Habitat restoration in degraded rural streams: The Granite Creeks Project

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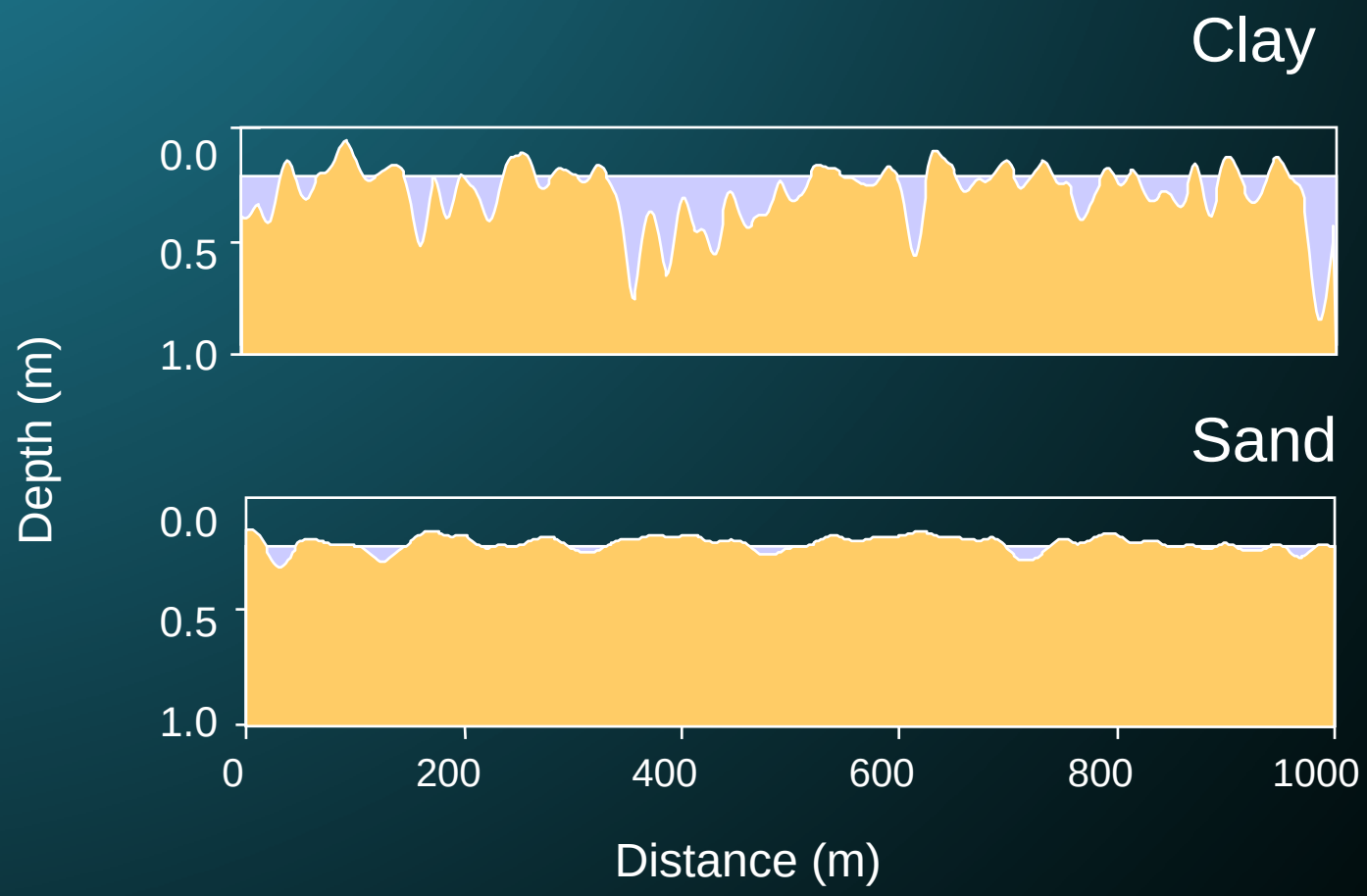
The granite creeks system

- Sand slug formation in the early1900's
- Agents of major geomorphic change and habitat loss
- Major ecosystem changes - especially fish communities

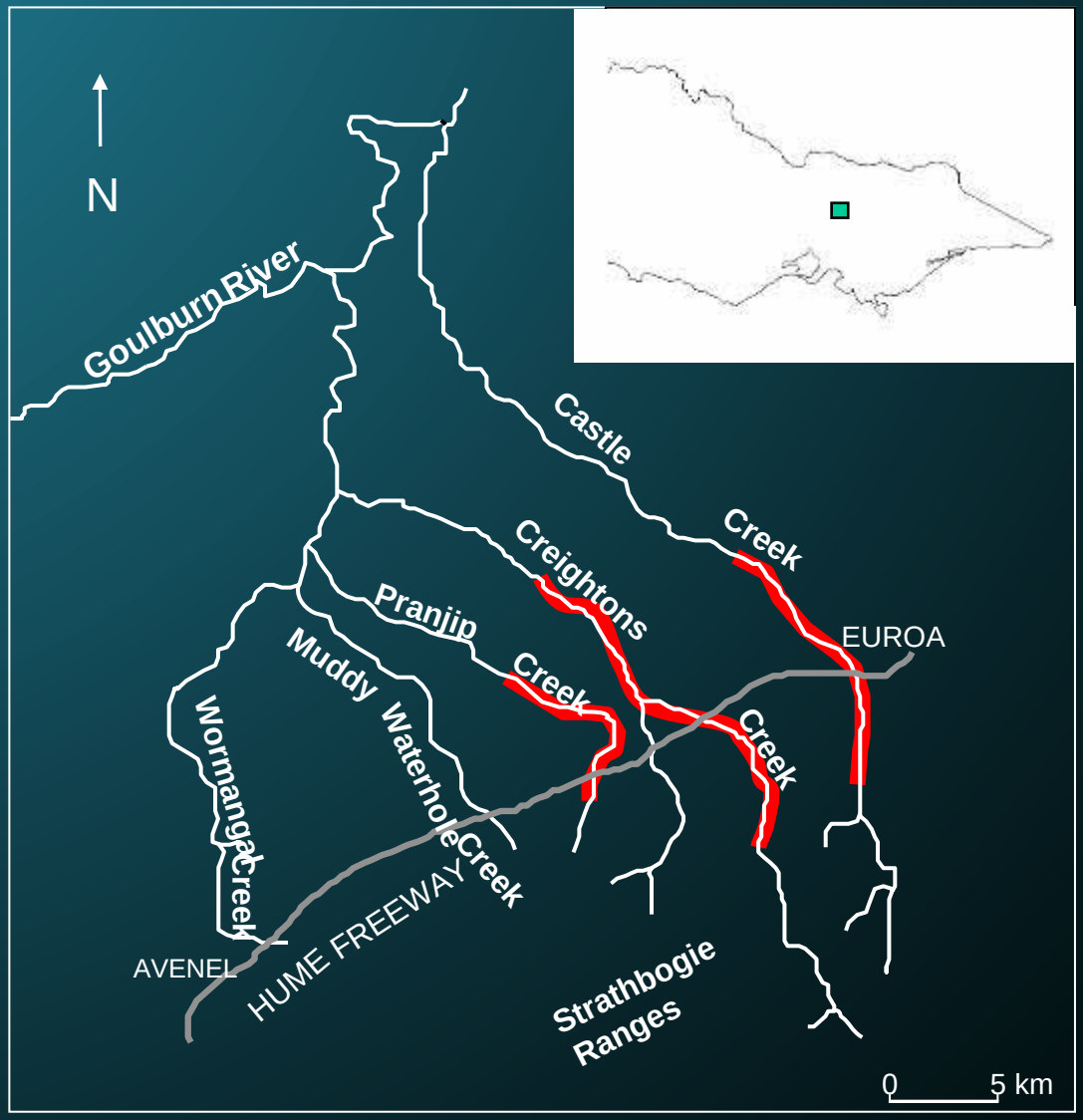
Degradation by sand slugs

- Greatly reduced habitat diversity
- Loss of stable substrates (burial of large timber)
- Decreased retention of organic material.
- potential habitat and energy limitations on populations.

Decreases in geomorphic complexity



Sand slug locations



Sand Slugs

- A dramatic, and widespread form of stream degradaton

Research program

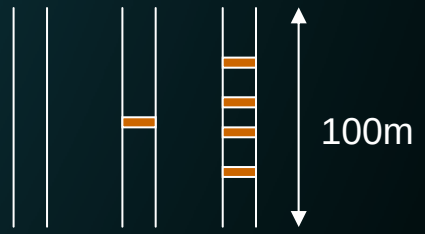
- Project established against a strong backdrop of earlier work on the ecology and geomorphology of these streams. (Nick O'Connor, Jenny Davis, Brian Finlayson, Barbara Downes et al.)

- A multidisciplinary project.
  - Geomorphology (Dan Borg & Ian Rutherfurd)
  - Fish & Invertebrates (Bond, Lake and Glaister)
  - Metabolic processes (Bonnie Atkinson, Mike Grace & Darren Baldwin)
  - Nutrient cycling (Kellie Vanderkruk)
  - Genetics and connectivity among populations (Ben Cook)
  - Large-scale disturbances & refugia (Bond & George Perry)

- Focus for todays talk is on localised faunal response to timber, and the meaning of these results from a streamscape perspective.

Granite Creeks Project overview

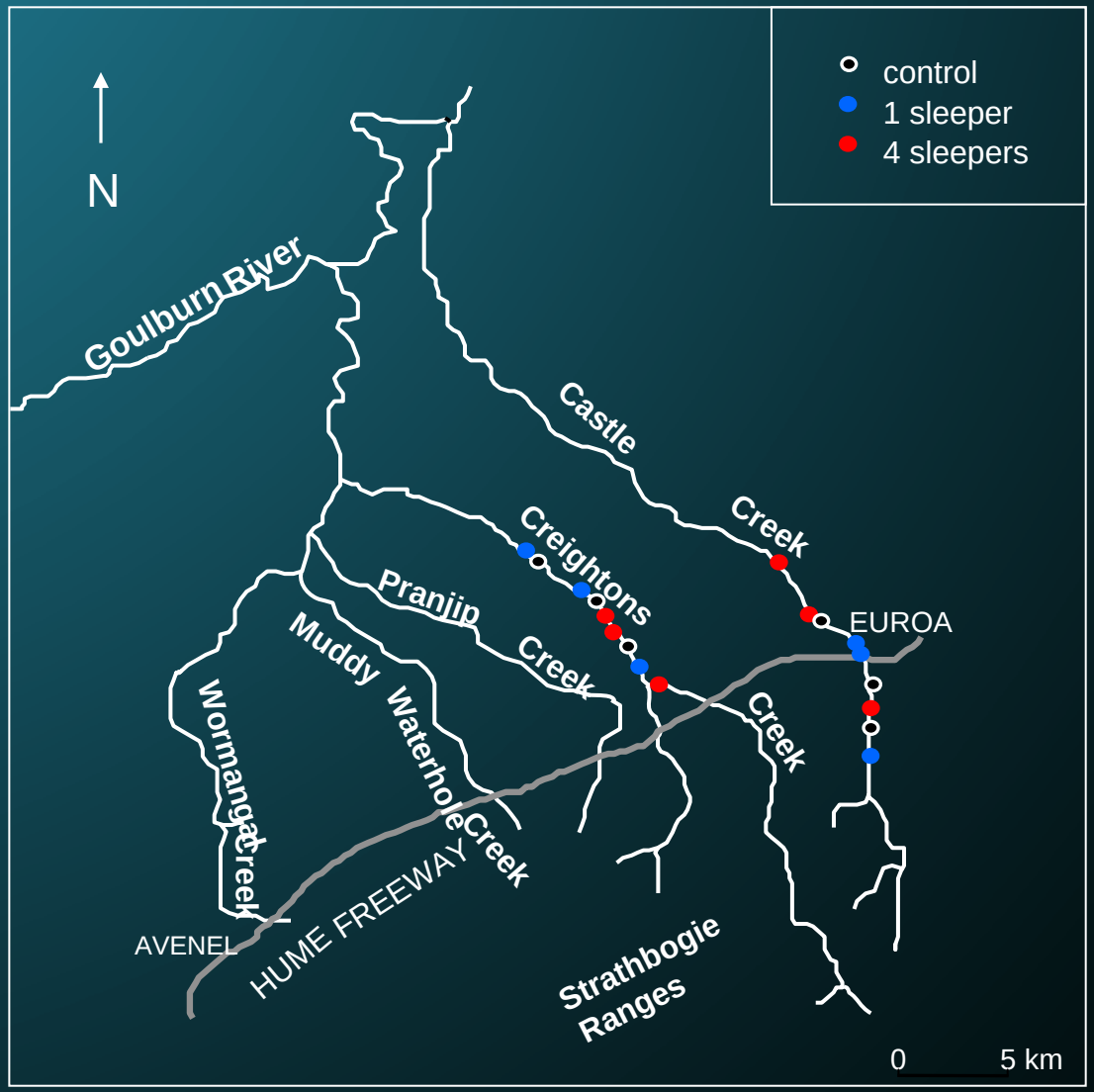
- The project has centered around a manipulative experiment, in which timber structures were added to sites on 2 streams.
- Control, 1-structure and 4-structure sites have been monitored over time.



AIMS:

- To test the “field of dreams” hypothesis, which underpins much stream restoration work, especially the reintroduction of timber.
- To bring together local and regional factors in understanding habitat-biota relationships in the context of stream restoration

Site locations

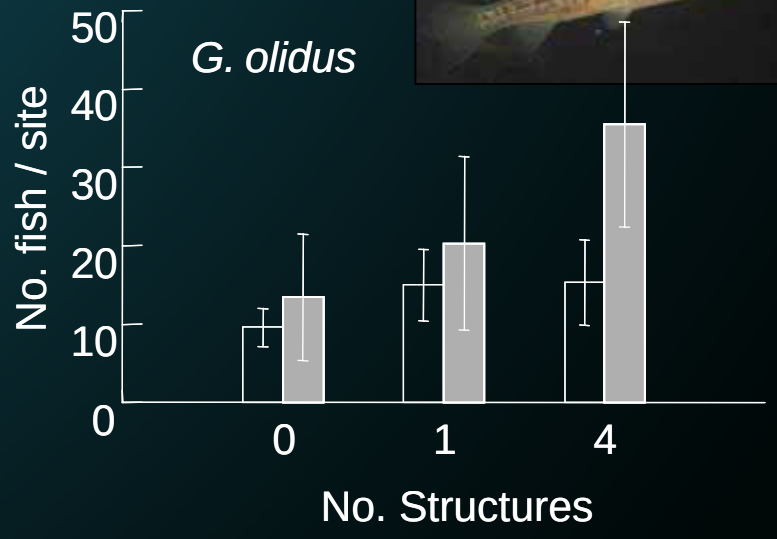


Timber addition – geomorphic change

- Sleeper addition caused scour pool development at most sites
- Most scour pools were dynamic – infilled at some lower lows but re-scoured again at high flows.
- Scour and fill patterns unpredictable in space and time
- Pools generally were smaller and less persistent than predicted from flume experiments

Habitat creation and fish response

- But, small scour pools complemented by debris build-up and the creation of cover.
- Resulted in a positive response by *G. olidus* and *G. marmoratus*
- No colonisation by exotics such as carp.



See Bond & Lake (in press) *restoration ecology*

Colonisation of introduced red gum

- 20 week colonisation exp.
- Rapid colonisation of algae (diatoms and blue-greens) closely tracked by invertebrates
- Some evidence of nutrient limitation in Castle Creek.
- Loss of algae due to summer drying
- Positive GPP on redgum substrates*

*Whole-stream GPP strongly negative (B. Atkinson) – ie.

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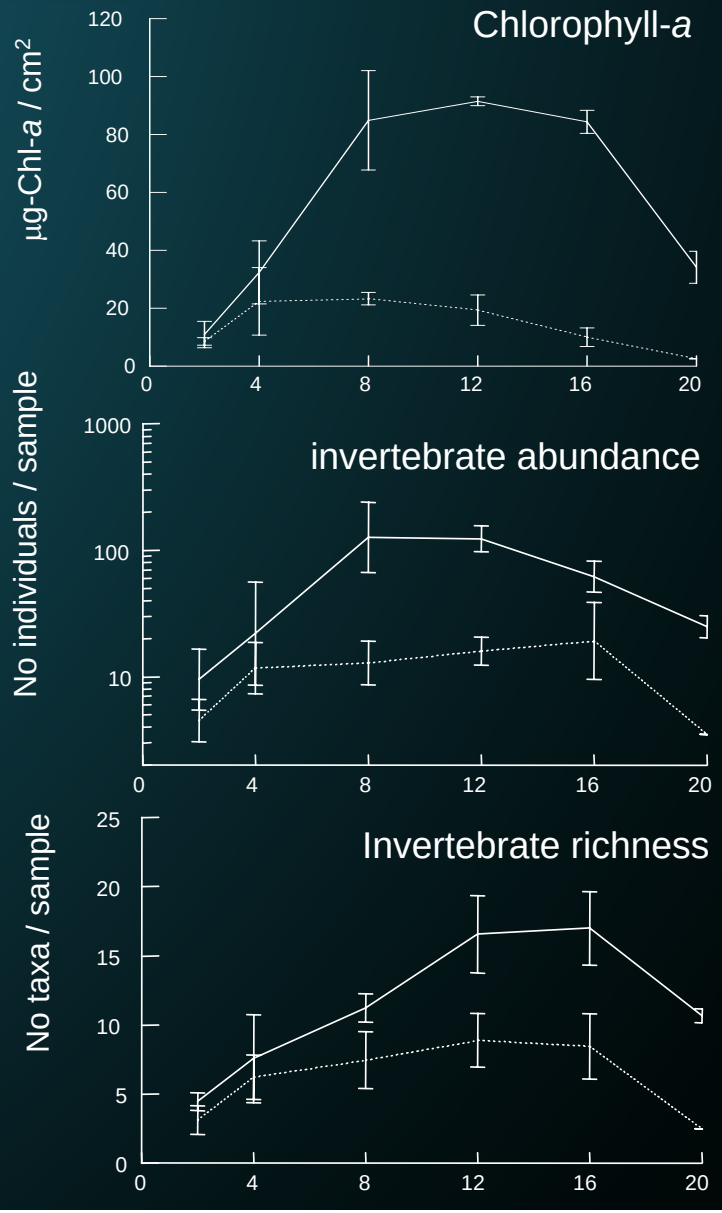
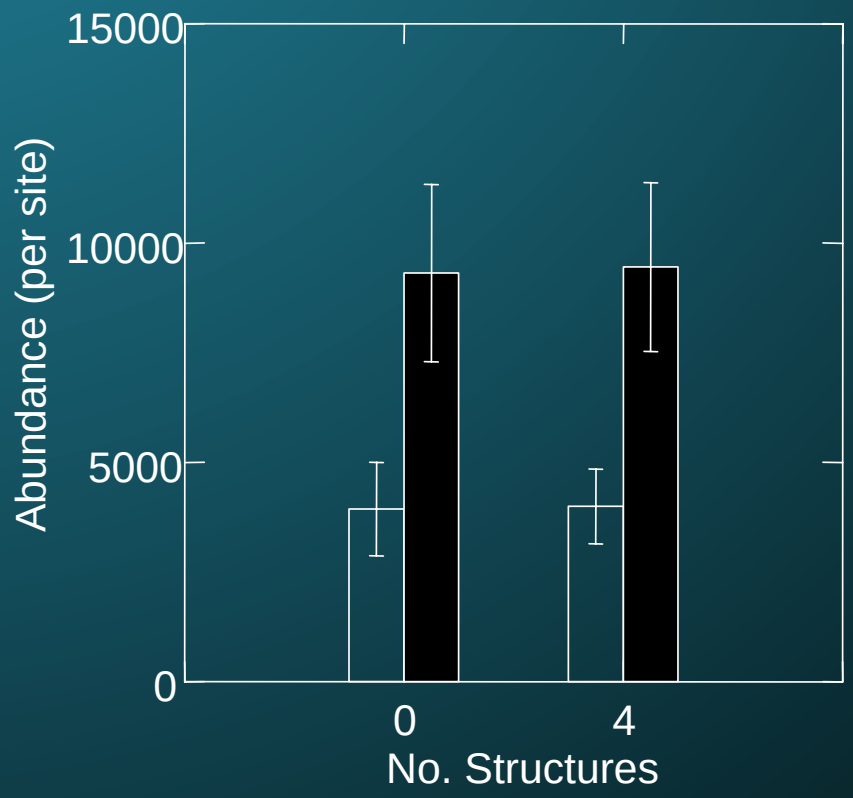
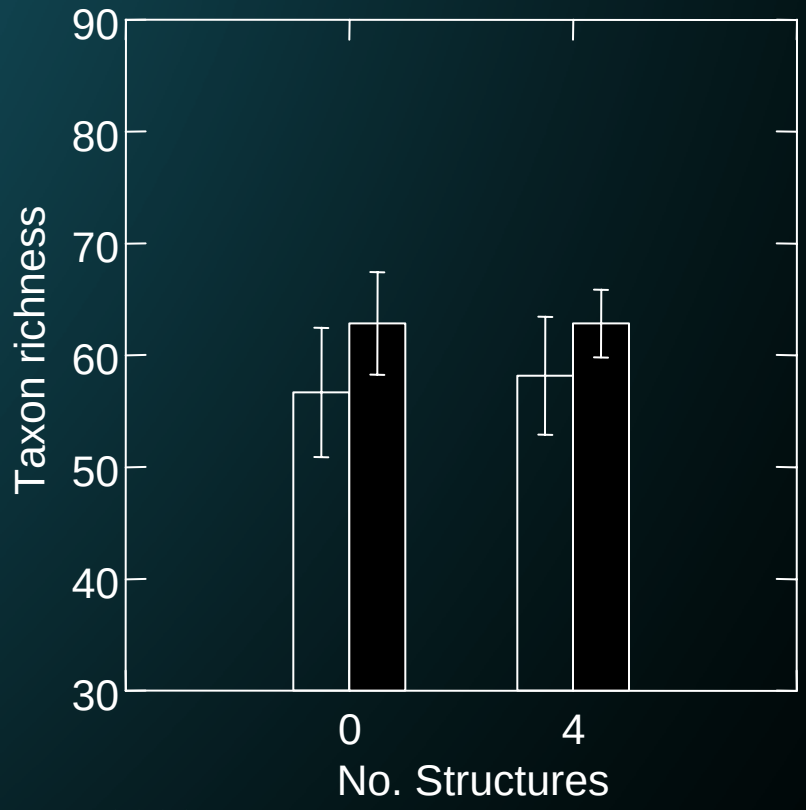


Response by benthic fauna





□ Before - Dec 2000

□ After - Dec 2001

Summary of local response

- Population increases for two fish species – mountain galaxias and river blackfish
- A weak response by benthic invertebrates around timber structures.
- Rapid colonisation of timber by algae and invertebrates.
- Increase in algal production in a system that is otherwise strongly heterotrophic.

Drought and stream drying

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Diversity of refuge habitats

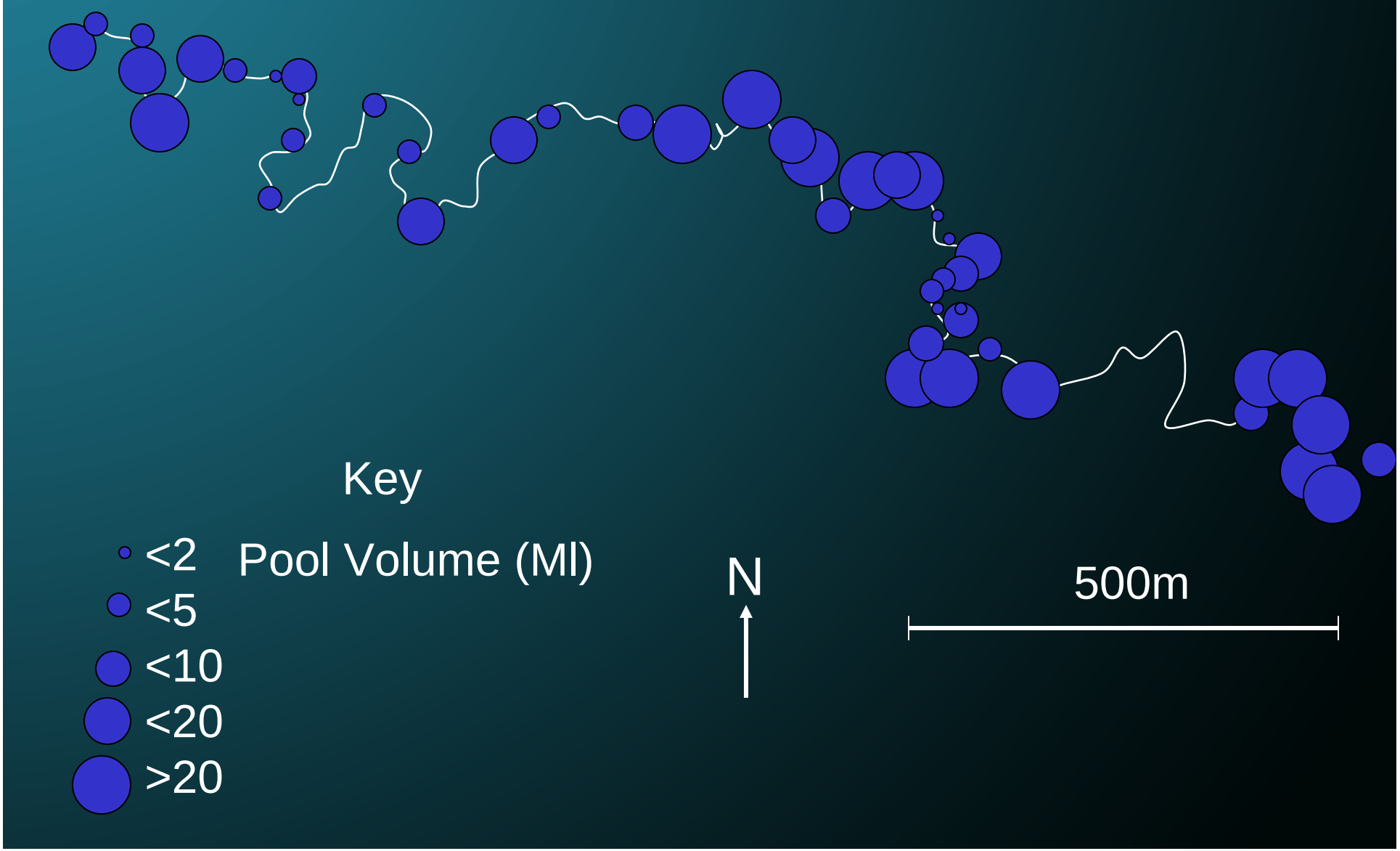
Loss of refuge habitats

	Habitat area (m^2)	Total No. Fish
Clay	210	325
sanded	9	13


Creightons Creek 20 November 2002


Creightons Creek 22 November 2002

Habitat loss and fragmentation - 5/12/02



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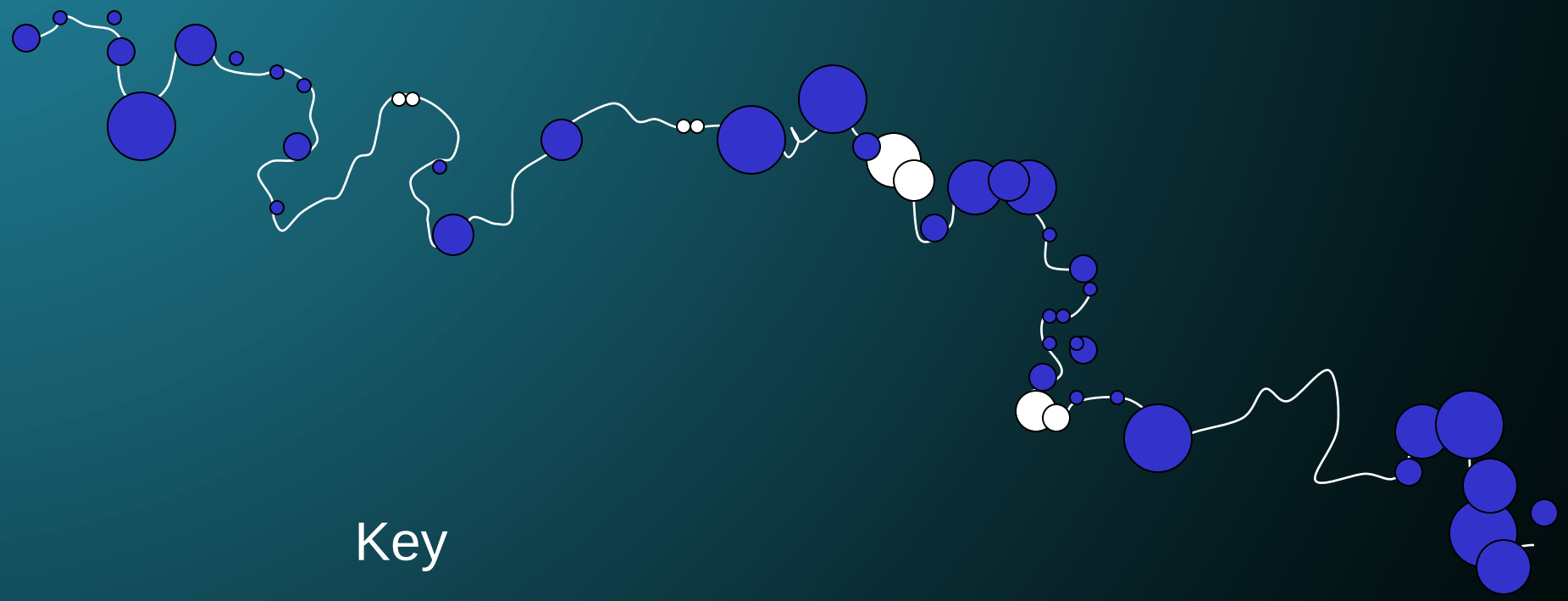


Key

<2
<5
<10
<20
>20

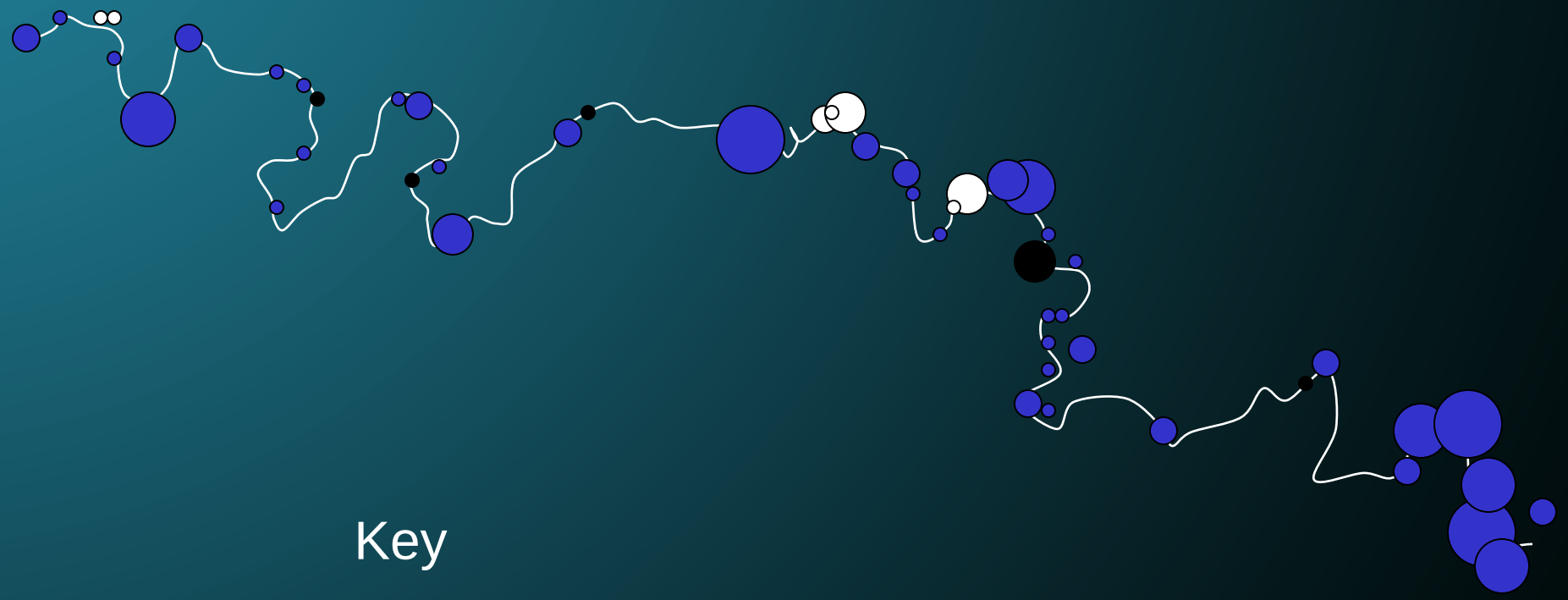
Pool Volume (Ml)

Newly split pools

N

500m

3/1/03



Key

Pool Volume (Ml)

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<5
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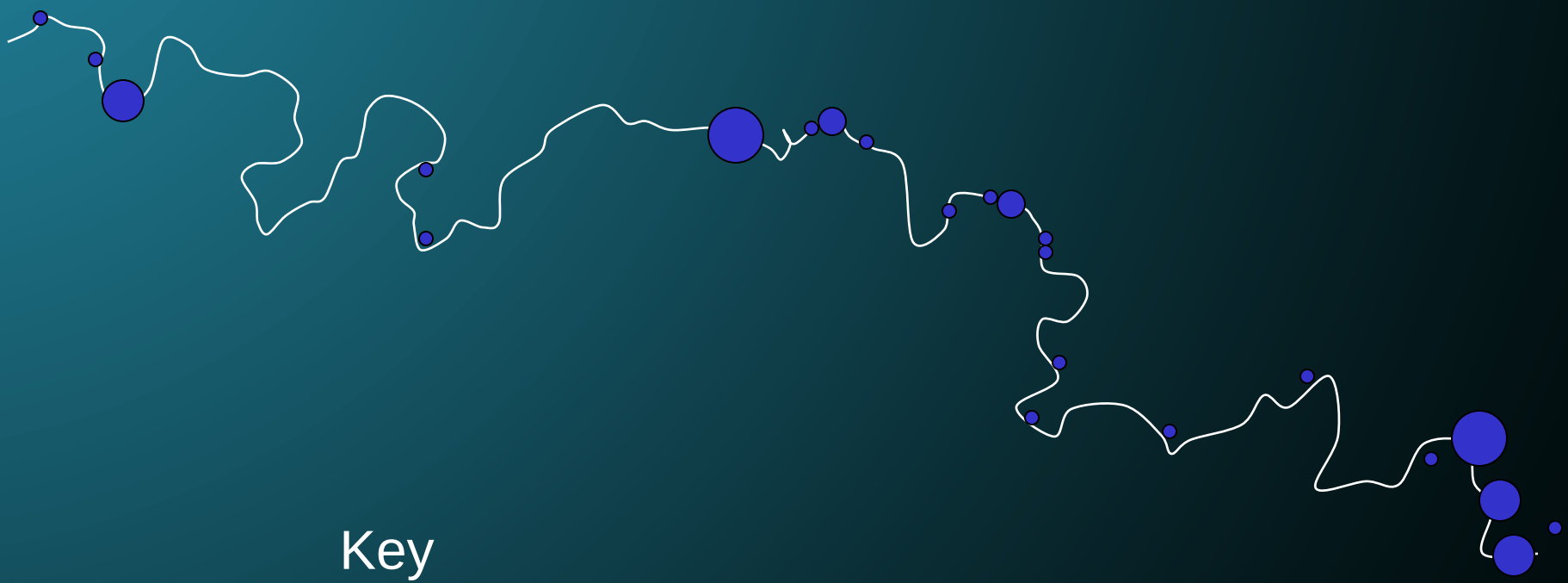
Newly split pools

New rain-filled pools

N

500m

15/1/03



Key

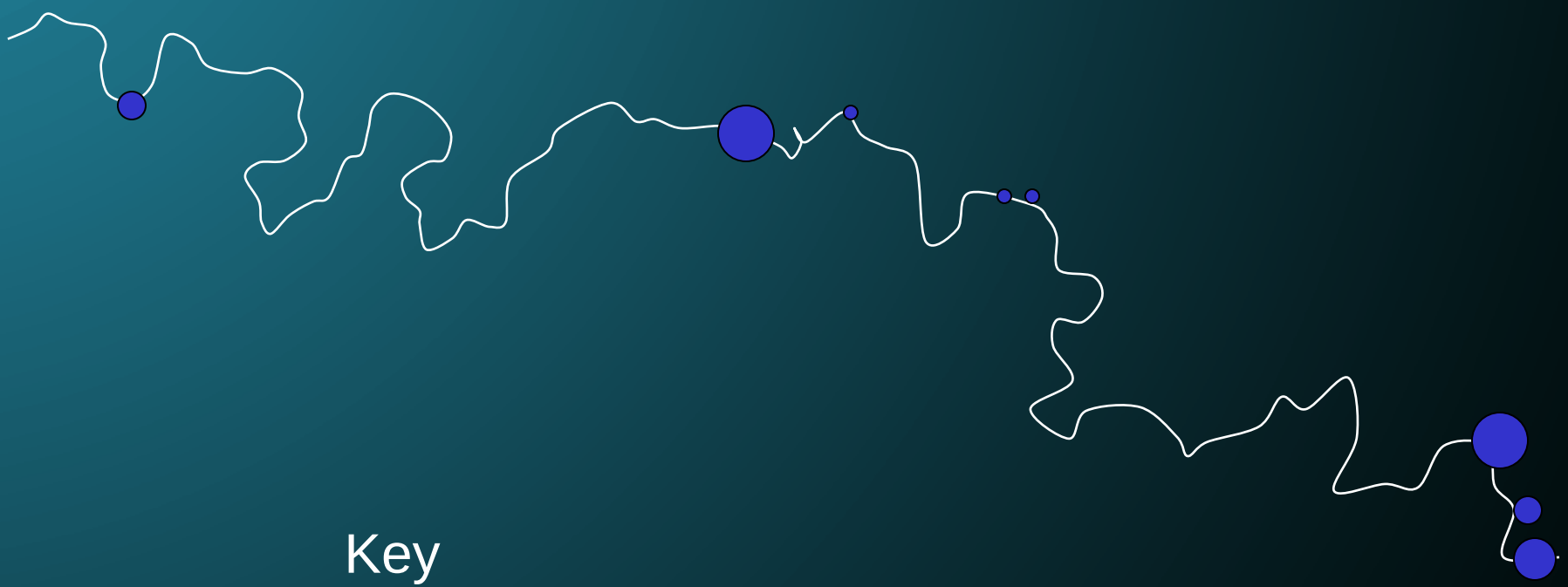
Pool Volume (Ml)

<2
<5
<10
<20
>20

N

500m

27/1/03



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Pool Volume (Ml)

<2
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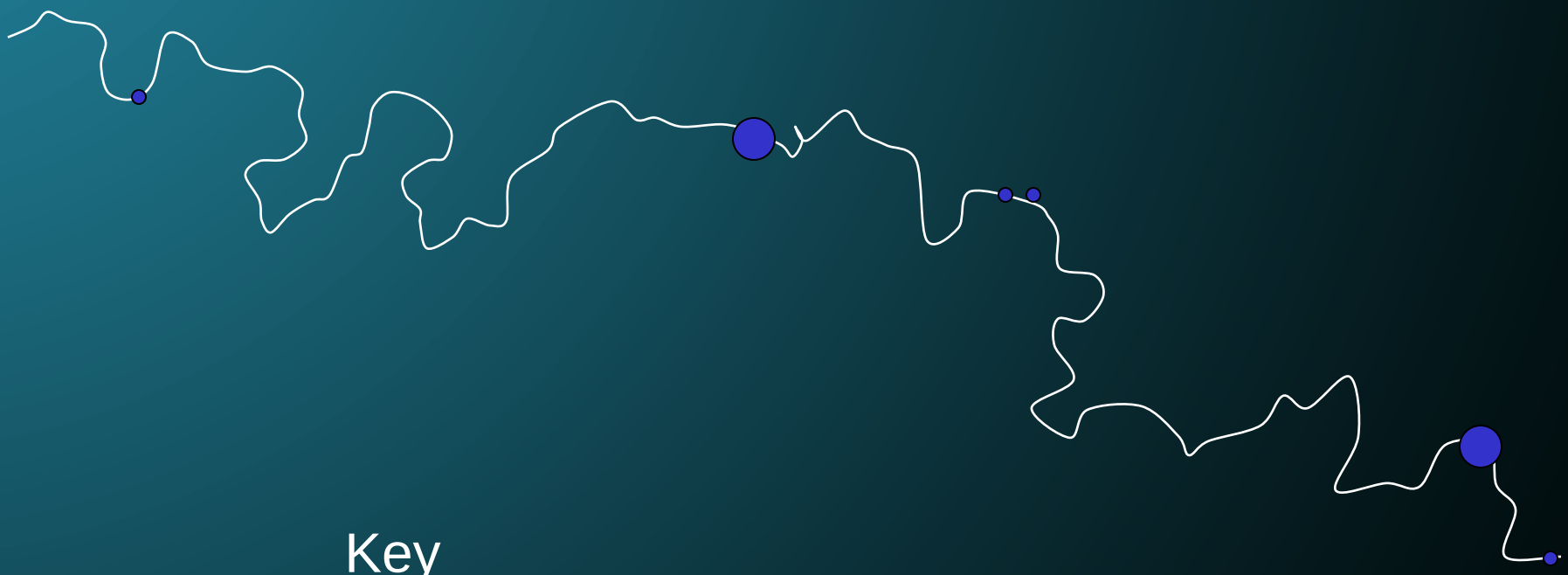
N

500m

11/2/03



Key

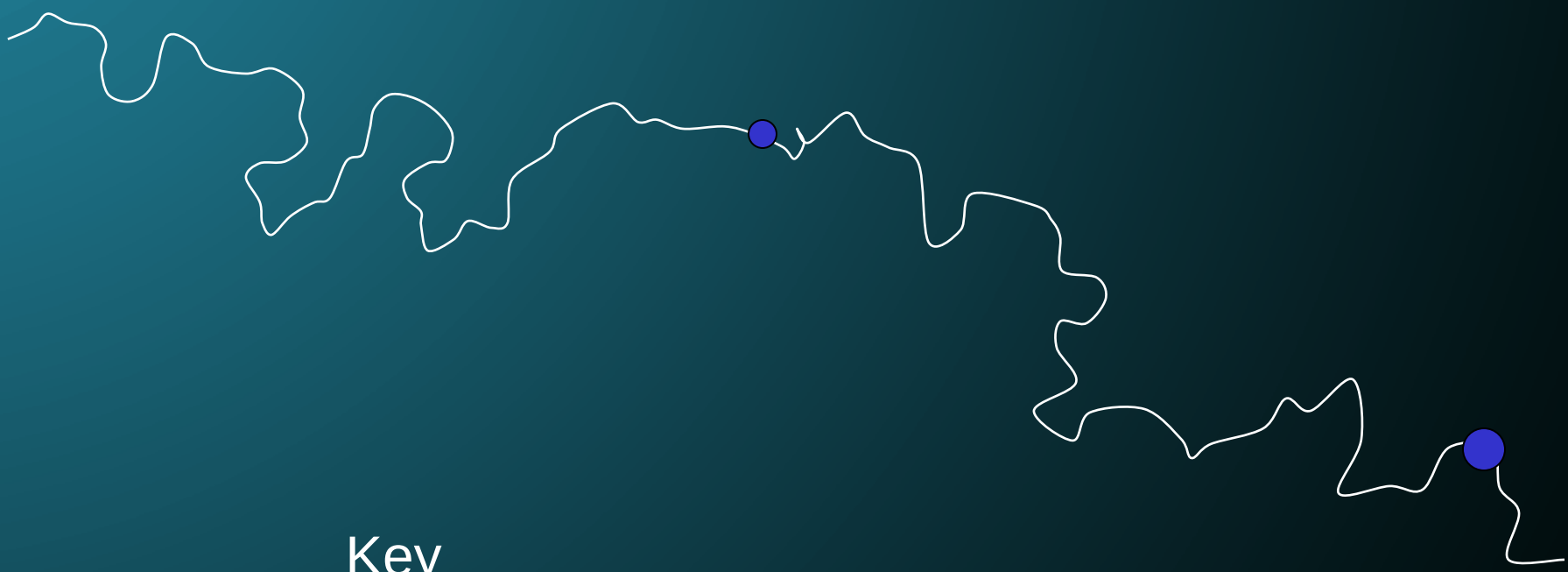
Pool Volume (Ml)

<2
<5
<10
<20
>20

N

500m

23/2/03



Key

Pool Volume (Ml)

- <2
- <5
- <10
- <20
- >20

N

500m

7/3/03

Key

<2 Pool Volume (Ml)

<5

<10

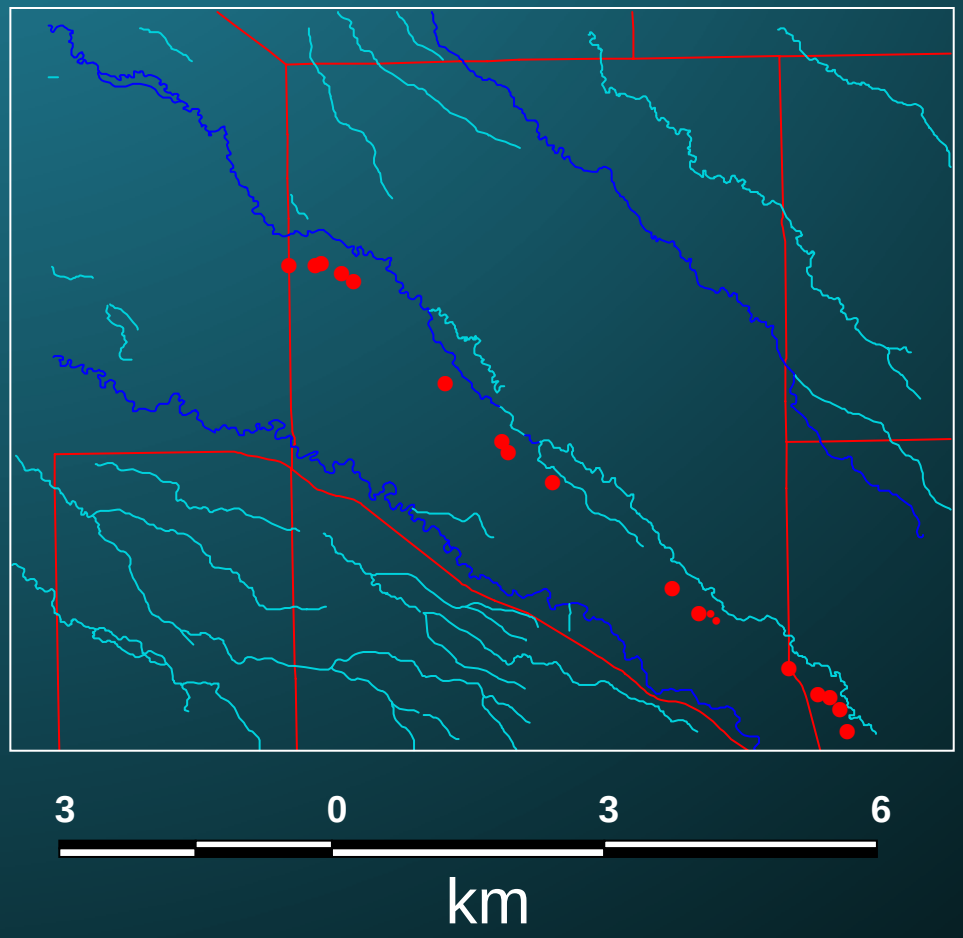
<20

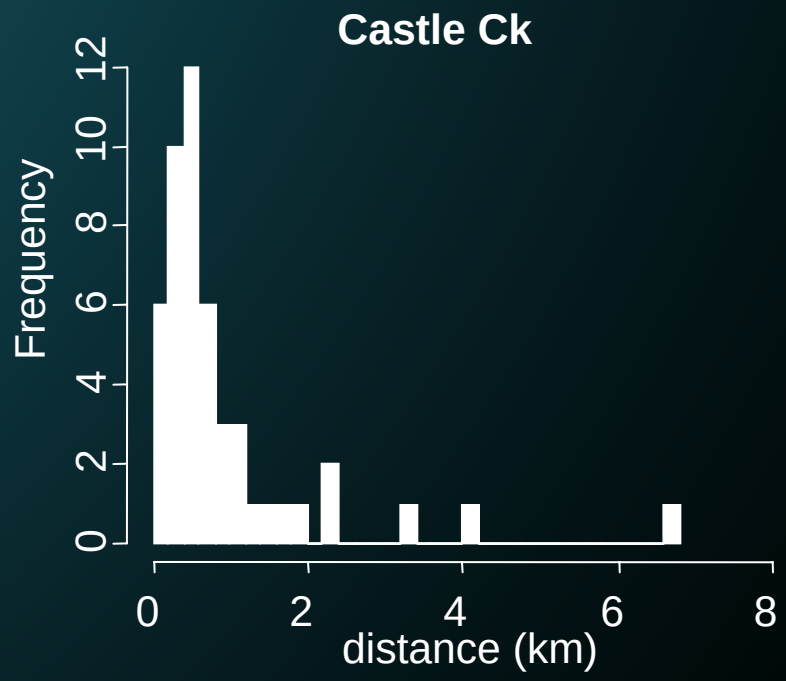
>20

N

500m

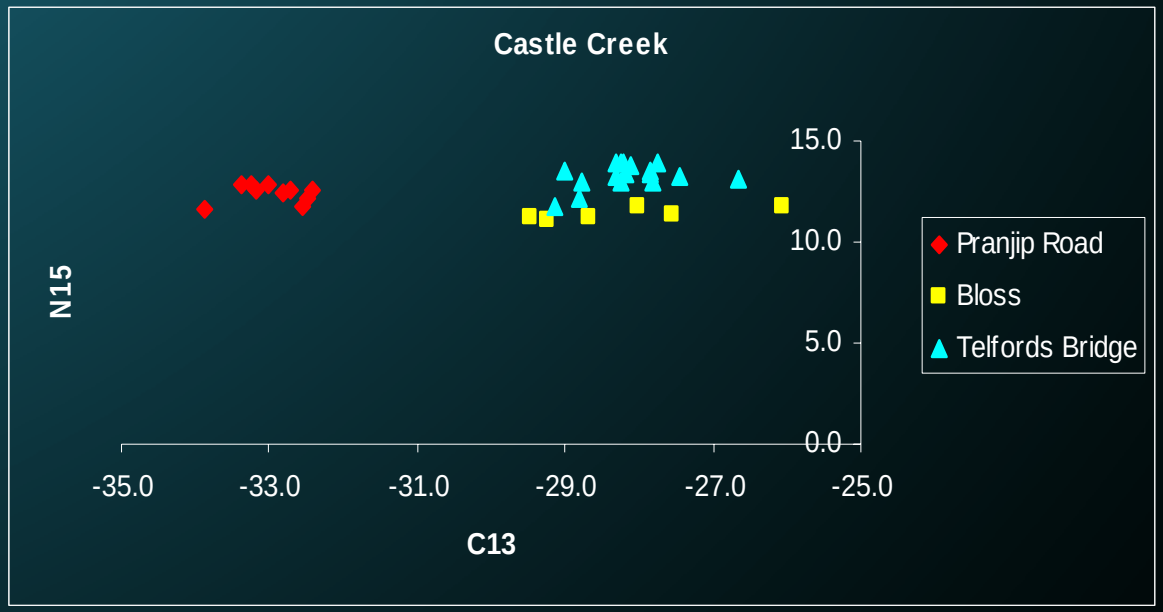
Refugia at the landscape scale





Dispersal patterns of fish

- Genetic and stable isotope data used to look at dispersal by Ben Cook, Griffith University
  - Both techniques show strong population differentiation even within creeks, indicating very limited dispersal.
- Implications for response to restoration and use of refugia.



Local manipulations in a landscape context.

- Drought dramatically overrode the positive short-term response.
- Creation of refuge habitats a possible future target?
- Lack of dispersal runs counter to dominant belief about connectivity.
- *Are many localised manipulations better than a small number of large ones?*
  - Providing critical thresholds (e.g. permanent water) are crossed.

Conclusions

- Local fish populations responded positively when habitat was created by sleeper addition.
- Sleeper addition did not always create new habitat – both temporally and spatially variable.
- Drought and lack of water a major constraint on the likely success of habitat manipulations.
- Dispersal may be much more limited than one might expect – constrains population recovery rates.
- Refuge habitats of critical importance in these streams - often threatened by water extraction & stock access.

Future Research

- Continue macroinvertebrate and fish monitoring; both restoration and drought recovery.
- Assess responses to restoration of solute retention capacity, POM storage and retention, metabolism (production + respiration), microbial diversity and DOC processing.
- Modelling of future restoration strategies—scaling-up of structures, restoring riparian sustainability.