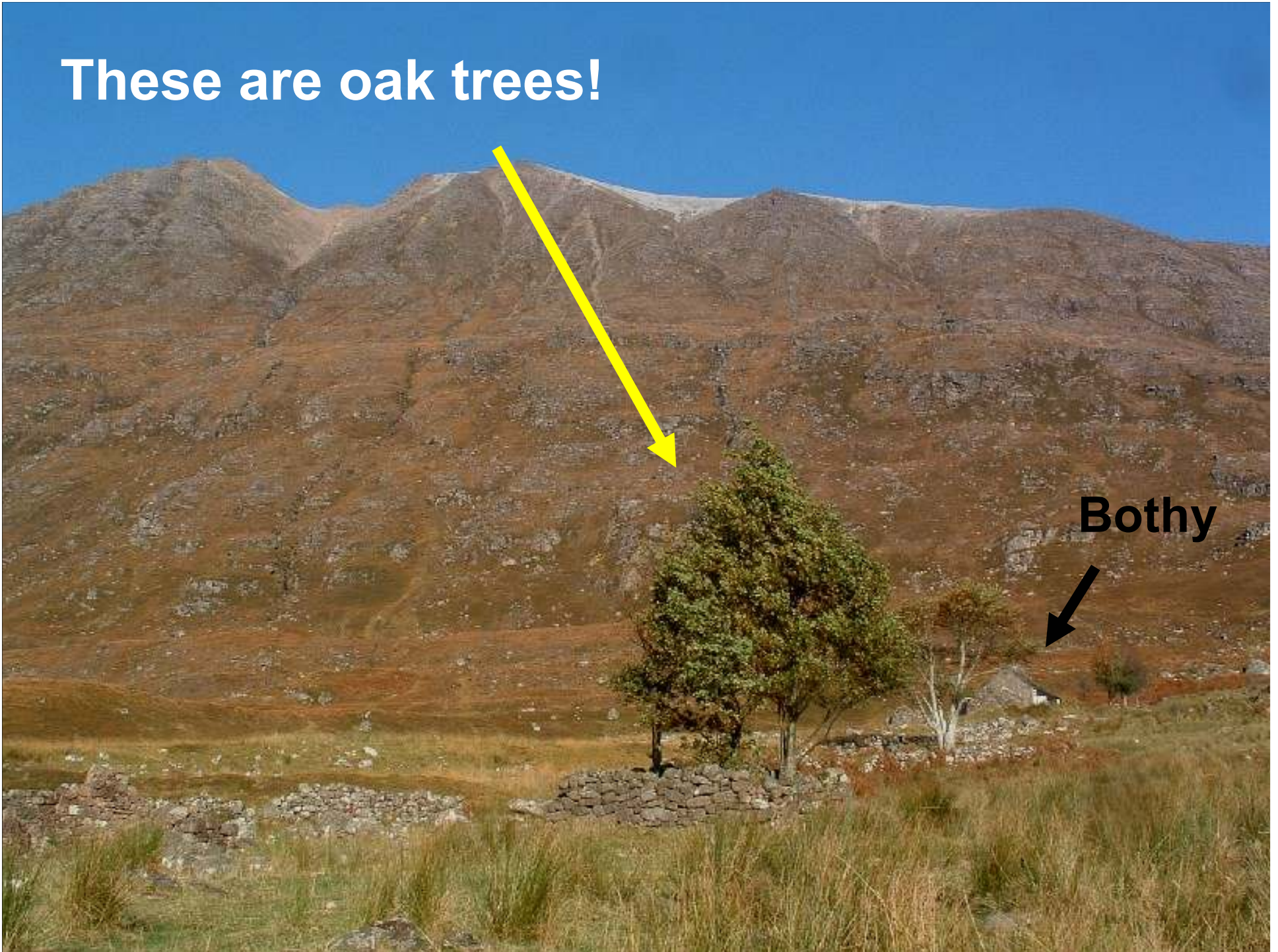
**Nearby soils are richer in earthworms and support a (?healthy) population of moles . . .**

**The stream is green and mossy . . .**

**These are oak trees!**



**Bothy**





**Juvenile salmon in Allt Sheneval grow faster!**



Kinlochewe River. Taagan, Otterstone  
Pool.

Best site for juvenile salmon in 2008:  
5.5 fry per min; 3.0 parr per minute

Note: green stream bed



**Upland areas are not uniformly infertile . . .**





**Rocks and knolls in prominent positions in upland areas have been enriched with nutrients delivered by birds and mammals.**



**Look out over Kinlochewe in Beinn Eighe NNR**



**Eagle pellet  
(containing fur) and  
grouse dropping from  
a green knoll in the  
Tollie Hills**

## ***Red Deer***

### **Milner *et al* (2002): A Highland Deer herd and its Habitat**

- **Carcasses left on hill.** . improve efficiency of cull, carrion feeding beetles; vertebrates: foxes, badgers, shrews, ravens, golden eagles, sea eagles and hooded gnows.
- **Vegetation [after decomposition of carcass]** had significantly higher nitrogen ; additional nutrient input associated with whole carcass. . Leaving carcasses on hill may therefore benefit grazing animals by enhancing the nutrient content of forage . . . Mineral concentrations are likely to increase as bone material degrades and bones provide an important source of calcium and other minerals for deer.



**Where nutrients are recycled . . .**

**. . .from vegetation to sheep back to vegetation. . . .**

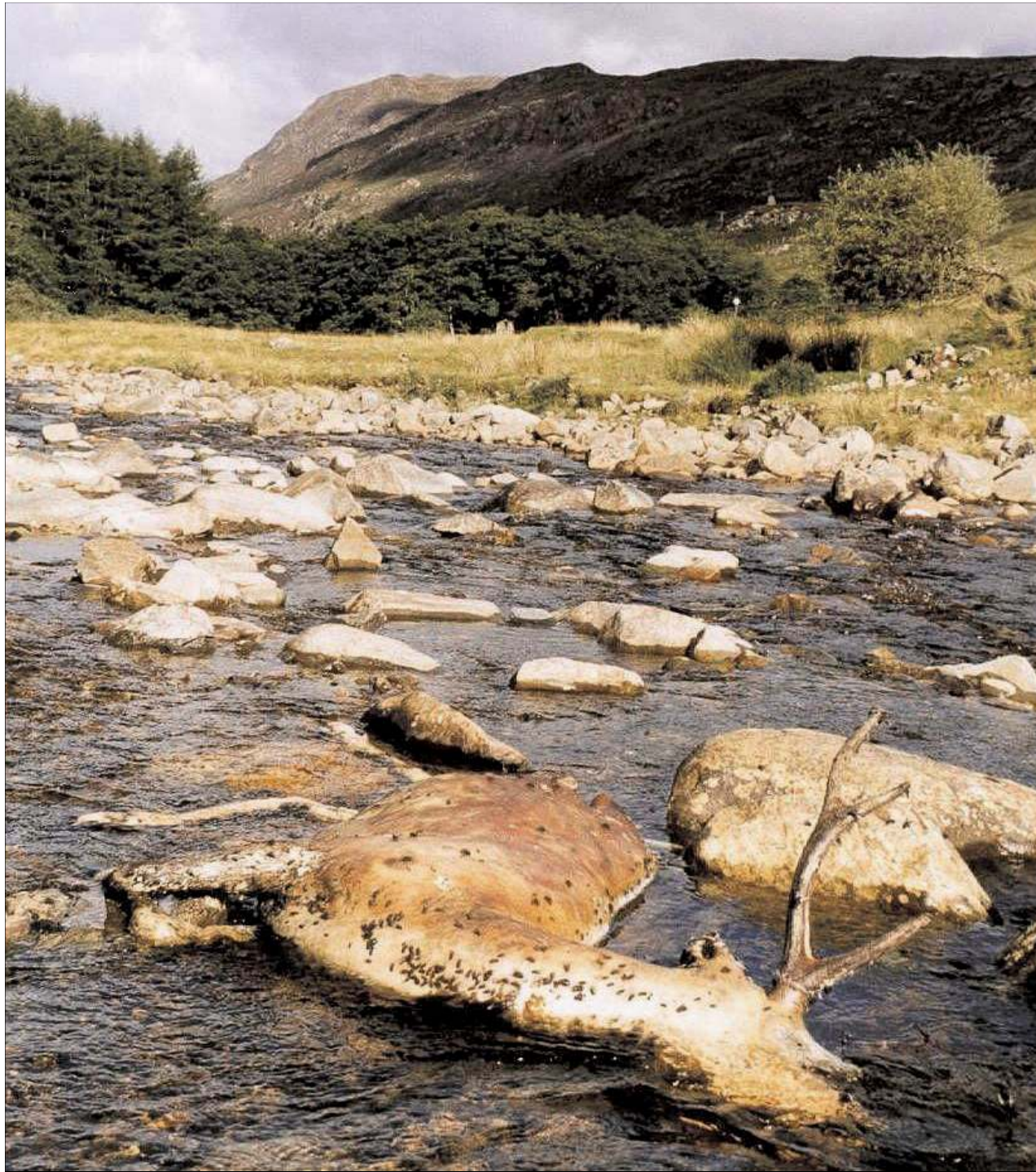
**•*growth of plants - and insects - can be prolific***

**•*more insects: more food for trout and salmon. . . .***



**Bog near Redpoint (2002)**





**A deer carcass contains ~3 kg of phosphate: mainly in bones.**

***The removal of deer, sheep or cattle from upland catchment areas represents an unnatural loss of nutrient from the ecosystem.***





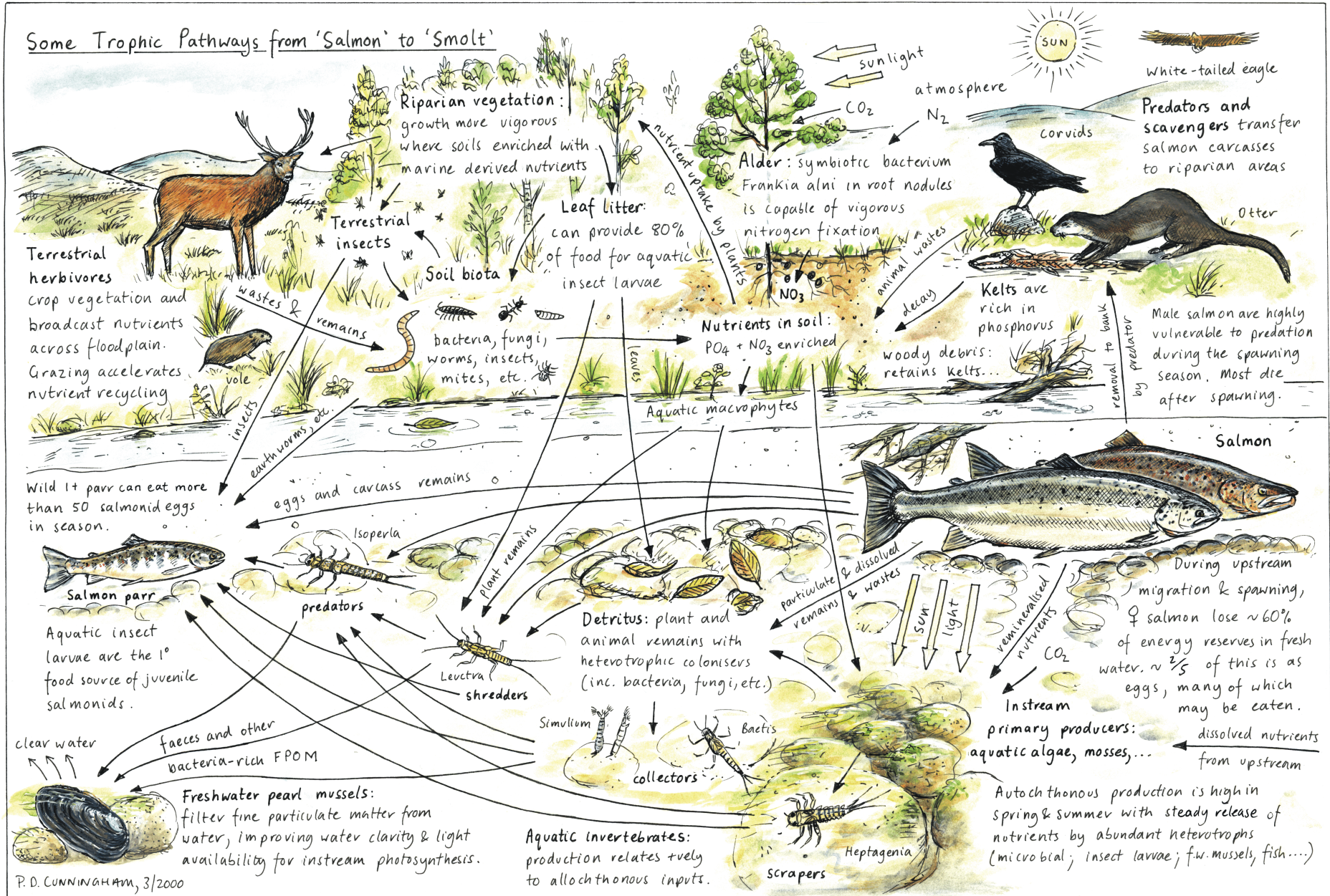




**Otter spraint with  
trout bones.**



# Adult salmon can provide food for juvenile salmon



**Should fertility restoration programmes be promoted for upland catchments?**



**Abhainn Strath na Sealga (Gruinard River)**

*photo by Ben Rushbrooke*

**Beinn Eighe NNR: soils are thin and infertile**

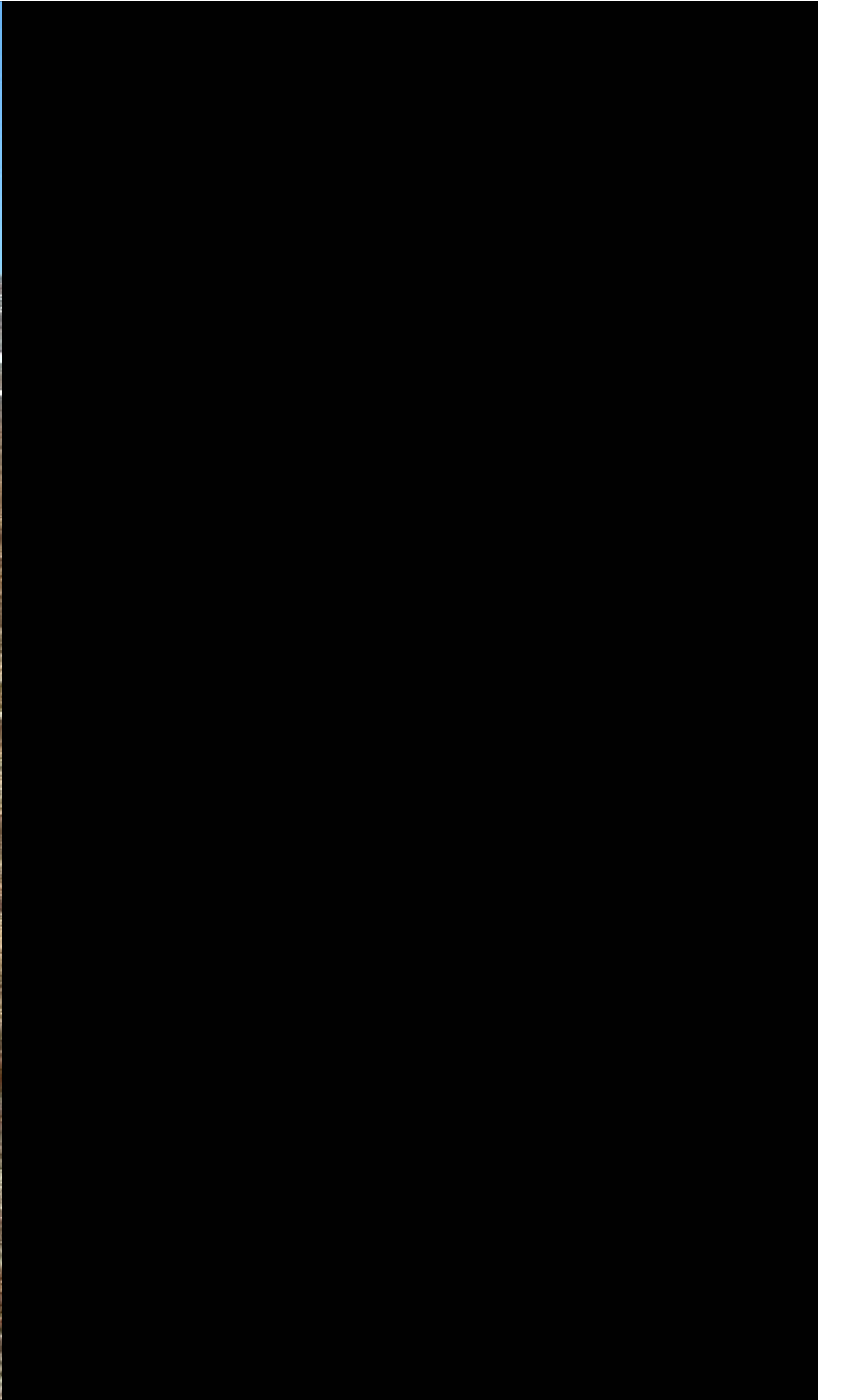




**Few plants grow, and biodiversity is low**







**Fertilisation trials were carried out on Beinn Eighe NNR in the 1950s to find out how to enhance soil fertility.**



***Fertilised area***

***Unfertilised area***

**Details are sketchy, but 50 yrs on,  
results can still be clearly seen.**

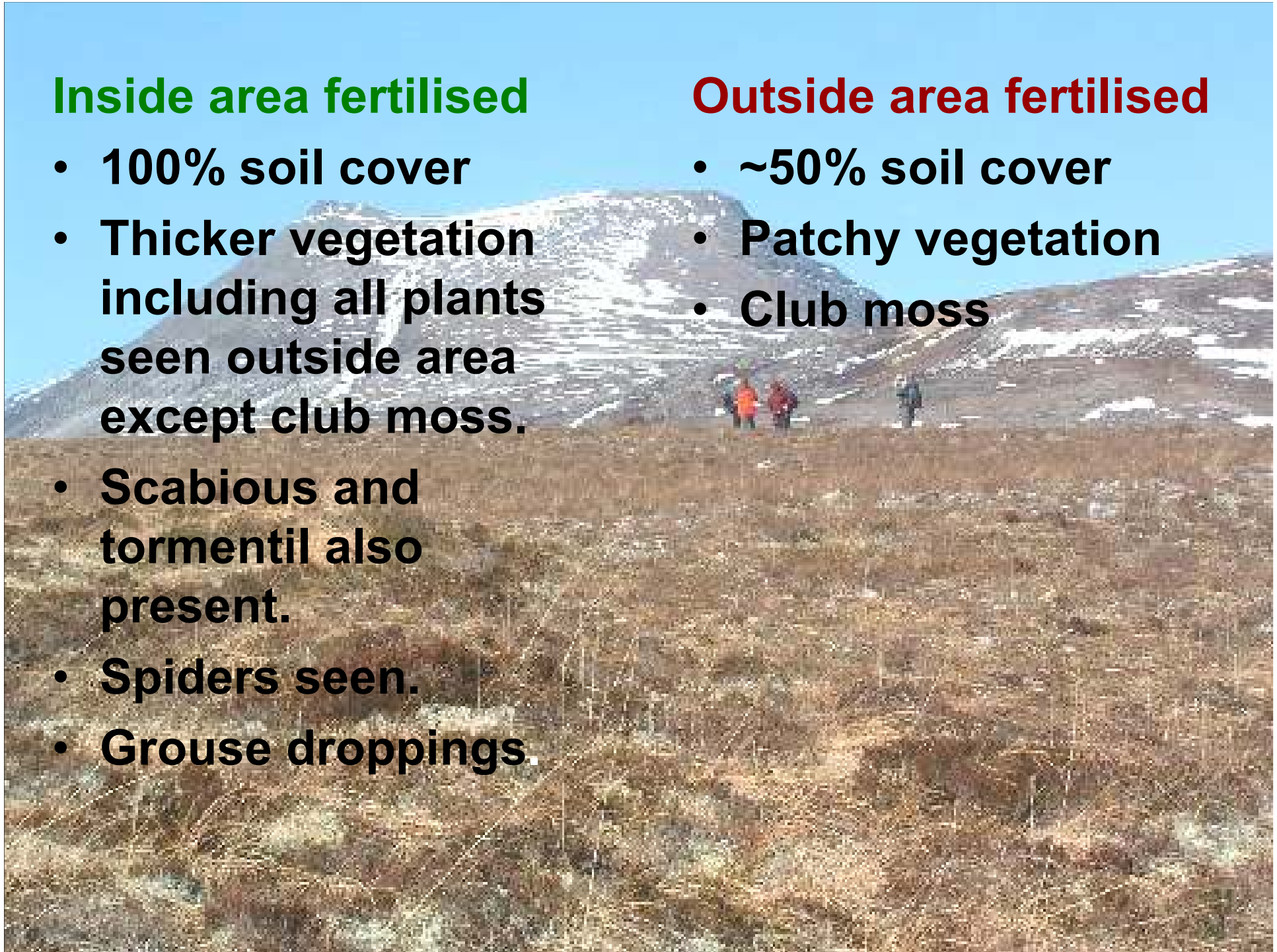
***Looks like the trial was successful??***

## Inside area fertilised

- 100% soil cover
- Thicker vegetation including all plants seen outside area except club moss.
- Scabious and tormentil also present.
- Spiders seen.
- Grouse droppings.

## Outside area fertilised

- ~50% soil cover
- Patchy vegetation
- Club moss



Trail fertilised plots on Beinn Eighe NNR bear a resemblance to the 'green knolls' created by birds and mammals.

Would the following animals benefit:

Red grouse, Mountain hare, Golden eagle, Ring ouzel, small mammals, Merlin, other predators of small mammals, insects, spiders, frogs and other animals which feed on insects and spiders, moths, earthworms, animals which feed on earthworms, moles . . . **trout, salmon.**

And many more, including large grazing animals such as red deer. . . . ?

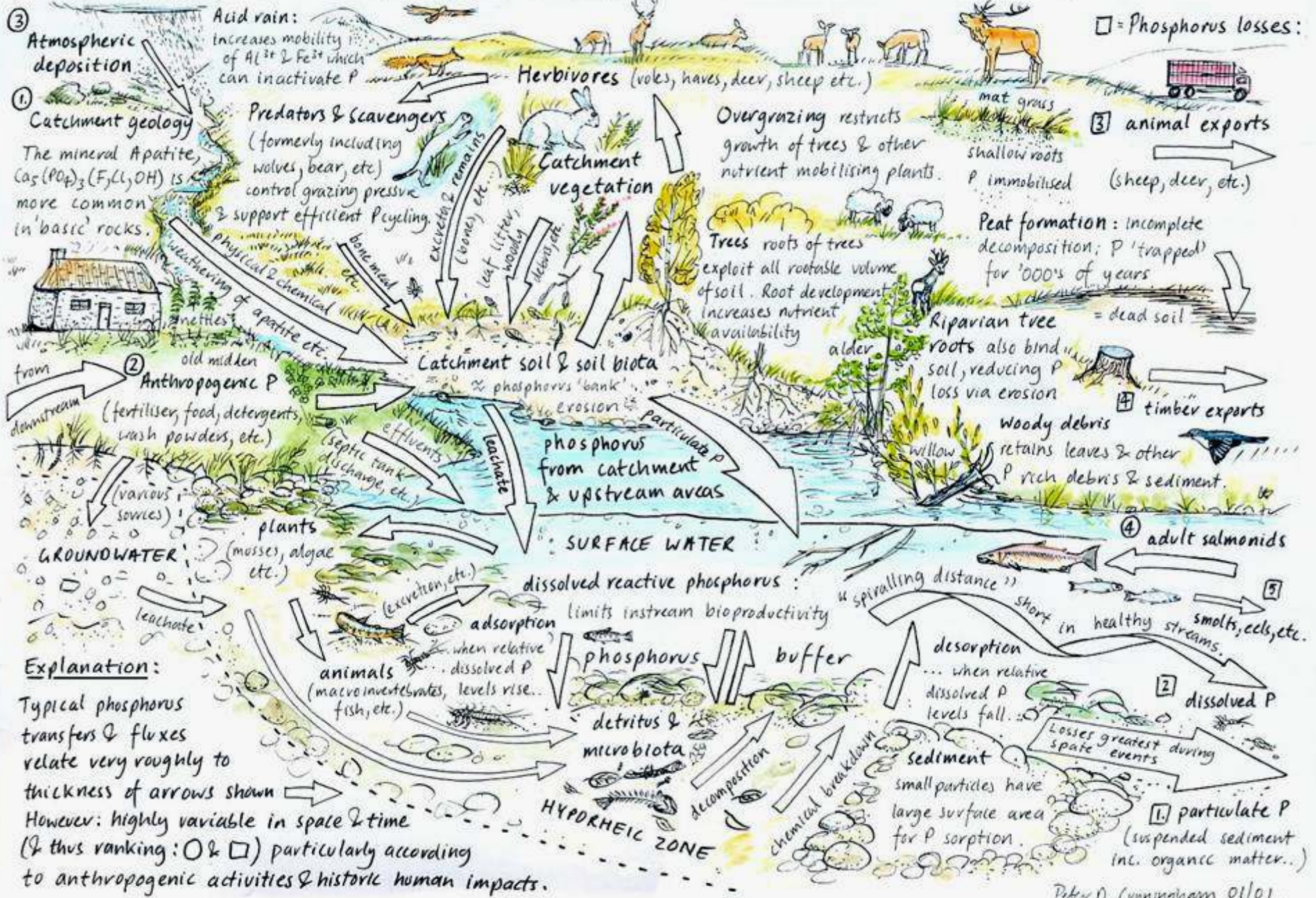
Trail fertilised plots on Beinn Eighe NNR bear a resemblance to the 'green knolls' created by birds and mammals.

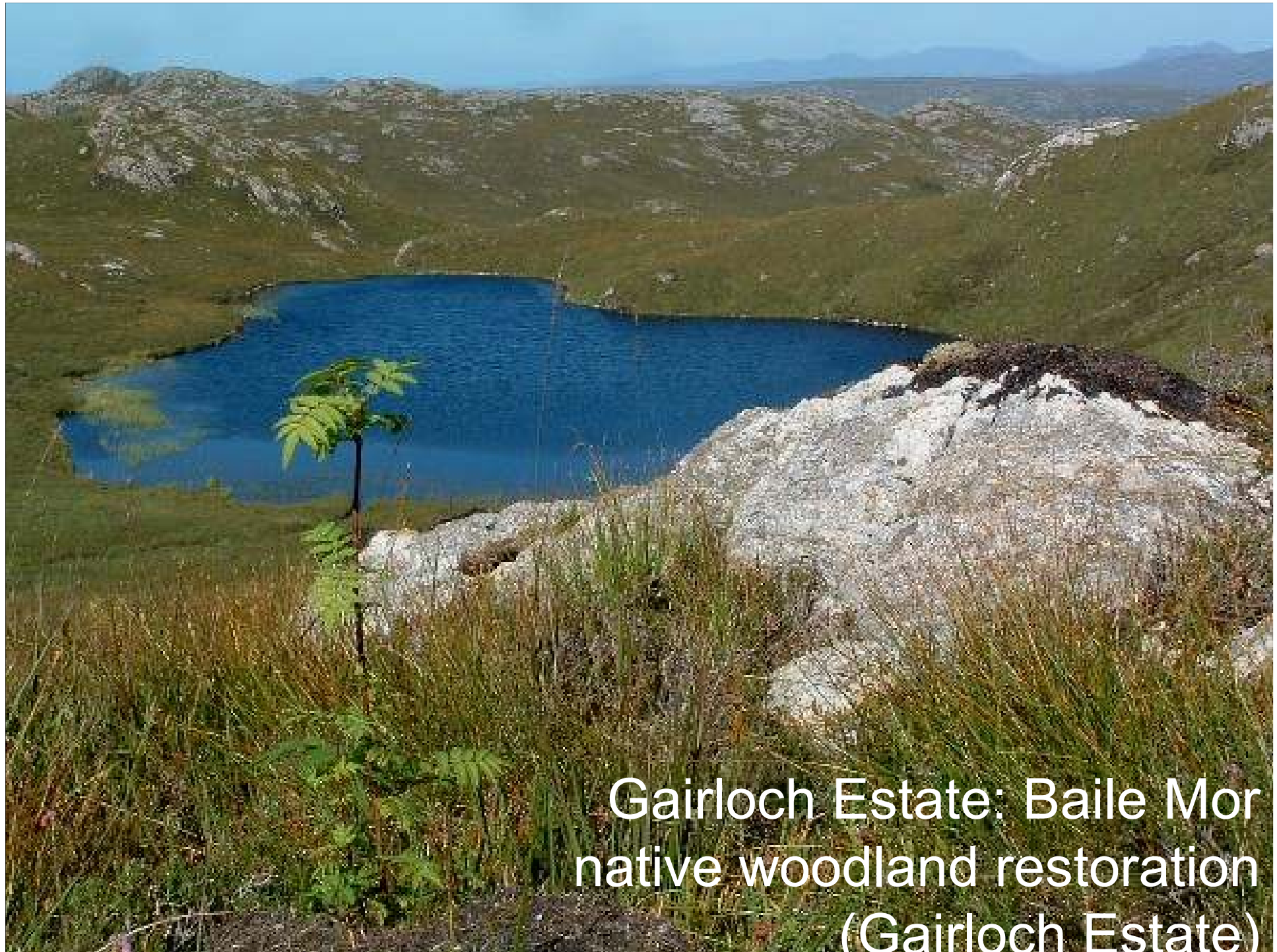
Could the biodiversity and productivity of upland areas be restored without risk of changing oligotrophic status of catchment areas through application of small amounts of slow-release phosphate fertiliser (e.g. bone meal) at frequent (annual or more often) intervals?

# Phosphorus availability is dependent upon ecosystem health

○ = Phosphorus source

□ = Phosphorus losses:





Gairloch Estate: Baile Mor  
native woodland restoration  
(Gairloch Estate)



**Ground Rock Phosphate  
fertiliser applied at 125g / tree**

**Note grass growth**



# Young woodland, Larachantivore, upper Gruinard (Letterewe Estate)



# Annual electro-fishing survey





# How does strong riparian vegetation affect food supply for juvenile salmon?

1. Roots protect riparian soils which support many invertebrates (earthworms, leather jackets, other beetles and grubs).

2. Leaves provide additional nutrition for the river – especially caddis fly larvae (shredders).

3. Woody debris traps other organic matter which feeds insect larvae and increases food availability for juvenile fish.

4. However, if trees overgrow river channel and create too much shade, instream production (mayfly and stonefly larvae) may be reduced from lack of sunlight.

5. Extensive shading can reduce summer water temperatures (though increase winter water temperatures)

.....





# Riparian tree roots

1. Structural: roots link together to strengthen river bank, confining river channel to narrower deeper channel.
2. Reduce the rate of erosion and mobility of sediment in the river.
3. Reduce the rate of mobility of the channel itself.
4. Retain nutritious organic matter (including larval insects) enhancing food supply for juvenile fish.
5. Reduce frequency and severity of redd washout (and washout of fry and parr)?
6. Protect deep holes – cover for adult fish as they enter smaller streams at spawning time. Deeper channels enable large fish to evade a predator more easily?
7. Can choke river channel though log jams.



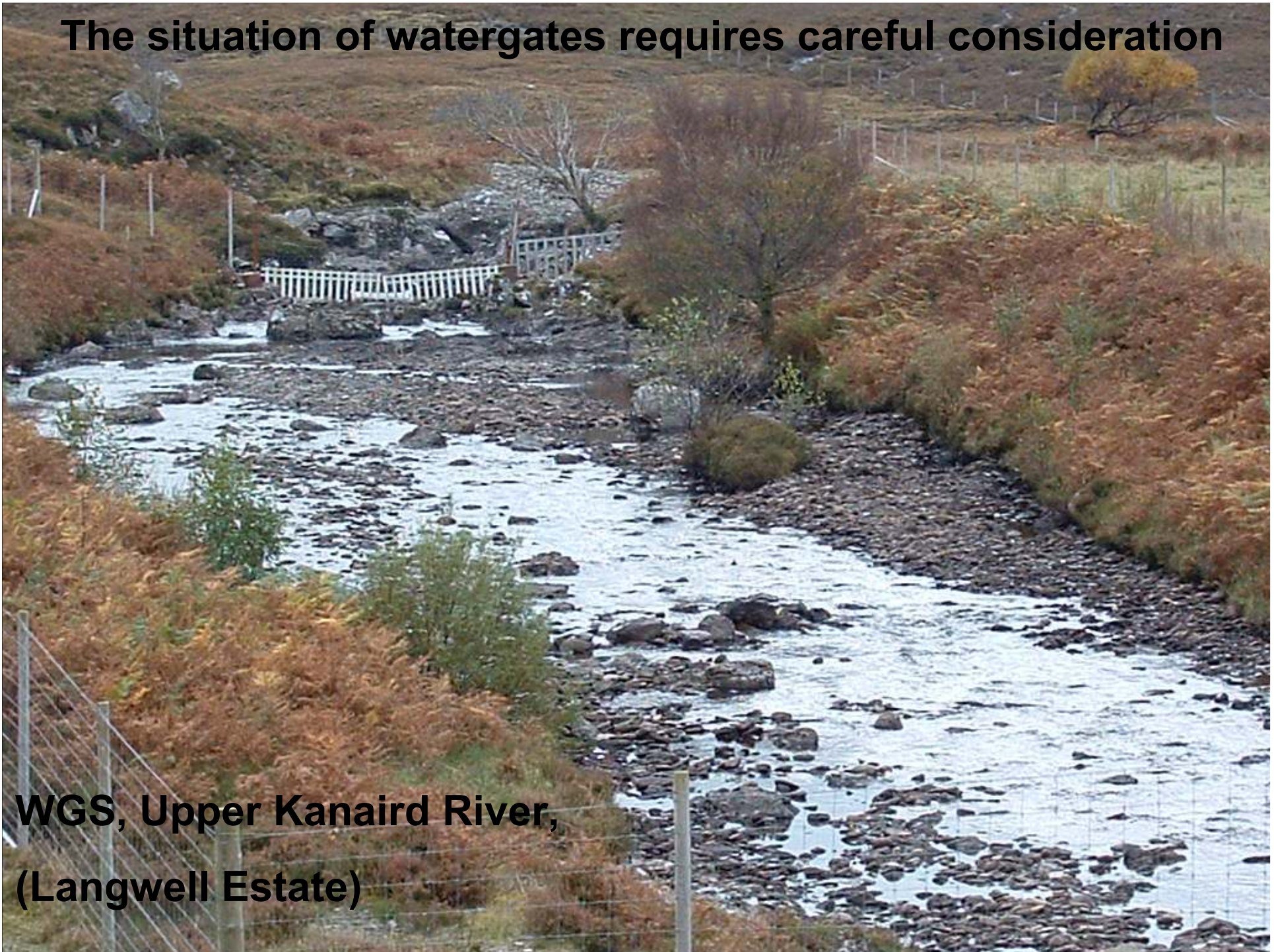
**Some estates have developed enclosed woodlands to stabilise streams and enhance food availability.**



**WGS enclosure, Farmhouse Burn (Coulin Estate)  
(headwaters of River Ewe)**



**The situation of watergates requires careful consideration**



**WGS, Upper Kanaird River,  
(Langwell Estate)**



Watergate, A' Ghairbhe  
above Kinlochewe  
(Coulin Estate)



**Loch na Fideil Burn, by  
Loch Maree**



# Freshwater pearl mussels



## Soils, ecosystem fertility & salmon smolt production in Wester Ross

1. Much of **Wester Ross** is underlain by hard, insoluble Lewisian gneiss, Torridonian sandstone or Moine granulate, yielding very **little nutrients**.

2. **Soil fertility** is therefore dependent upon the retention and cycling of nutrients, particularly phosphate, through the **ecosystem**.

14. Increasingly **heavy rain** leaches nutrients from soils and washes away ash from fires. Spates erode away the richest riparian soils notably where alder trees have died back.

13. **Heather burning** is carried out to convert woody matter to ash, thereby releasing nutrients to promote the growth of grasses and other leafy matter for grazing deer or livestock.

5. Historically there were **bears and wolves**. Wolves eat deer, ingesting bone and recycling phosphates.

7. Look for **wee green knolls** in the peatlands where birds and mammals have enriched the soil: note the increased plant growth and biodiversity.

3. Unlike many rivers in the east of Scotland, there is **little human habitation** within the catchments of local rivers so little added nutrient from human sources.

4. **In the past** there were more **people** living in river catchment areas. Without modern sanitation, they **contributed to nutrient recycling**.

6. **Peat** has formed where sphagnum moss smothers the ground, acidifying the soil and preventing aerobic decomposition.

8. Similar green patches are found along river banks where otters defecate. In the autumn, these **otter 'spraint sites'** may contain salmon bones.

10. Given sufficient phosphate (e.g. bone meal in mammal faeces), **Alder trees** grow in symbiosis with symbiotic nitrogen-fixing bacteria, further enriching riparian soil fertility.

11. Most plants develop **mycorrhiza networks** with symbiotic fungi which deliver phosphate to plant roots in exchange for carbohydrate.

15. Growth of **periphyton** is faster where the streambed is stable and stream fertility is naturally high.

12. **Earthworms** help to recycle and retain organic matter and increase the porosity of riparian soils.

17. **Salmon parr** growth rates are highest where the food supply is richest. Over-winter survival and smolt production may depend upon the supply of mayfly and caddisfly larvae.

16. Flat-headed 'Heptageniid' **mayfly larvae** scrape periphyton from the streambed. Other mayfly and **caddisfly larvae** gather or filter organic detritus including leaf and periphyton fragments.

In some areas invasive **New Zealand flatworms** have reduced earthworm populations, displacing **moles** with adverse consequences for soils.

9. **Adult salmon** deliver nutrients of marine origin to headwater streams especially if their carcasses are scavenged by other animals.

18. **Well-nourished smolts** are better prepared for life at sea than emaciated smolts.



# Woodland Grant Scheme, Flowerdale (Gairloch Estate)









**Local estates work together to support stock restoration programmes**

# Stocking.



**Wild salmon have failed to spawn in the upper Bruachaig since the 1990s**

**. . . stocked fish may grow well.**







Badachro, Allt a' Ghuibhais 2008,  
5.9 salmon fry per minute

# Stocked fish may compete with wild fish for food



'Wild' and stocked salmon from the River Carron, September '07

# Some Conclusions

Production of juvenile salmon and other wildlife in Wester Ross is limited by fertility and food availability. Many areas have lost fertility due to land management practices over hundreds of years.

The most productive sites for juvenile salmon are usually those where the nutrient levels and food supply are highest (e.g. below loch; below septic tank outflow).





## Some Conclusions 2

Stream stability is also important: where the streambed is *very* unstable and moves every winter, densities may be low due to frequent scouring and washout.

However, some 'unstable' streams support high densities of fish (e.g. Kinlochewe River, Badachro).

Problems of bank erosion and scouring often originate in the upper catchment area: a catchment management approach is best for addressing these problems.



## Some Conclusions 3



The primary aim of habitat restoration in Wester Ross should be to increase the 'natural' fertility of soils. This will lead to increased vegetation growth and higher production of food for wildlife including fish.

Trees help to stabilise the river channel and retain fertile soil. However, they may shade the water and do not, on their own, increase production.

Bushes are better than trees: alder and willow can be coppiced to allow sunlight onto the water.







**Thank you!**

