Control measures of freshwater cyanobacterial blooms: a mini review

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Outline of this talk

1. Meaning of “control”
2. Closed-loop control system
3. Control elements
4. Issues
5. Ecosystem perspective
6. Integrative approach
7. Key points
What does “control” mean here?

Associated elements and attributes

Health
Environmental
Social
Economical

Physical
Chemical
Biological

Cyanobacteria (blue-green algae or BGA)

Effectiveness
Longevity
Resource requirements
For most of us “control” may mean:

Realising a negative feedback system, using guideline values as a reference input and observed values as a controlled output in a modelled ecosystem
Guideline value < Observed value
(G – O < 0)

Feedback system

Guideline value
Health
Environmental
Social
Economical

Control elements
(Physical, chemical, biological)
Effectiveness
Longevity
Resource requirements

BGA

Observed value
Control elements

Effectiveness
Longevity
Resource requirements

Physical: flushing, mixing, aeration, sonication, UV-ray, harvesting

Chemical: algaecides, chlorine, activated carbon, ozone, nutrients

Biological: virus, fungi, bacteria, zooplankton, fish, non-BGA (competition), macrophytes (regime shift)
Issues

• A growing sophistication in studying the small and an increasing irrationality in handling the whole (Puccia and Levins, 1985): forgetting something that should not be forgotten

• Inevitable un-modelled dynamics that produce substantial uncertainly (Doyle et al., 1992): something else goes wrong
Ecosystem perspective

• Ecosystem size and components (species-area relationship: more species in larger ecosystems)

• Ecosystem process and functioning (species interaction through predation and competition; transformation and transfer of energy and matter by species)

• Ecosystem boundary and connectivity (tangible and intangible; things are connected)
Integrative approach

Ecosystem elements
(size, components, process, functioning, boundary, connectivity)

Control elements
(Physical, chemical, biological)

BGA

Effectiveness
Longevity
Resource requirements

(G – O < 0)

Guideline value
Health
Environmental
Social
Economical

Observed value

Value

Integrative approach

Ecosystem elements
(size, components, process, functioning, boundary, connectivity)

Control elements
(Physical, chemical, biological)

BGA

Effectiveness
Longevity
Resource requirements

(G – O < 0)

Guideline value
Health
Environmental
Social
Economical

Observed value

Value
Key points

• Articulation of a system
  Corollary: Importance of modelling
  (conceptual, qualitative, quantitative; simple, complex)

• Effective negative feedback system,
  weighted by an ecosystem perspective
  Corollary: Need for diverse research, monitoring and reporting
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