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The Structure and Function of Chalk Streams

Habitat and ecology of perennial chalk stream headwaters

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The Structure and Function of Chalk Streams

Physical aspects
Biological aspects
Characteristics and diversity

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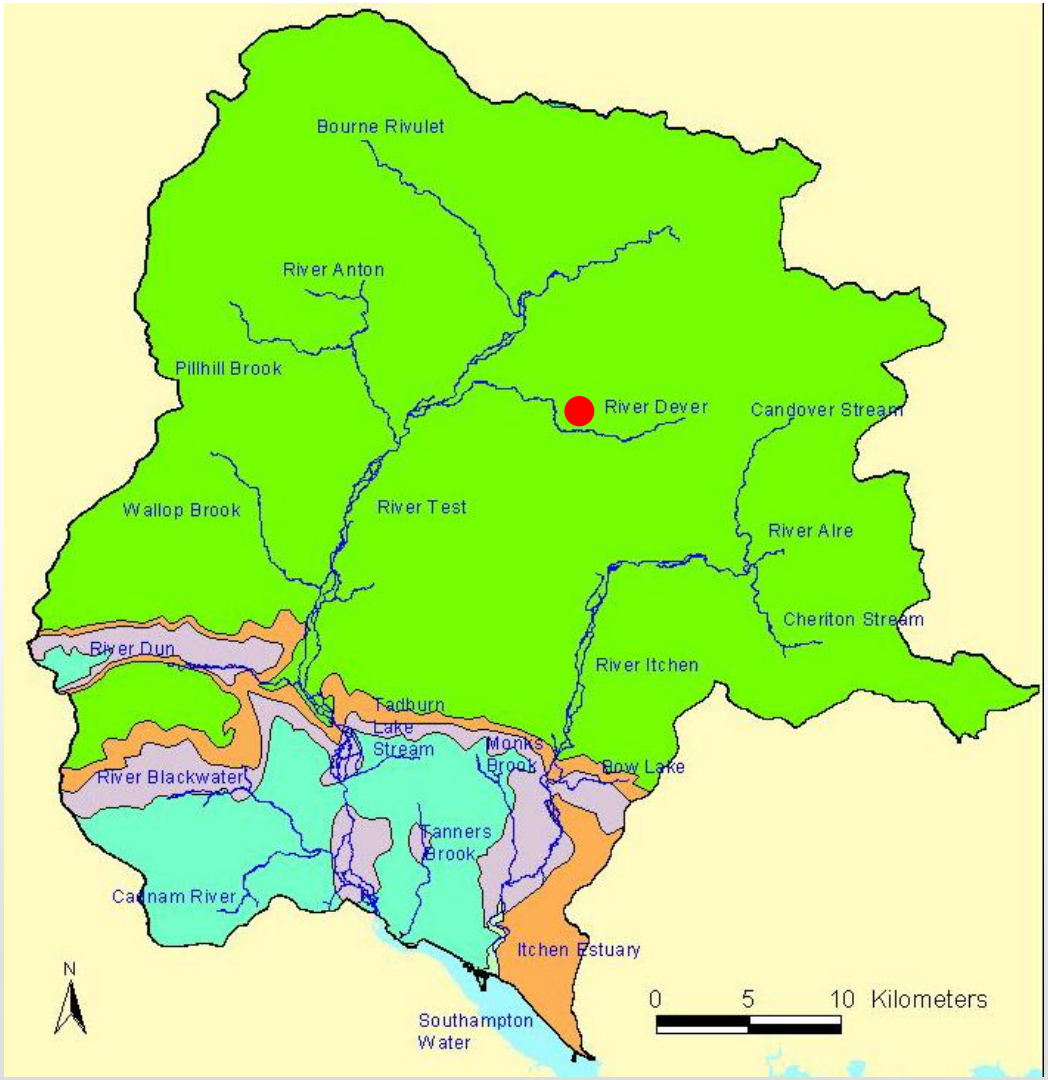
Physical aspects

Examples: The Test and Itchen



Aquifer fed (chalk)
Low gradient: headwaters *ca.* 1 in 300 to 1 in 400 [1]

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Physical aspects: overview

- Around 90% of the annual discharge may derive from groundwaters **[2]**
- Temperature is relatively constant **[3]**:
- Springs *ca.* 11°C; rivers *ca.* 5 to 17°C
- Relatively persistent hydrology and flow, with dampened discharge fluctuations **[4]**: maximum to minimum daily flows typically 3:1 **[5]**
- Large, high energy floods are rare **[4]**
- Stable substratum dominated by gravel **[1,4]** and sensitive to siltation **[6]**
- Limited erosion processes **[6]**

Other physical aspects

Natural influences:

Feedback between organisms and the physical environment – e.g. ranunculus [7]

Human impacts & influences:

- Structures (e.g. mills [8], weirs, dams, ponds, drains, ditches, flood defences).
- River & bank management, and other catchment activities (e.g. weed cutting, bank protection, restoration/rehabilitation, bank poaching by livestock, runoff from agriculture and roads, water abstraction)

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Biological aspects

Food webs & trophic interactions

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Big Fish Eat Little Fish (1557)
Pieter van der Heyden, after Pieter Bruegel the Elder

www.metmuseum.org

Example of a river food web

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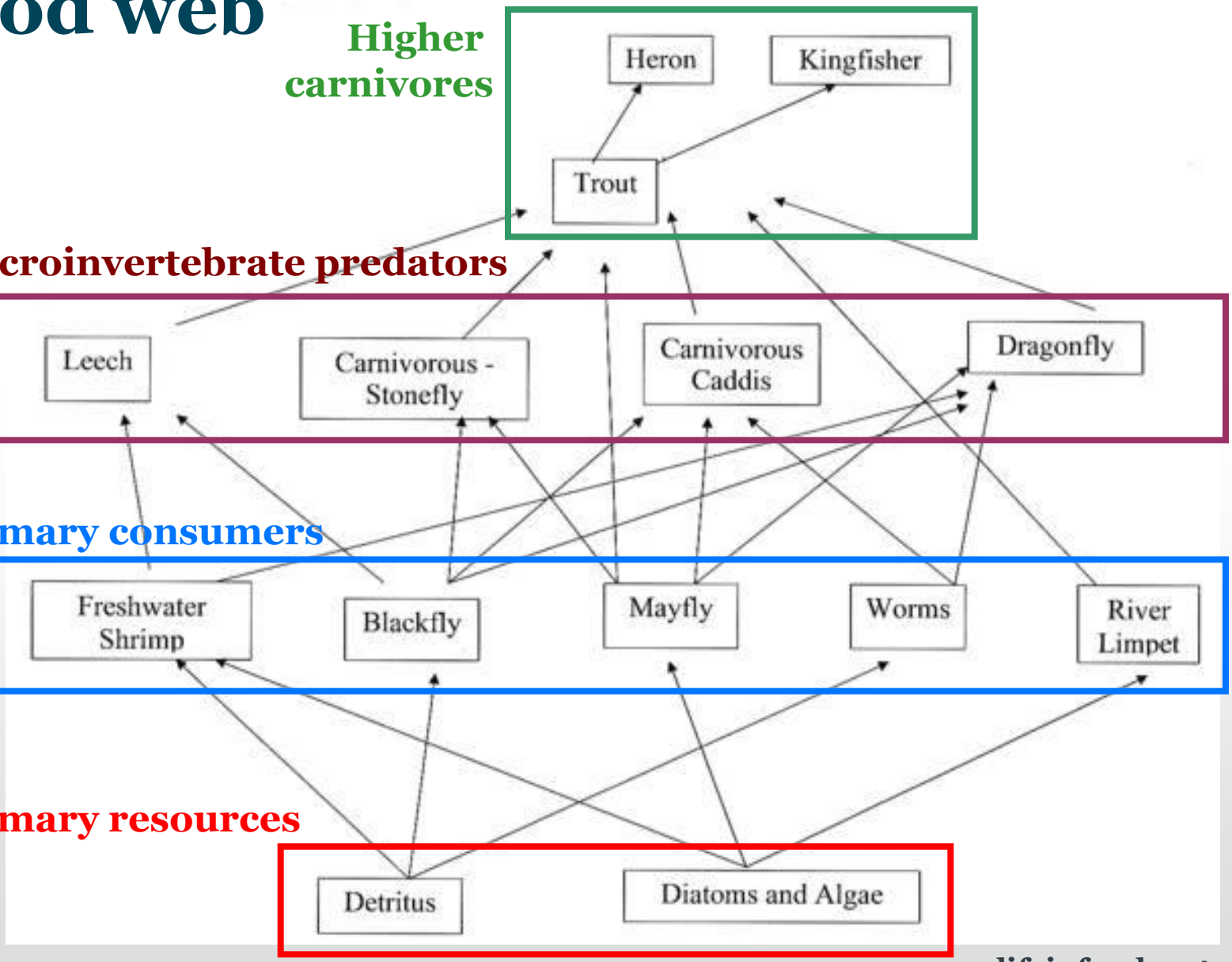

Food webs: key considerations

Do alterations in food web elements (basal resources or top predators) lead to “bottom-up” or “top-down” effects?

Is there predominance of “generalist” or “specialist” feeders?

Are some species more important than others?

Can we diagnose the causes of past changes and can we predict the impacts of contemporary change?

Bottom-up/top-down effects?

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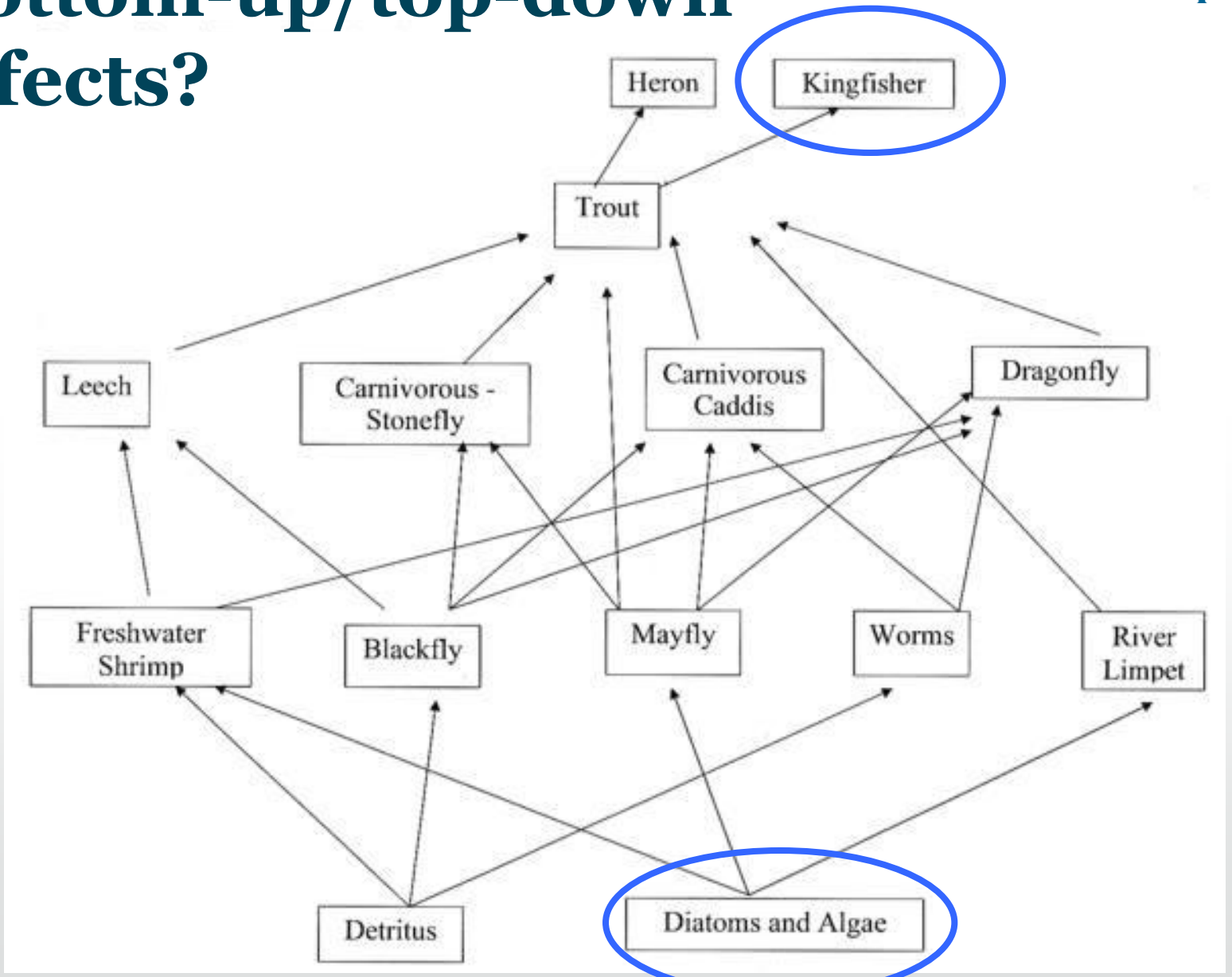

Specialist/generalist feeders?

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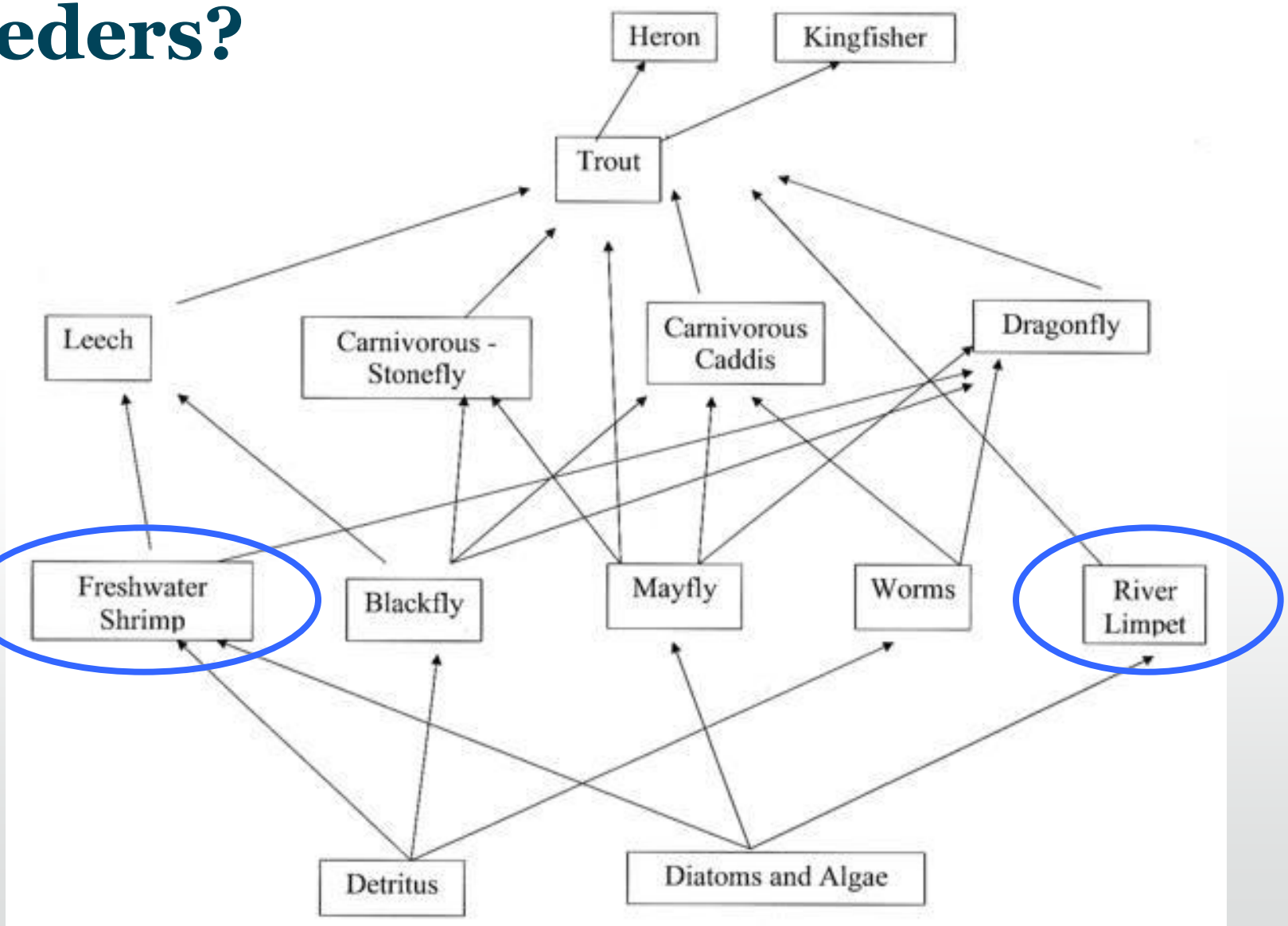

Relative importance?

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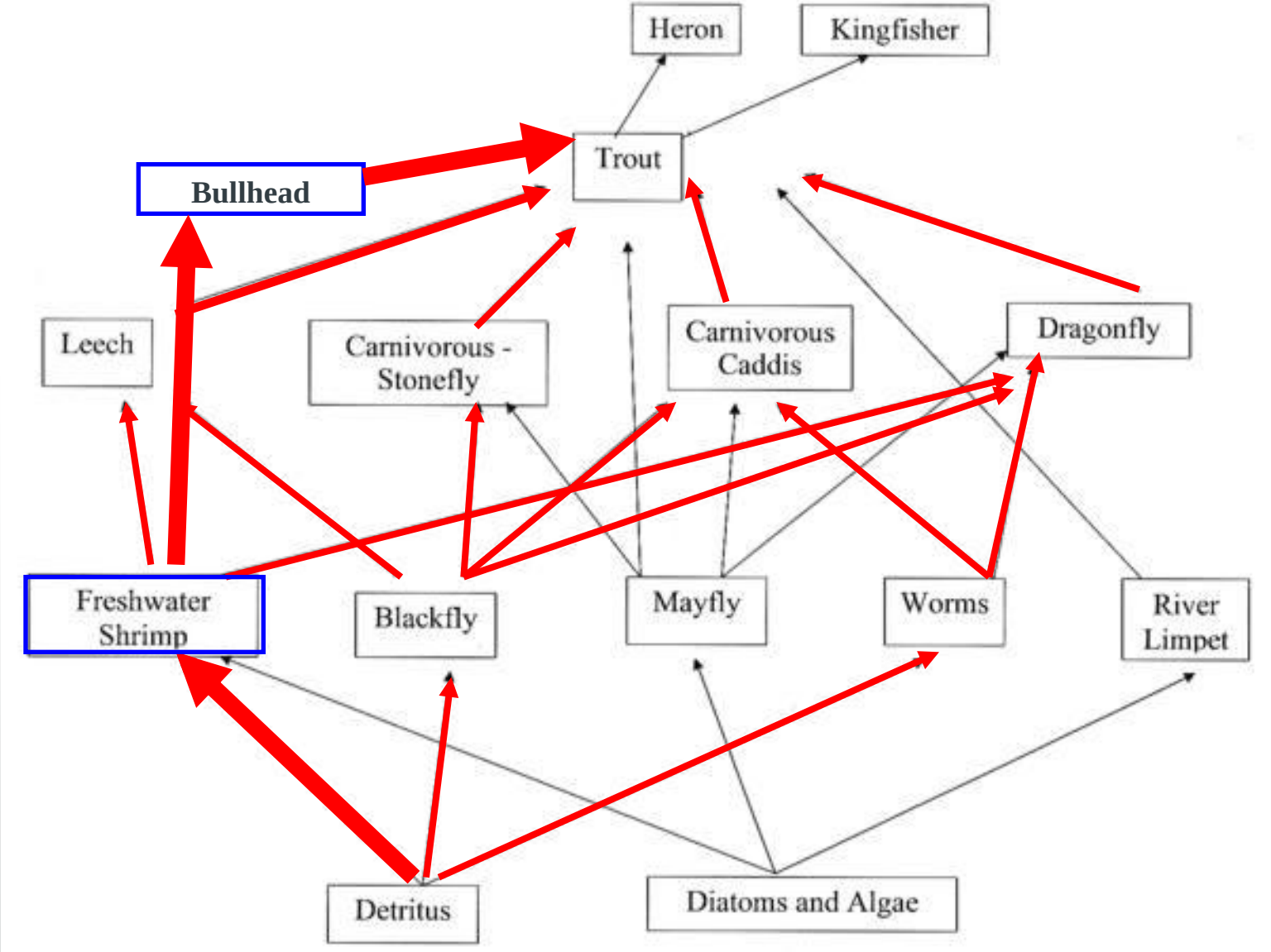

Food webs & trophic interactions: remarks

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All organisms have an ecosystem role, but some may be more important than others [9]:

The *Trout-Bullhead-Gammarus-detritus* "cascade"?

Change the predation and change resource use?

More trout ➔ fewer bullhead ➔ more gammarus ➔ more detritus processing?

Systems are complex: the Bere stream food web for example has an estimated 142 species and comprises 1383 feeding links. [9]

Food webs & trophic interactions: applications

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Can we use our understanding of food web structure to achieve:

- ***Ecology goals*** (ecosystem resilience and functioning; diversity)?
- ***Conservation goals*** (protection and enhancement of rare or threatened species)?
- ***Ecosystem service goals*** (recreation, amenity, water resources)?

Are these aims compatible and can we keep everyone happy?

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Characteristics and diversity

Characteristic plants of perennial chalk stream headwaters [11]

"Expected"	*"Very likely"*	*"Typical"*
Fool's water cress	Sweet grass	Gipsywort
Water cress	Water figwort	Branched bur-reed
Reed canary-grass	Comfrey	Brook water -crowfoot
Water mint	Meadowsweet	Lesser water parsnip
Water forget-me-not	Hemlock water -dropwort	Lesser pond sedge
Brooklime	Water flag	Common starwort
Blue water speedwell		

Characteristic fish of perennial chalk stream headwaters [11]

- Atlantic salmon
- Brown trout
- Brook lamprey
- Minnow
- Bullhead
- Three-spined stickleback
- Stone loach
- Eel

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Characteristic birds of perennial chalk stream headwaters [11]

- Green sandpiper
- Lapwing
- Snipe
- Redshank
- Kingfisher
- Grey wagtail
- Sedge warbler
- Reed warbler
- Reed bunting

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Macroinvertebrate species and communities in perennial headwaters

"…even within a single geological type [chalk streams] there is considerable variation in faunal [macroinvertebrate] community."

(RIVPACS and TWINSPAN evaluation [4])

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Characteristics and diversity of perennial chalk stream headwaters

Specific hydraulic conditions and *local* channel, hydraulic and riparian features are important for ecology, possibly more so than the influence of groundwater. **[4]**

"The perception of what is a typical chalk stream or groundwater dominated river is probably never realised along a whole river."

[4]

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Diversity aspects

1. Biota *within* each headwater stream are influenced by local conditions: different habitats, different environmental conditions, and different ecology **[4]**
2. Diversity *among* headwater streams is supported by the differences between them and contributes to diversity on a broader scale **[12]**

Challenges for the chalk river community

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Can we apply our understanding of the science of perennial chalk streams to achieve:

- ***Ecology goals*** (ecosystem resilience and functioning; diversity)?
- ***Conservation goals*** (protection and enhancement of rare or threatened species)?
- ***Ecosystem service goals*** (recreation, amenity, water resources)?

References

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