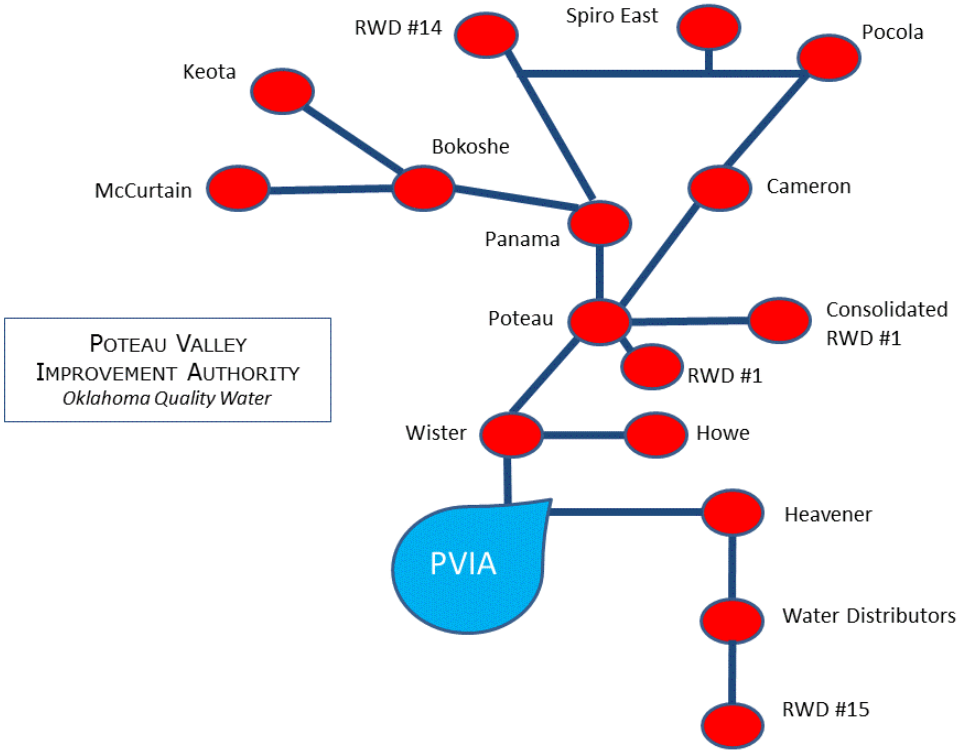
Constructed Floating Wetland Ecological Processes

Steve Patterson

bioXdesign

OCLWA
Stillwater
April 18, 2013

Poteau Valley Improvement Authority



Poteau Valley Improvement Authority
Oklahoma Quality Water

Constructed floating wetlands

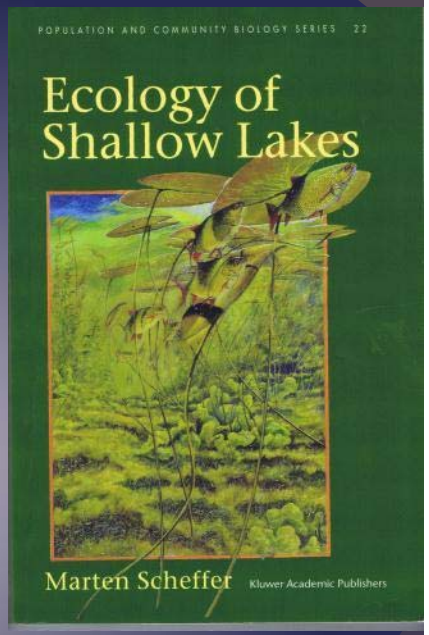
Tyson Foods, Berlin, MD
Credit: Ocean Arks International

Tyson Foods, Berlin, MD
Credit: Ocean Arks International

Lake Wister

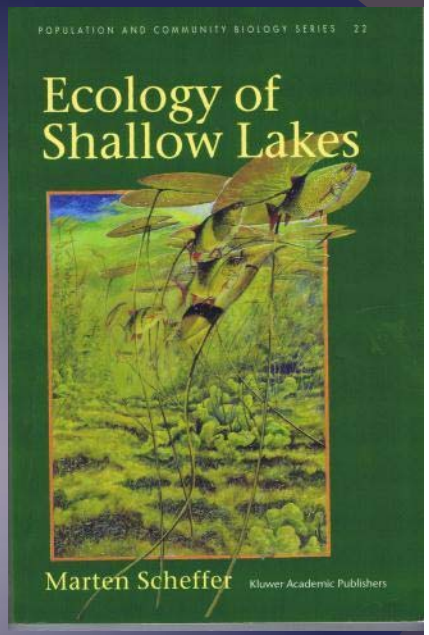
Ecosystem effects of aquatic vegetation:

- Structuring role of submerged aquatic vegetation
- Alternate states of shallow lakes
- Biomanipulation



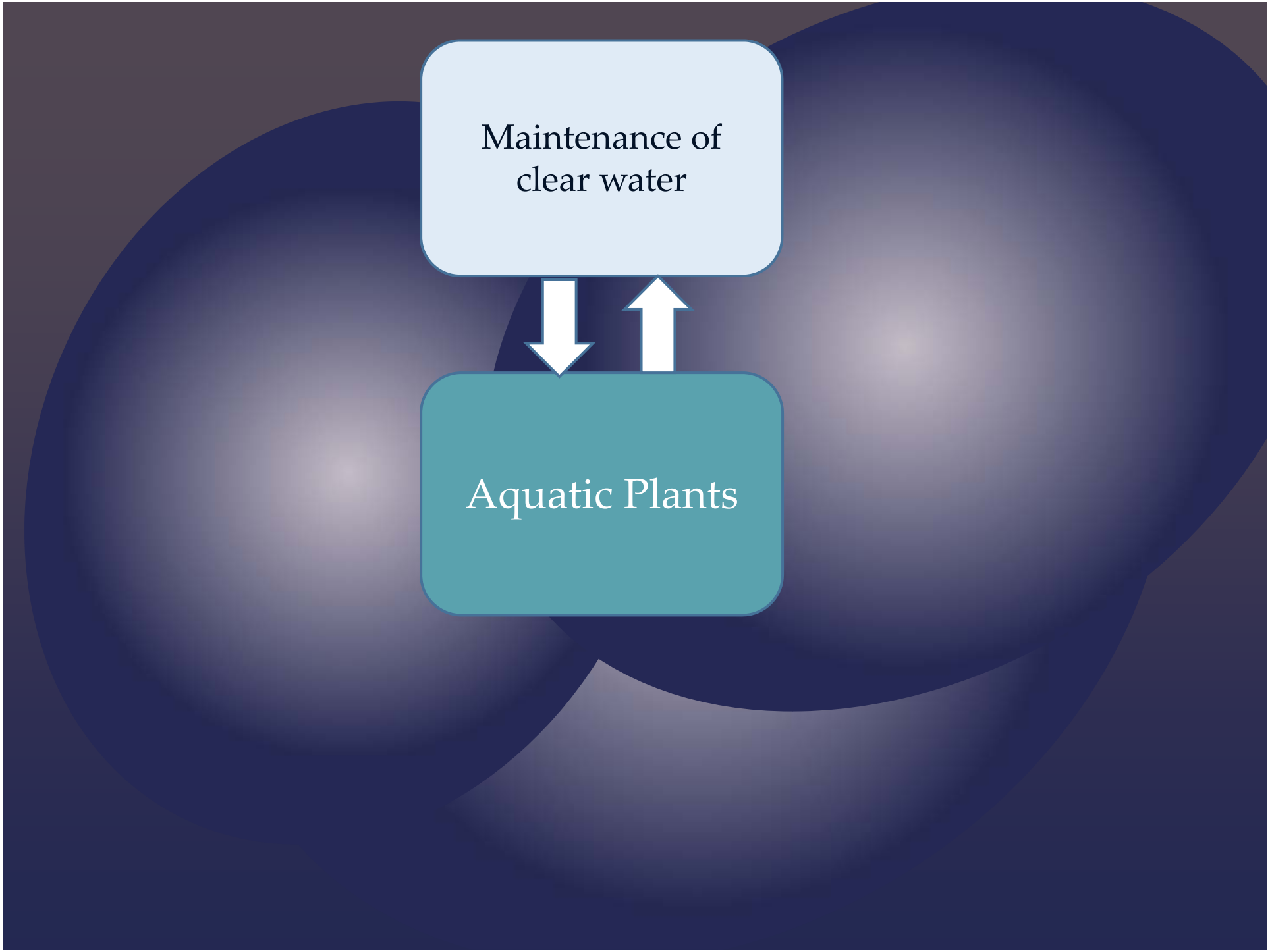
Ecosystem effects of aquatic vegetation:

- Structuring role of submerged aquatic vegetation
- Alternate states of shallow lakes
- Biomanipulation

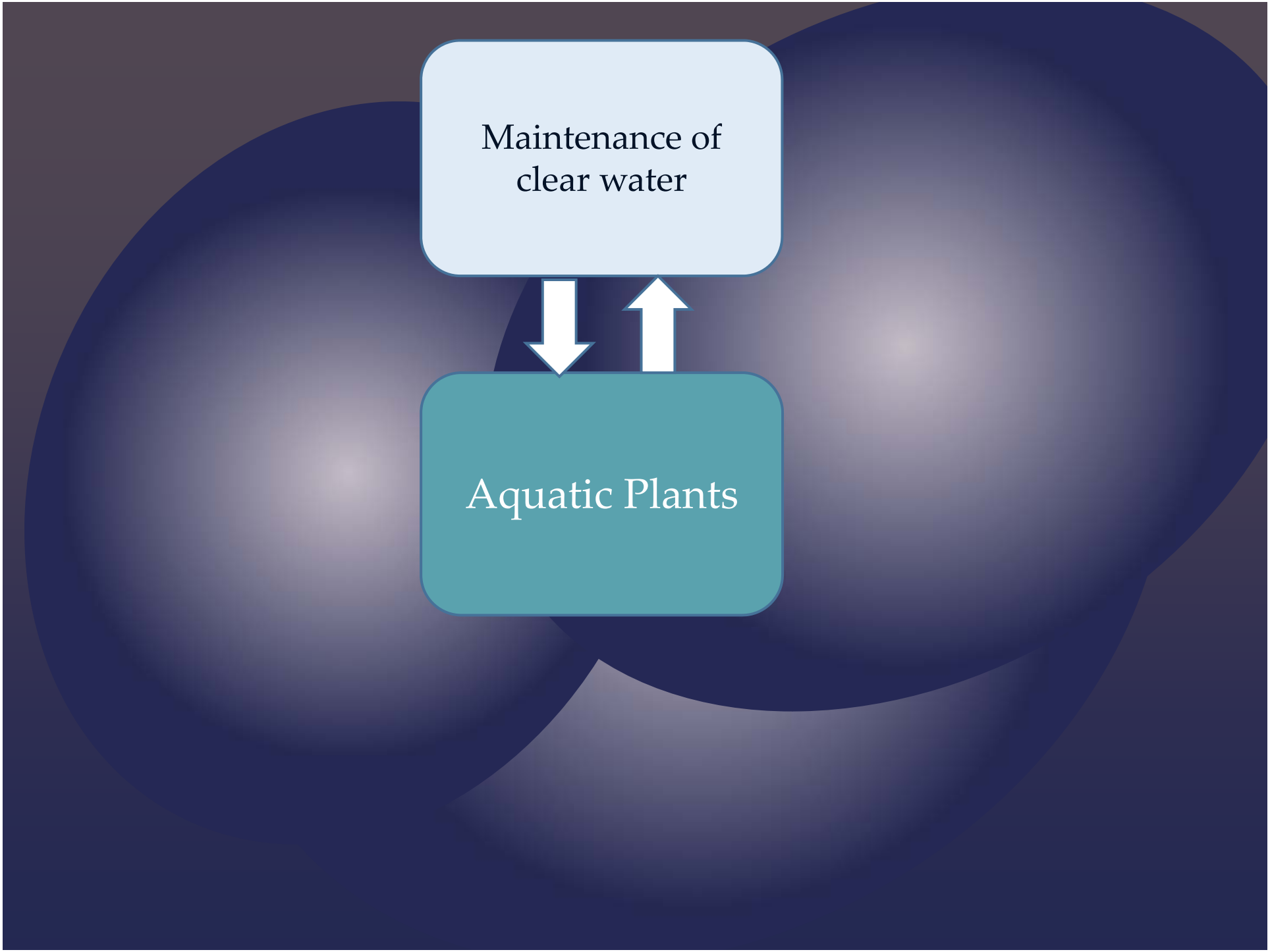


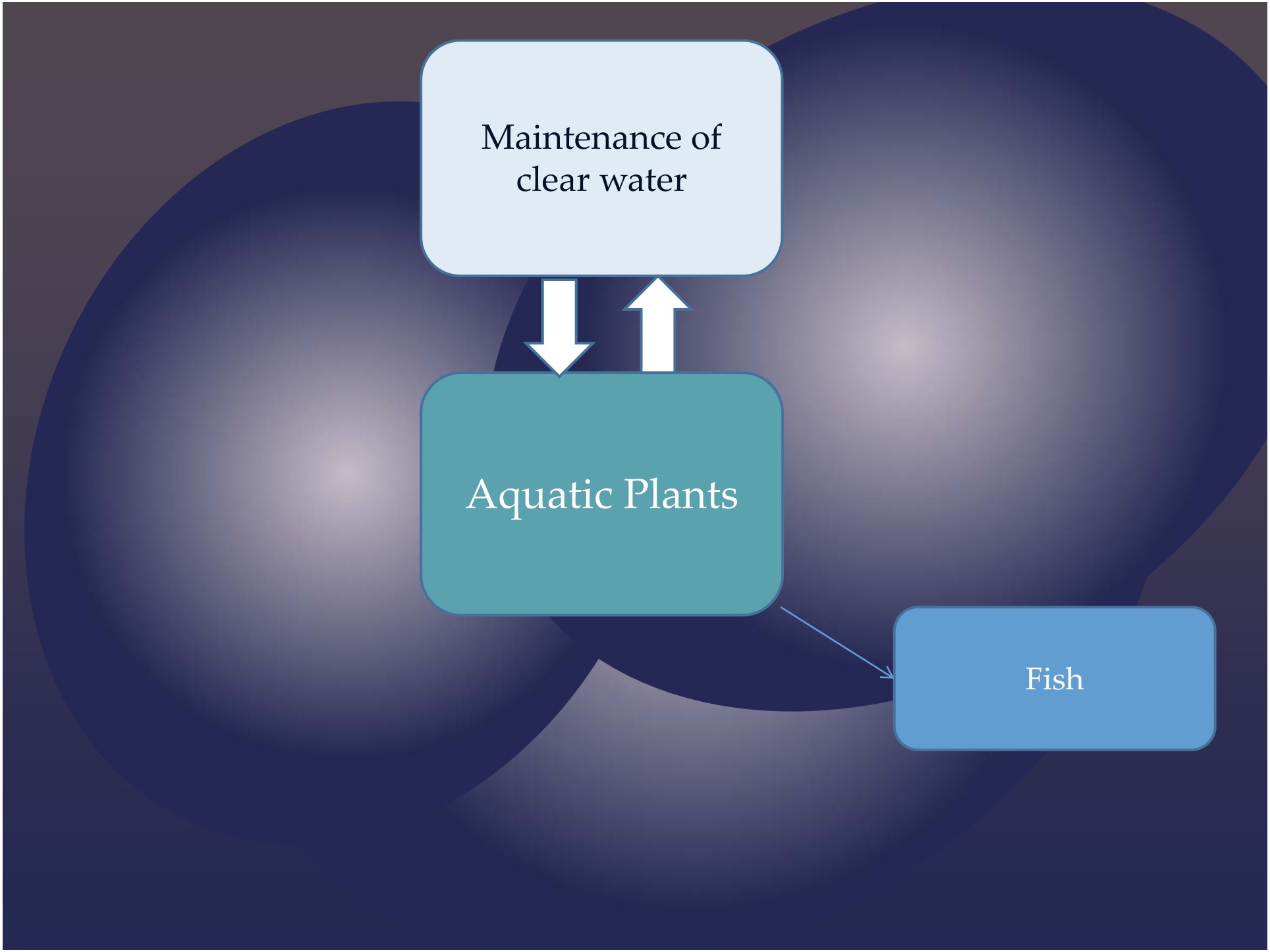
Alternate states:

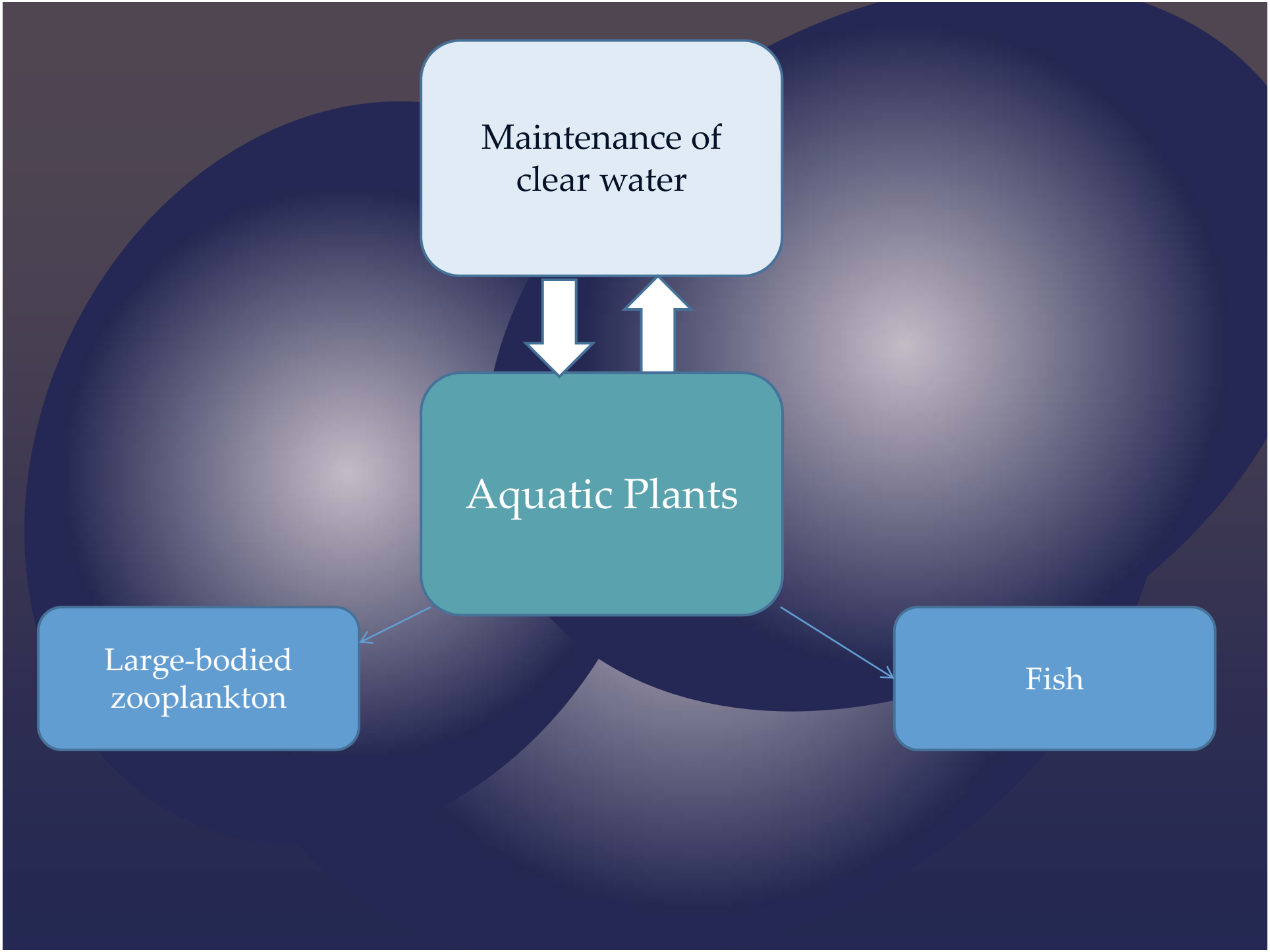
- Over a fairly wide range of TP levels (~25 to 100 µg/l)
- Either:
- Clear water and well-vegetated, or
- Turbid, with little or no vegetation

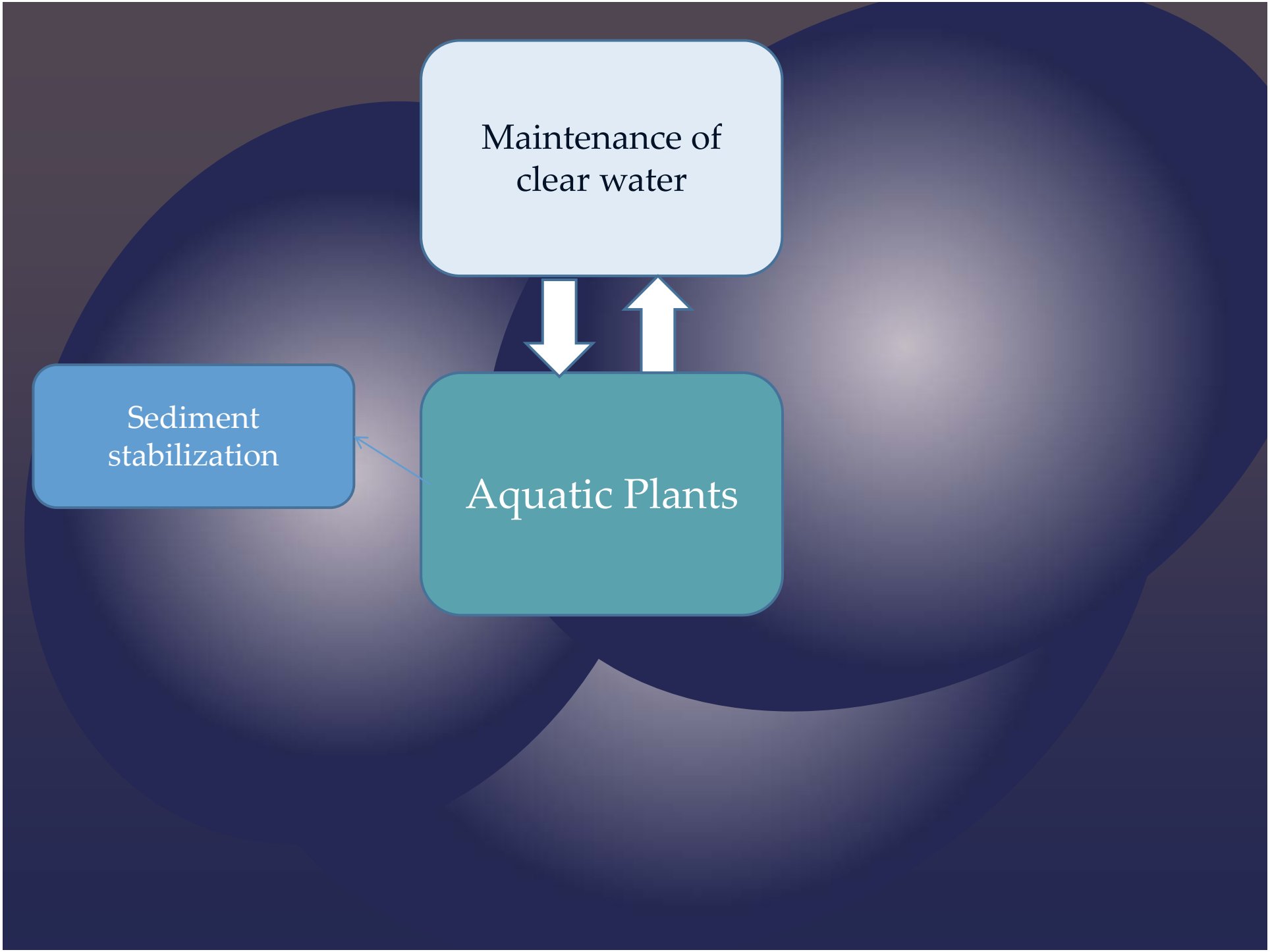

Maintenance of clear water
Aquatic Plants

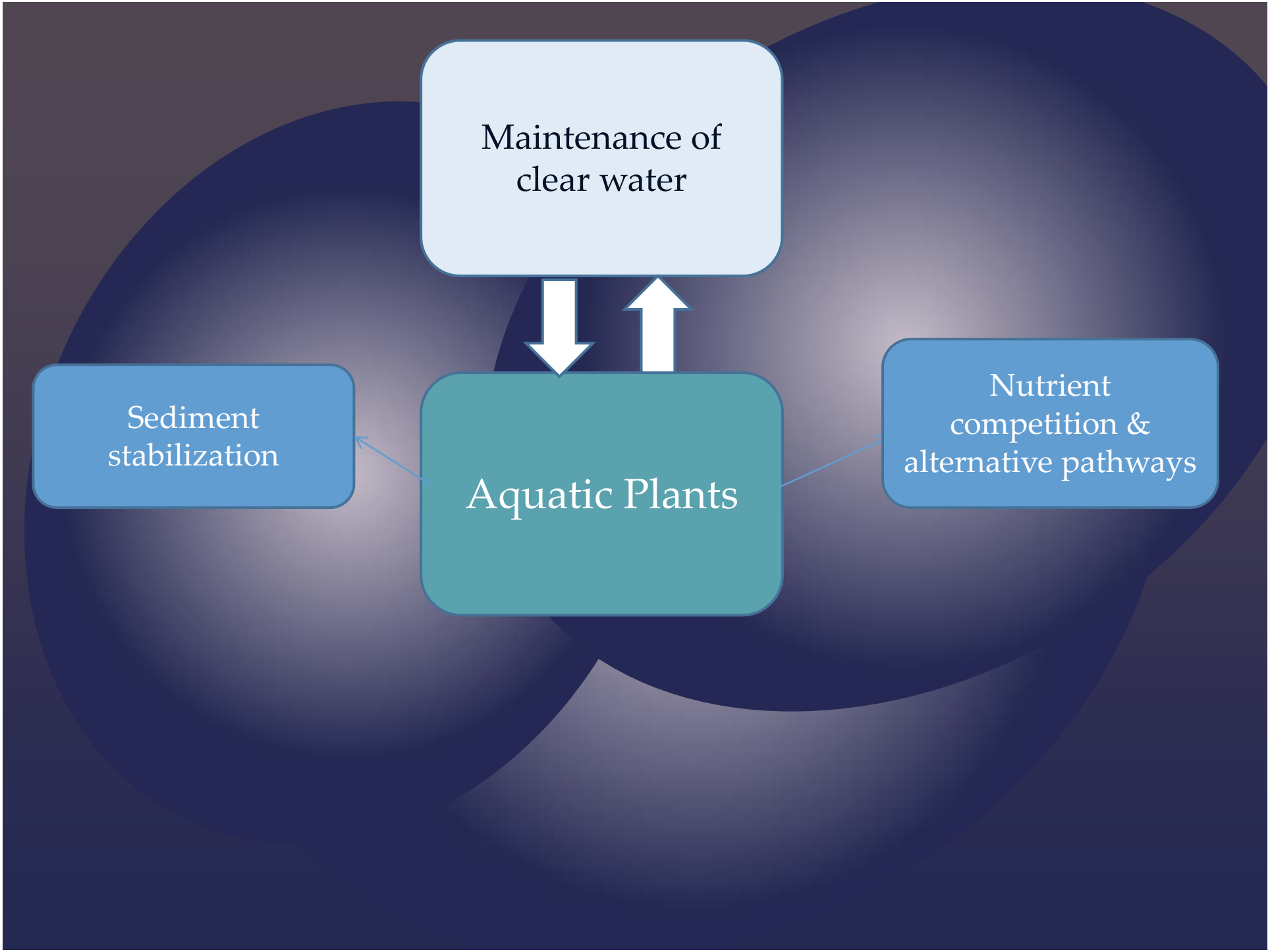
Can floating wetlands act as
"aquatic vegetation"
and facilitate a clear water state in
reservoirs?

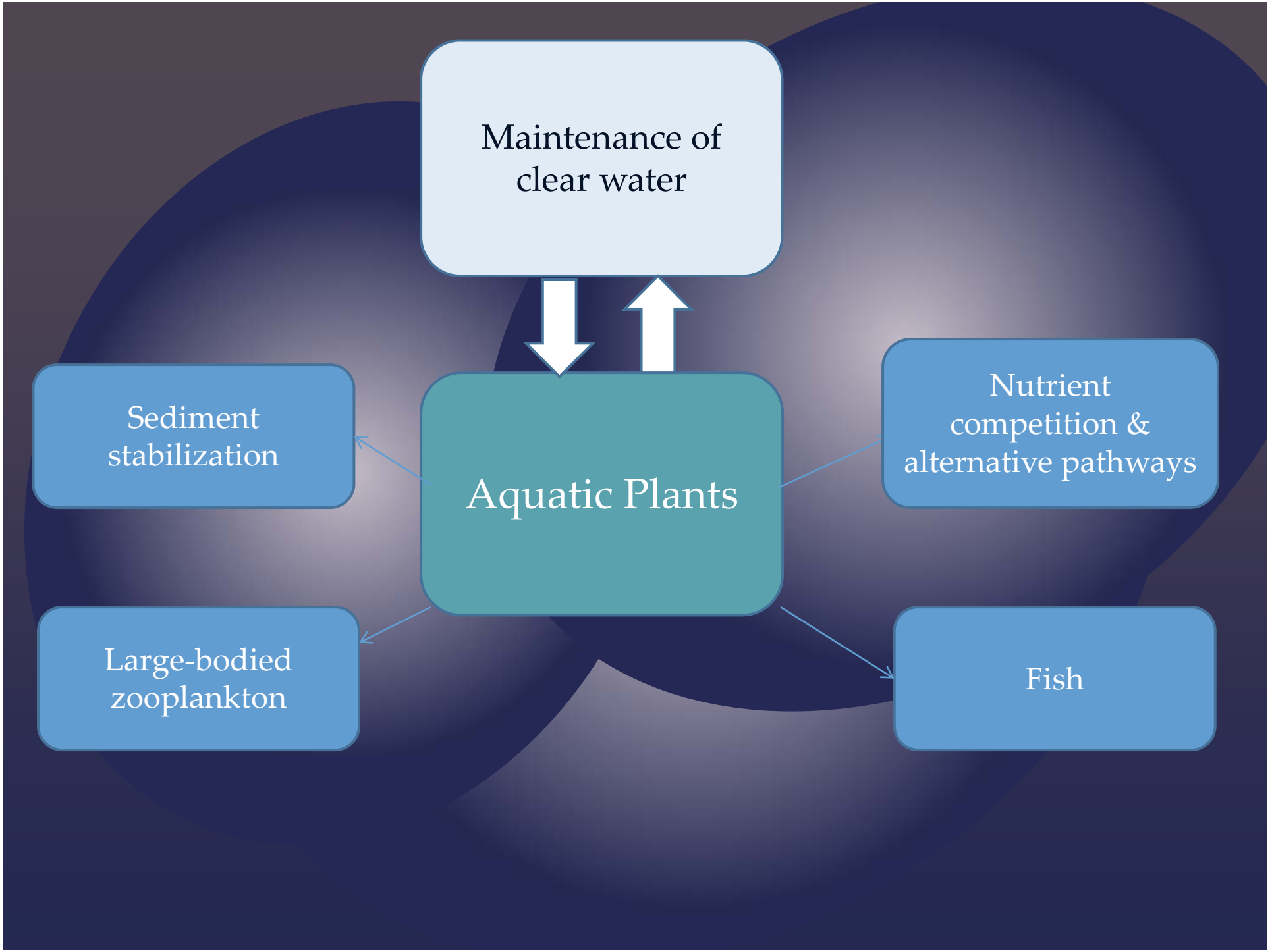

Maintenance of clear water
Aquatic Plants

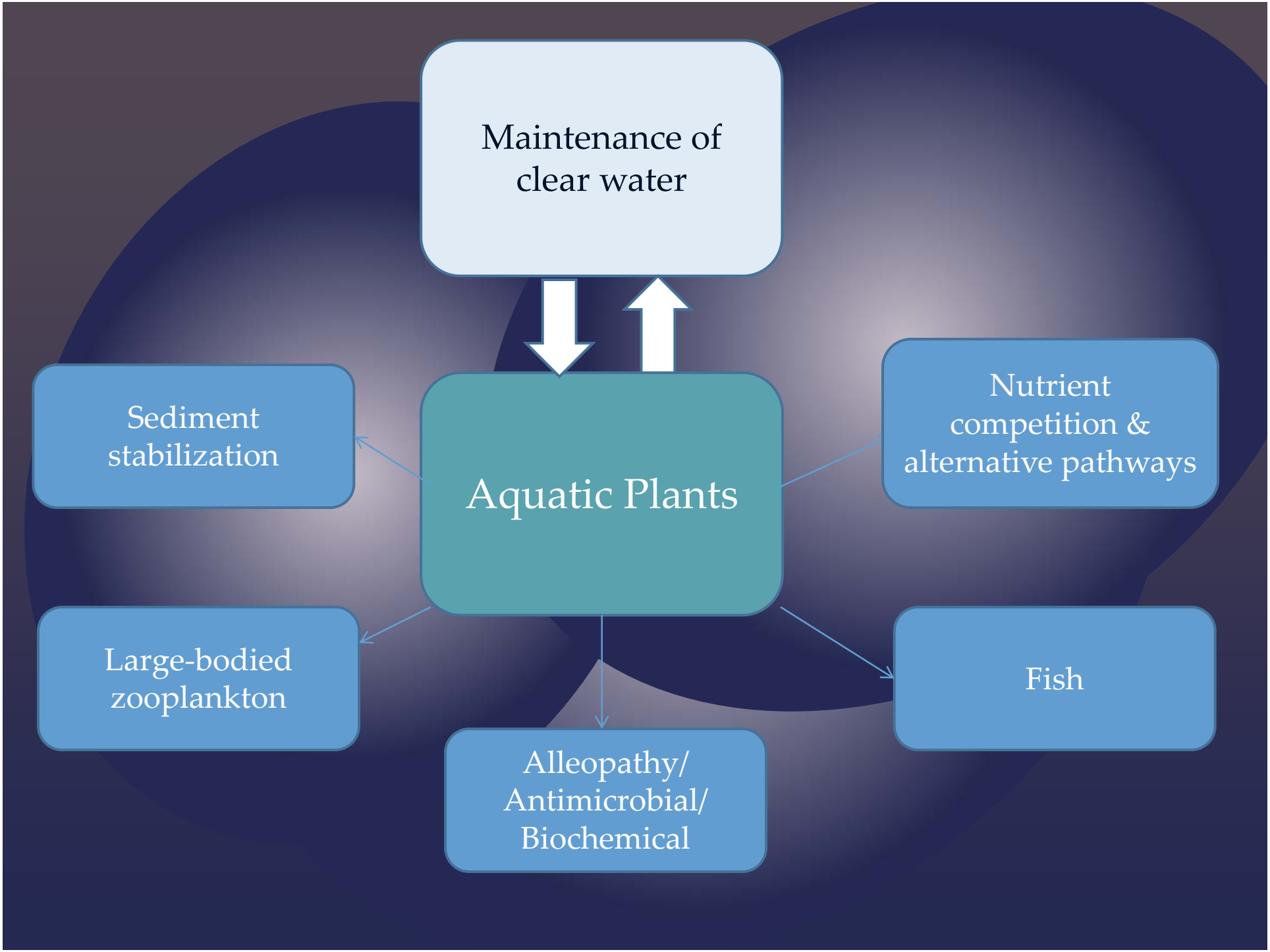

Maintenance of clear water
Aquatic Plants
Fish


Maintenance of clear water
Aquatic Plants
Large-bodied zooplankton
Fish


Maintenance of clear water
Sediment stabilization
Aquatic Plants


Maintenance of clear water
Sediment stabilization
Aquatic Plants
Nutrient competition & alternative pathways


Maintenance of clear water
Sediment stabilization
Aquatic Plants
Nutrient competition & alternative pathways
Large-bodied zooplankton
Fish

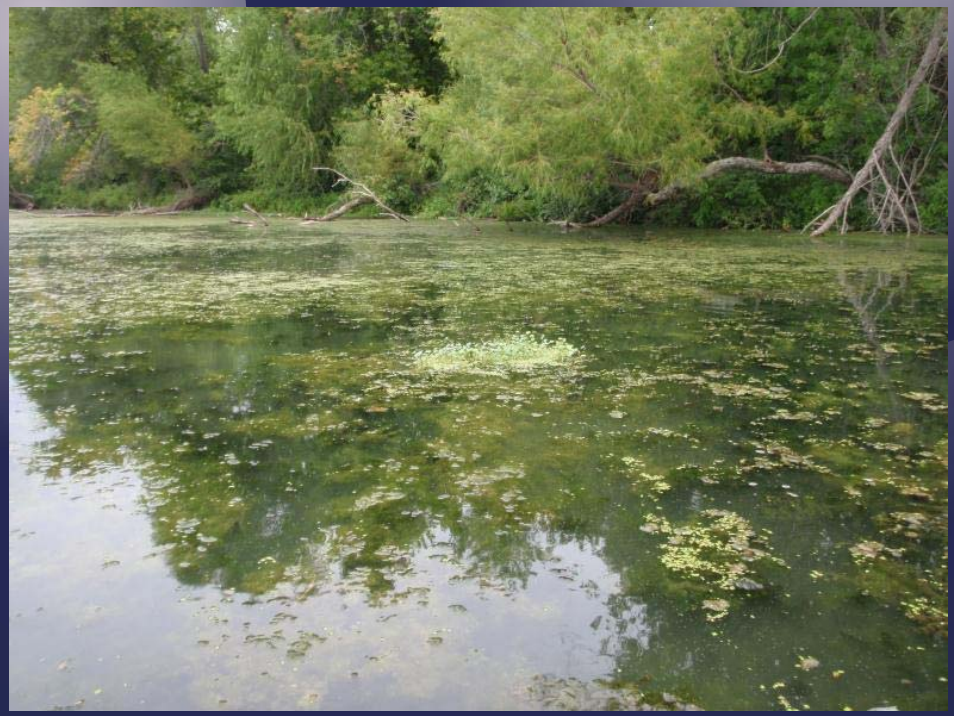

Maintenance of clear water
Aquatic Plants
Sediment stabilization
Nutrient competition & alternative pathways
Large-bodied zooplankton
Fish
Alleopathy/ Antimicrobial/ Biochemical

Sediment stabilization

Submerged aquatic vegetation	Floating wetlands
Rooted in sediment	**Roots in water**

Sediment stabilization

Submerged aquatic vegetation	Floating wetlands
Rooted in sediment	Roots in water
Stems & photosynthetic surfaces largely submerged	Stems & photosynthetic surfaces largely emergent



Sediment stabilization

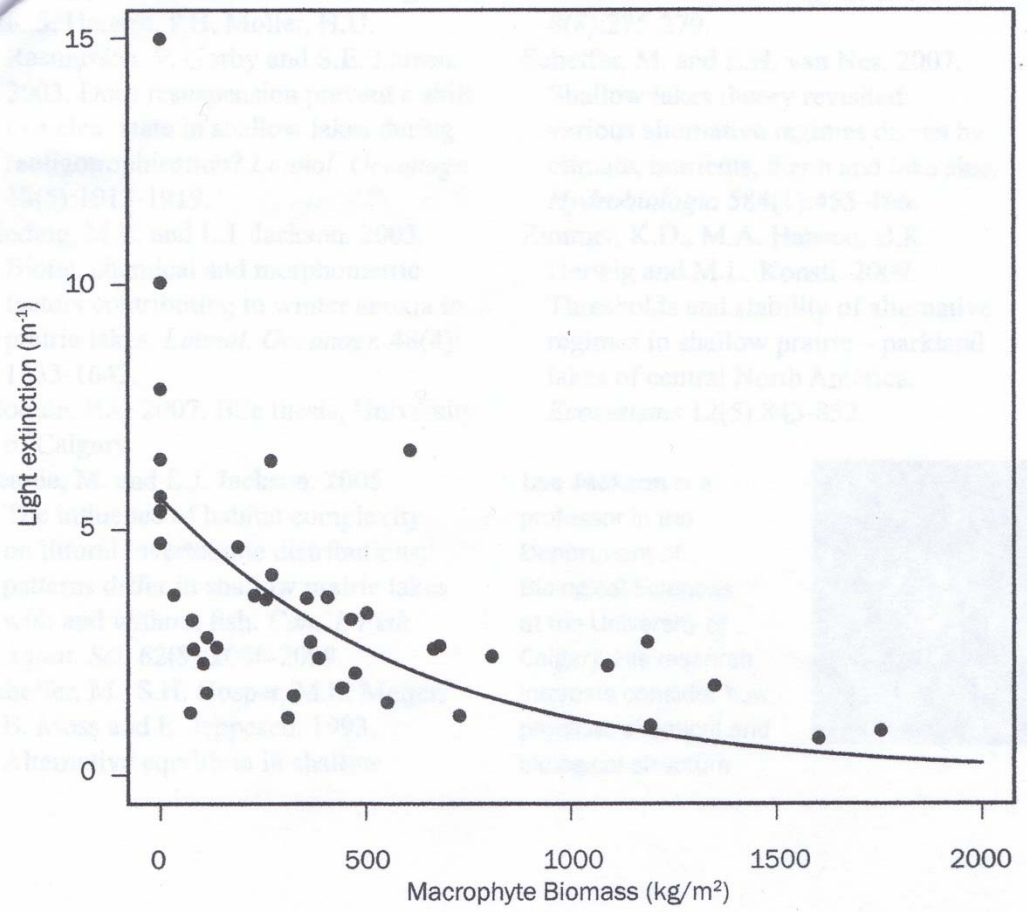


Figure 5. Relationship between the light extinction coefficient (λ) and submerged macrophyte biomass throughout summer, 2006 in eight lakes that vary in turbidity and macrophyte biomass (Moquin, unpublished data).

Jackson & Moquin 2011

Sediment stabilization

Floating wetland sediment processes:

- Roots in the water column
- Promote sedimentation
- Trap sediments (w/ sticky biofilms on roots)
- Can function as breakwaters & reduce wave-driven resuspension & bank erosion

Nutrient competition & alternative pathways

Submerged aquatic vegetation	Floating wetlands
Rooted in sediment	Roots in water
Stems & photosynthetic surfaces largely submerged	Stems & photosynthetic surfaces largely emergent
Nutrients primarily from the sediment	**Nutrients from the water**

Nutrient competition & alternative pathways

Submerged aquatic vegetation	Floating wetlands
Rooted in sediment	Roots in water
Stems & photosynthetic surfaces largely submerged	**Stems & photosynthetic surfaces largely emergent**
Nutrients primarily from the sediment	Nutrients from the water
Photosynthetic biofilms	**Largely non-photosynthetic biofilms**

"The macrophyte-epiphyte complex is functionally inseparable. Whenever we generally use the term macrophytes, it is inclusive of their epiflora.

Gasith & Hoyer 1998

Nutrient competition & alternative pathways

Litter accumulation on the surfaces of floating marsh

- Under oxic conditions:
- There was a rapid uptake of phosphorus by *Typha* (cattail) litter (and associated microbial community)
- Uptake was slower and less complete under hypoxic conditions (Grace et al. 2008)

Nutrient competition & alternative pathways

Life cycle/nutrient cycling rates

Organism type	Relative life cycle length	Length
Phytoplankton	Short	Days
Plants	Intermediate	Annual
Fish	Longer	Years

Large-bodied zooplankton & fish

Submerged aquatic vegetation	Floating wetlands
Large-bodied zooplankton production & refuge	**Large-bodied zooplankton production & refuge?**
Fish refuge & spawning	**Fish-food, yes; refuge? spawning?**

- In the absence of fish, clearwater state could be maintained by zooplankton grazing alone (Peretyatko et al 2012)
- In ponds with fish, SAV could buffer their effect
- Except, at the high end of nutrient levels

- Meerhoff (2006) found in subtropical and tropical lakes, submerged aquatic vegetation much less effective as refuge for zooplankton

How much area of floating wetlands is required to make a difference?

- For 139 lakes, emergent macrophytes covered **7% of surface area**, across a range of sizes and depths (Duarte et al. 1986, in Gasith & Hoyer 1998)
- 9 to 12% (Planter 1973, in Gasith & Hoyer 1998)
- Local clearing is possible--patches of locally very clear water within turbid lakes—has been observed (Scheffer 2007)

Summary

- Improve floating wetlands designs to improve breakwater function & dampening of sediment resuspension
- Need better understanding of role of non-algal biofilms in
  - Nutrient cycling, and
  - In production of large-bodied zooplankton
- How do we design floating wetlands to optimize large-bodied zooplankton production & refuge?
- Still need external nutrient reduction
- May still need to manage fish populations
- Local clearing possible

Questions?