

Diffuse phosphorus pollution; the case for further research

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Phosphorus as a pollutant
Sources and forms of phosphorus
Phosphorus in the headwaters of the
Itchen
Research needs

Phosphorus as a pollutant

Phosphorus: analysis

Soluble Reactive Phosphorus (SRP)

Passes through a filter and reacts readily with chemical reagents (often assumed to be or termed “phosphate”).

Soluble Unreactive Phosphorus (SUP)

Passes through a filter and reacts with chemical reagents only after digestion using acid (often assumed to be or termed “organic phosphate”).

Particulate Phosphorus (PP)

Doesn't pass through a filter and reacts with chemical reagents only after digestion using acid.

General assumptions

Soluble Reactive Phosphorus (SRP)

In a form that is readily available to biota. [1]

Soluble Unreactive Phosphorus (SUP)

Not readily available to plants, but could be. [2]

Particulate Phosphorus (PP)

Not readily available to plants but can be exchanged with soluble forms (mainly SRP; SUP also possible). [3,4]

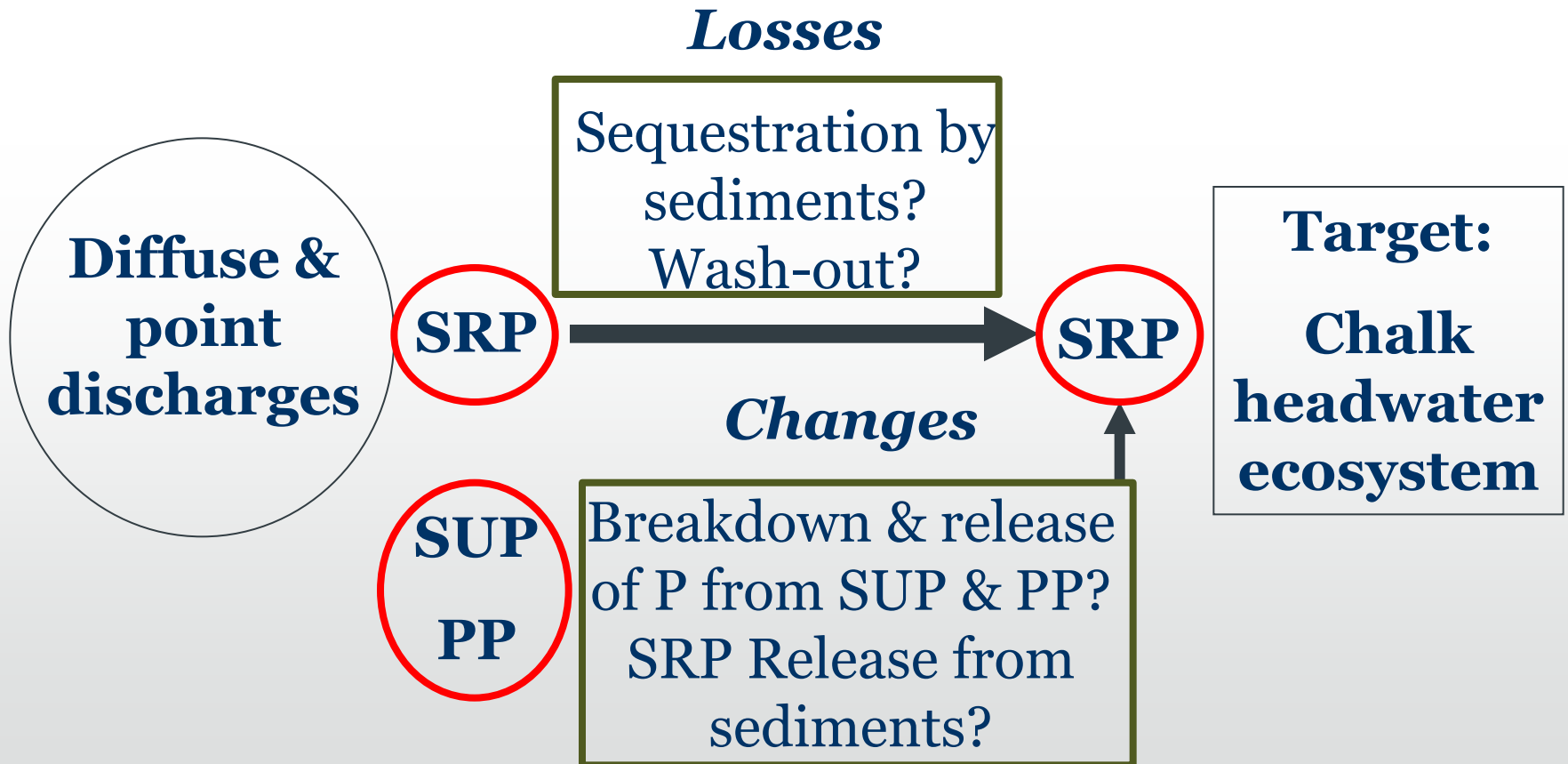
Discharges containing phosphorus

May contain SRP, SUP and/or PP in varying proportion and quantity.

SRP might be considered the “pollutant” given its availability, i.e. a *primary pollutant* that exerts an effect in the form in which it is released (e.g. increased plant biomass [1]).

SUP and **PP** are more likely *secondary pollutants* that might exert an effect after changes have occurred that render the phosphorus more readily available. [2,3,4]

Holdgate's model adapted for phosphorus pollution



Sources and forms of phosphorus

Point and diffuse discharges of P

“Conventional wisdom”:

Point discharges comprise sewage treated and other wastewaters.

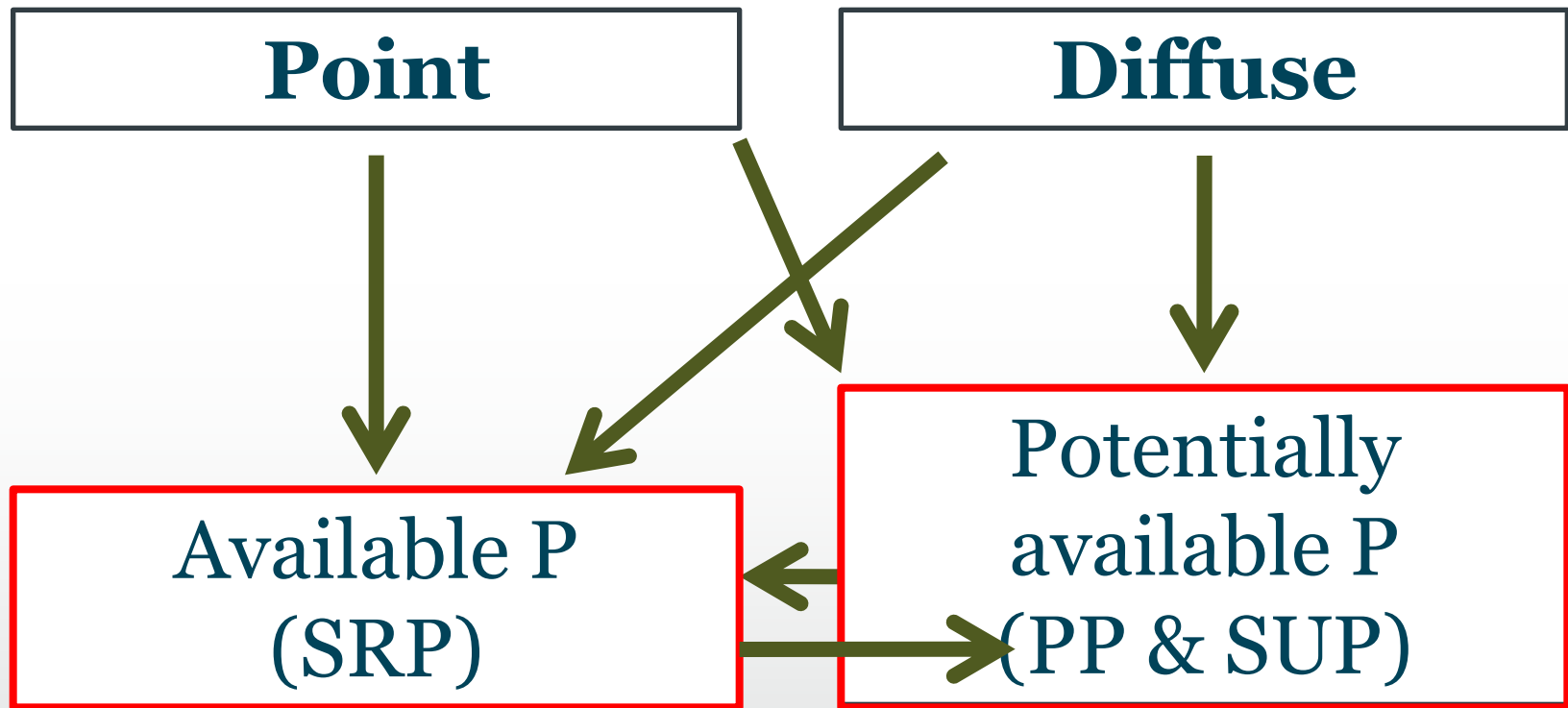
Diffuse releases arise from agriculture.

Chalk stream headwaters:

Point discharges also include agriculture and aquaculture.

Diffuse releases also arise from sewage and sewerage.

Point *cf.* diffuse discharges of P



Interactions of SRP in water and PP in sediments

There are reversible interactions/exchange.[3,4]

Exchanges control baseflow SRP loads [5]

Release of SRP when SRP in overlying water is low (i.e. a **source** of SRP).[4]

Sequestration of SRP when SRP in overlying water is high (i.e. a **sink** of SRP).[4,6]

There may be rapid shifts between behaviour as sink or source in response to changing SRP levels. [4,5]

Other factors & considerations

Movement and redistribution of sediment?

(Episodes *vs.* persistent conditions?)

Uptake *vs.* transport of nutrients? [7]

Timing of high SRP levels relative to timing of plant growth? [5]

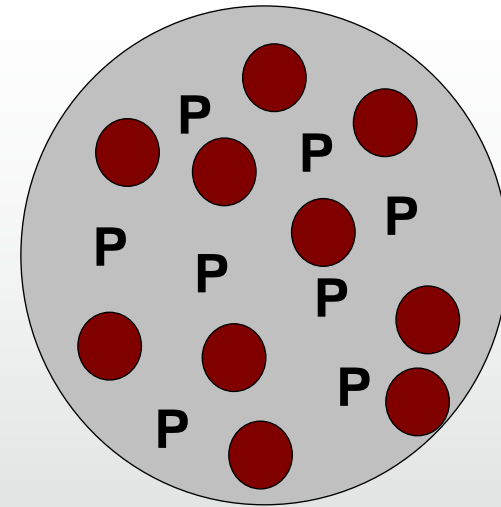
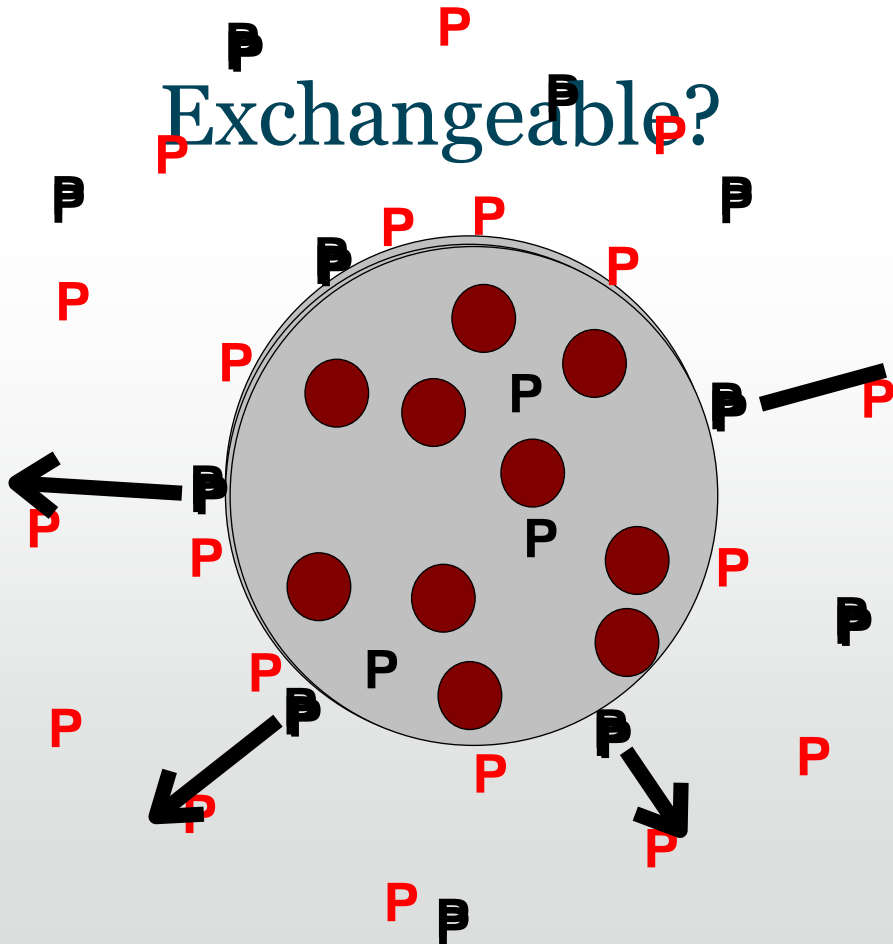
Stream size & geomorphology? [3]

Structure and nature of SUP and PP?

The nature of SUP and PP *cf.* exchange and release of SRP [8,9]

Exchangeable?

Non-exchangeable?

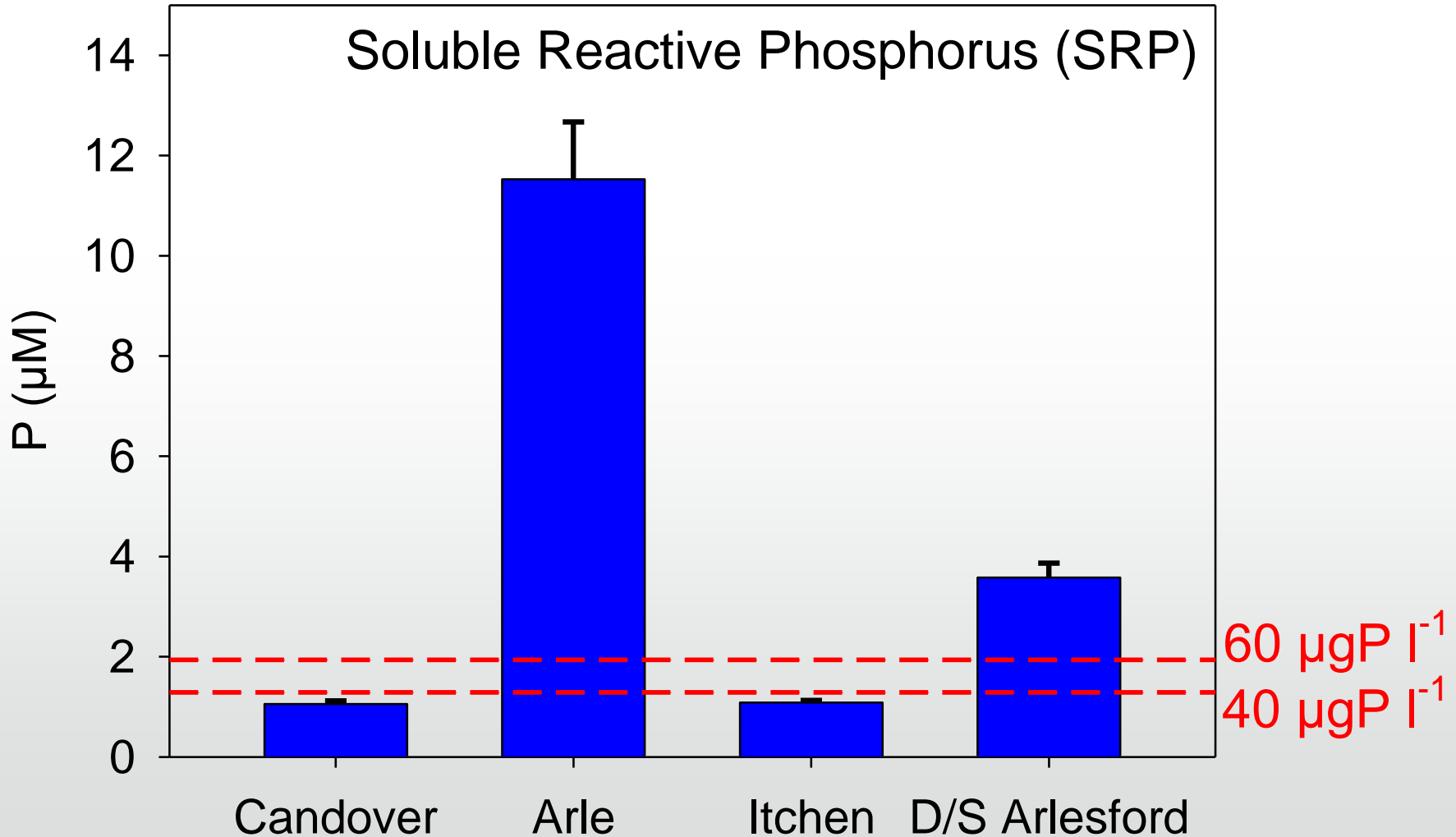


Phosphorus in the headwaters of the Itchen

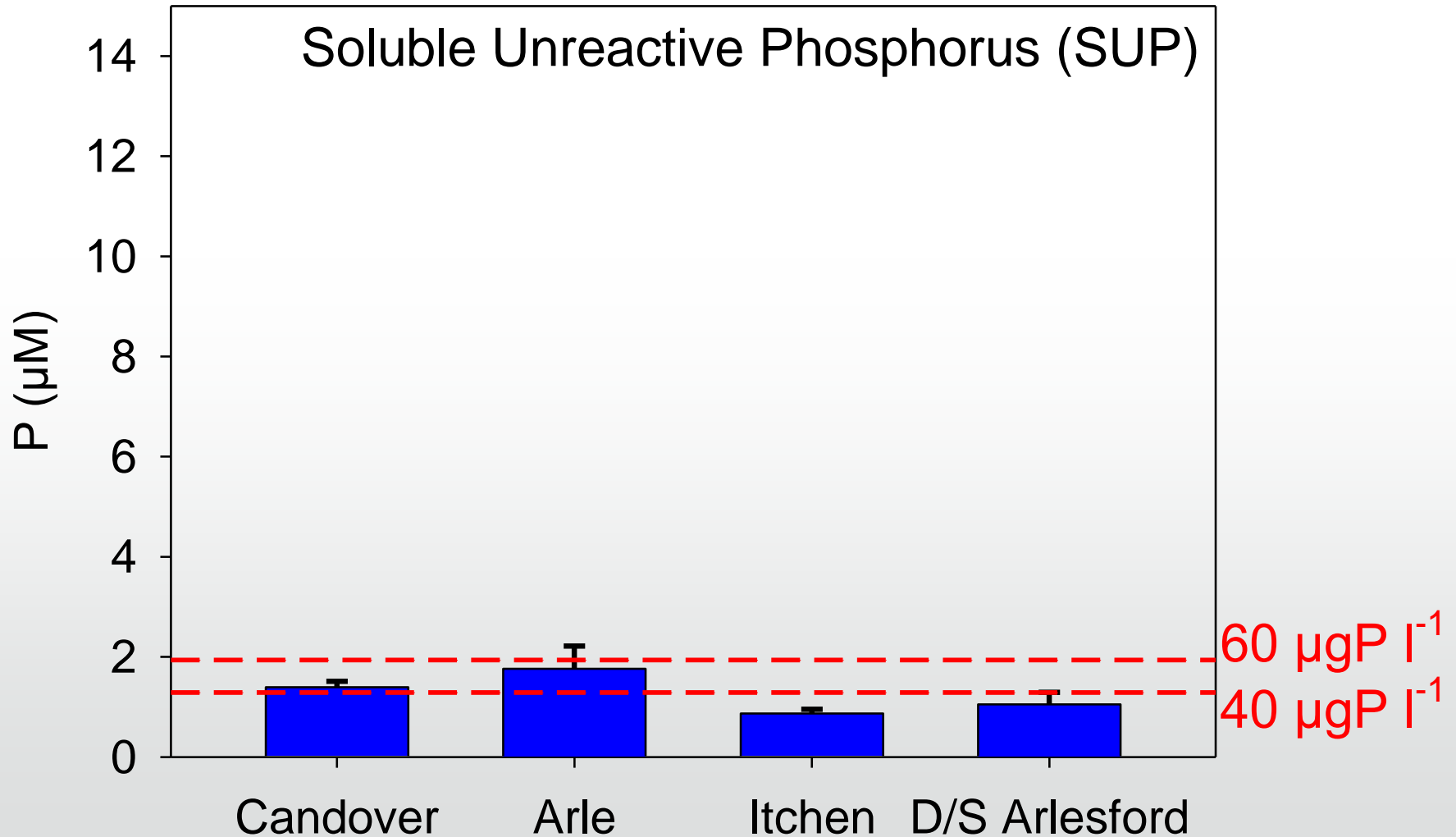
Spatial survey, July 2010

- Multiple (33) sites across the upper Itchen.
- Three headwater tributaries - Arle, Candover & Itchen (Cheriton) streams – plus sites along the main channel downstream of Alresford.
- SRP, SUP and PP determined using the Malachite Green method.
- Sampling under baseflow conditions.
- Single survey 20/7/2010.
- Analysis & sampling by Arthur Leung & Graham Roberts.

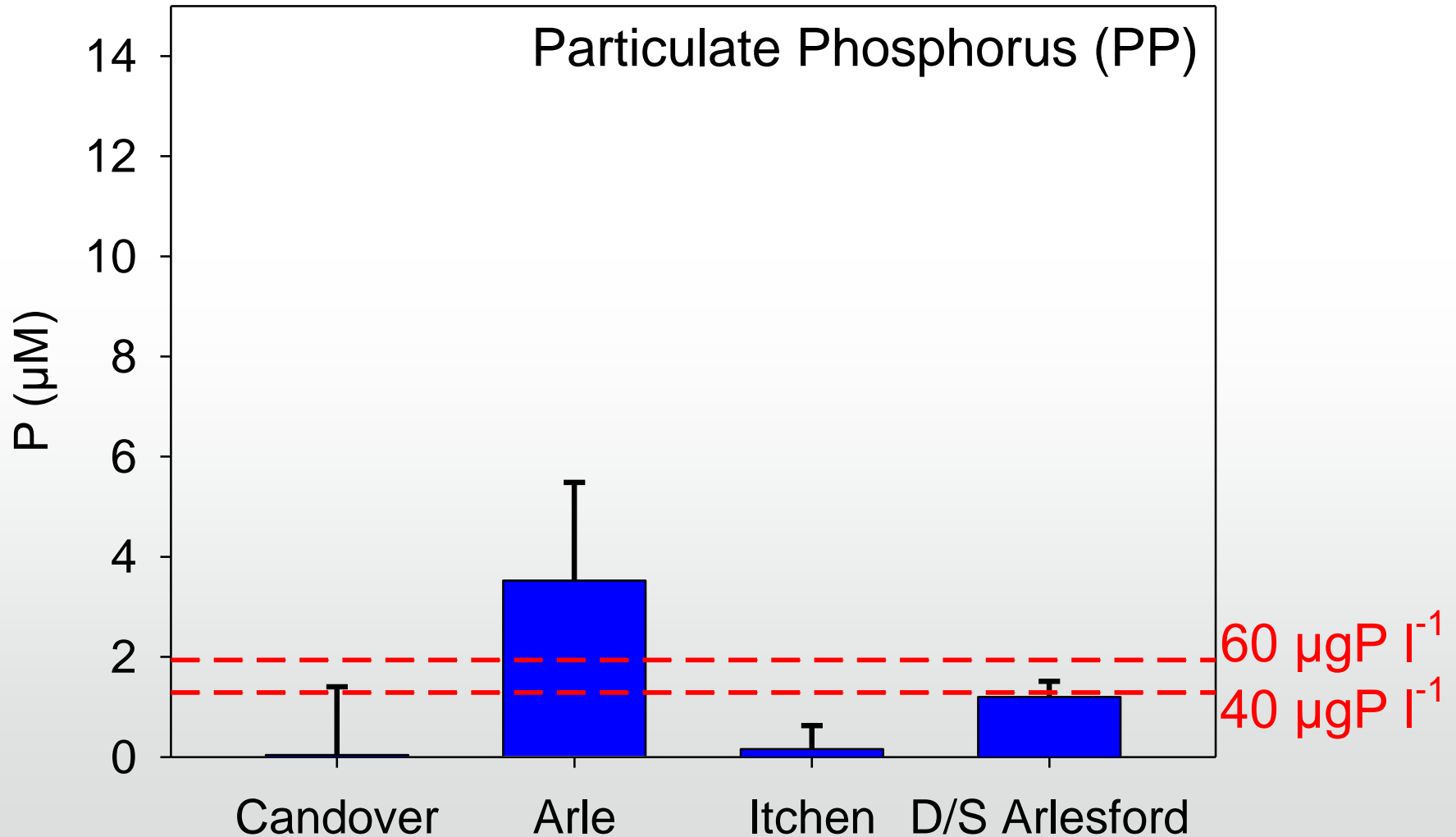
Phosphorus in the upper Itchen



Phosphorus in the upper Itchen



Phosphorus in the upper Itchen



Notes and comments

Only one survey under baseflow conditions.

A mass balance not yet attempted, *but*

- Do two tributaries with low P plus one with high P lead to moderate P levels downstream?
- Would three tributaries with low P lead to low P levels downstream?

SRP and PP appear highest on the Arle; what are the causal factors?

Where P levels are relatively low, SRP and SUP concentrations are similar.

Research needs

Research needs: proposal

1. Define the relative contributions of different species of P from diffuse and point sources.
2. Investigate transport mechanisms and pathways of P (timing, rate and speciation).
3. Build a P mass balance model at sub-catchment level (fluxes, and physical, chemical, and biochemical mechanisms of storage and release).
4. Identify priority targets and potential mechanisms for intervention to reduce the supply of available phosphorus to the river.

References

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- 3 P.J.A. Withers & H.P. Jarvie (2008). *Science of the Total Environment* 400: 379-395
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- 8 P.J. Shaw (1994). *Limnology & Oceanography* 39: 1734-1743
- 9 P.J. Shaw *et al.* (2000). *Freshwater Biology* 45: 383-393