Visual Guide to Observing Blooms

Important! When printing this guide, please use full color printing options to assist in the identification of a bloom.

BACKGROUND

This document is a guide for bloom observation prepared by the Surface Water Ambient Monitoring Program (SWAMP).

Cyanobacteria live in nearly every terrestrial and aquatic habitat. Some cyanobacteria are capable of producing a variety of toxins, such as neurotoxins, hepatotoxins, cytotoxins, and endotoxins. Collectively known as “cyanotoxins,” these compounds can cause numerous health effects in humans and animals (wildlife, dogs, etc.) that range from stomach pain to nerve damage and, in some circumstances, death. Cyanobacteria can quickly grow during favorable conditions and form toxic cyanobacteria harmful algal blooms (CyanoHABs). This guide provides images of various algae and cyanobacteria in the field in order to help users identify and report CyanoHABs and other types of harmful algal blooms (HABs). Photographs of non-toxic algae, cyanobacteria, and other organisms of concern are provided in this guide.

Please help authorities record and respond to potential HABs by using the *Freshwater Bloom Incident Form* linked below. State Water Resources Control Board (State Water Board) staff can also be reached directly by phone and email.

> **Phone: (844) 729-6466**
> **Email: CyanoHAB.Reports@waterboards.ca.gov**
> **The Freshwater Bloom Incident Form can be found on the My Water Quality HAB Portal.**

To obtain guidance for HAB incident response and posting advisories, we encourage Department of Public Health, county health departments, and waterbody managers to refer to the following guidance document when CyanoHABs pose a health threat: Cyanotoxin Guidance for Recreational and Related Water Uses.

CAUTIONS AND INTERFERENCES

The accuracy of visual monitoring for blooms depends on the experience of the observer and their familiarity with the affected waterbody. The use of a microscope by an experienced analyst is strongly recommended for cyanobacteria confirmation. Refer to the Field Microscope SOP for further guidance. Conversely, many laboratories provide organism identification services, refer to the Microscopy Sample Collection SOP for further guidance.

Please Review the Health and Safety Guide prior to approaching water with a potential bloom. It is also highly recommended to perform a pre-visit site reconnaissance to create a site dossier (See Site Reconnaissance Guide).

SCOPE

The intent of this guide is to assist users in recognizing the presence of HABs—caused by multiple types of aquatic organisms—in waterbodies. *The images in the following sections were taken in the field to show the variations of color and general appearance of these blooms. These images are provided as a guide and may not capture the organisms exactly like they will appear in local waterbodies.*

The organisms responsible for HABs originate from the bottom substrate of a waterbody and grow submerged in water. Majority of cyanobacteria are buoyant and can control their depth in open water to optimize positions for photosynthesis and to consume nutrients. Both algae and cyanobacteria require photosynthesis to survive and can appear visually alike; this guide will help users recognize the difference among these collective organisms.

Research has shown that a diverse range of cyanobacteria groups (i.e. genus/genera) exist in California's waterbodies. HABs vary in color and may range from vibrant to dark green, blue-green, yellow, brown, black, or red. It is also worth noting that not all CyanoHABs will appear as accumulations on the surface of water as some are benthic (i.e. attached to the bottom of the waterbody), and others are planktonic (i.e. float within the water column at various depths). While not all cyanobacteria produce toxins, many have the ability to do so. Therefore, when cyanobacteria blooms are suspected, use caution and notify the authorities listed above under *Background*. Authorities are also very interested in notifications regarding blooms that are not caused by cyanobacteria because these decrease water quality, harm fish, and often times give off strong odors.

Field Visit

1. Use the visuals provided in this guide during a site visit. Please review all sections prior to using this guide, the suggested sequence is as follows:
   1.1. Begin with the first two sections titled *Green Algae and Aquatic Plants* and *Aquatic Organisms of Concern* to become familiar with different colors and texture associated with various aquatic organisms found near the water surface.
   1.2. Then refer to the third section of this guide titled *Planktonic Cyanobacteria* when observing a large waterbody (i.e. pond, lake, reservoir) or other slow moving waterbody such as stream, river, or channel.
   1.3. Then refer to the fourth section of this guide titled *Benthic Cyanobacteria* when observing a stream, river, or channel; however, these benthic organisms can also be found in large waterbodies particularly in shallow areas.

2. Please take photographs to document observations and help update this guide with local sites. For instructions on how to photograph blooms, see page 4 of the Site Reconnaissance Guide. The photographs can be submitted by email along with the Incident ID Number after completing a *Freshwater Bloom Incident Form* (webpage listed above under *Background*).

3. Determine if the bloom material appears visually similar to the example organisms found in this guide or, if the user is unsure, please report the bloom to authorities listed above under *Background*.

4. If the bloom material does not appear visually similar to the examples, it is recommended to survey additional areas around the waterbody for bloom material and return within 1-2 days to observe any visual changes.

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Note: portions of this guide have been adapted from U.S. Geological Survey Open-File Report 2015–1164, herein identified as Rosen et al., 2015.

Green Algae and Aquatic Plants

Green algae and aquatic plants are commonly found in waterbodies but, when favorable conditions cause them to grow quickly, it can cause problems. While green algae and aquatic plants do not produce toxins, they cause other impairments to water quality, block movement of watercraft, and emit strong odors. There are many causes of algae and cyanobacteria blooms; a primary cause is from fertilizers washed into local waterways. Fertilizer contains nutrients, such as nitrogen and phosphorus, that promote the growth of these organisms.

This section includes photographs of green algae and aquatic plants that accumulate on the surface of water and near shorelines. These organisms can be confused with cyanobacteria blooms; the following photos highlight the various colors, texture, and visual appearance to help distinguish between the groups.

- Figures 1-8 (pp 4-8) show common green algae accumulating on the surface water and near shorelines.
- Figures 9-11 (pp 8-9) show common aquatic plants that are either rooted in shallow water or appear floating on the surface.

Photographs of Green Algae

Figure 1. *Mougeotia sp.* (Photograph: Steve Heiskary, Minnesota Pollution Control Agency)

Photographs of Green Algae (Continued)

Figure 2. *Cladophora sp.* detail (Photograph: Ann St. Amand; Rosen et al., 2015)

Figure 3. Filamentous green algae (Photograph: Rich Fadness)

Photographs of Green Algae (Continued)

Figure 4. Filamentous green algae (Photograph: Rich Fadness)

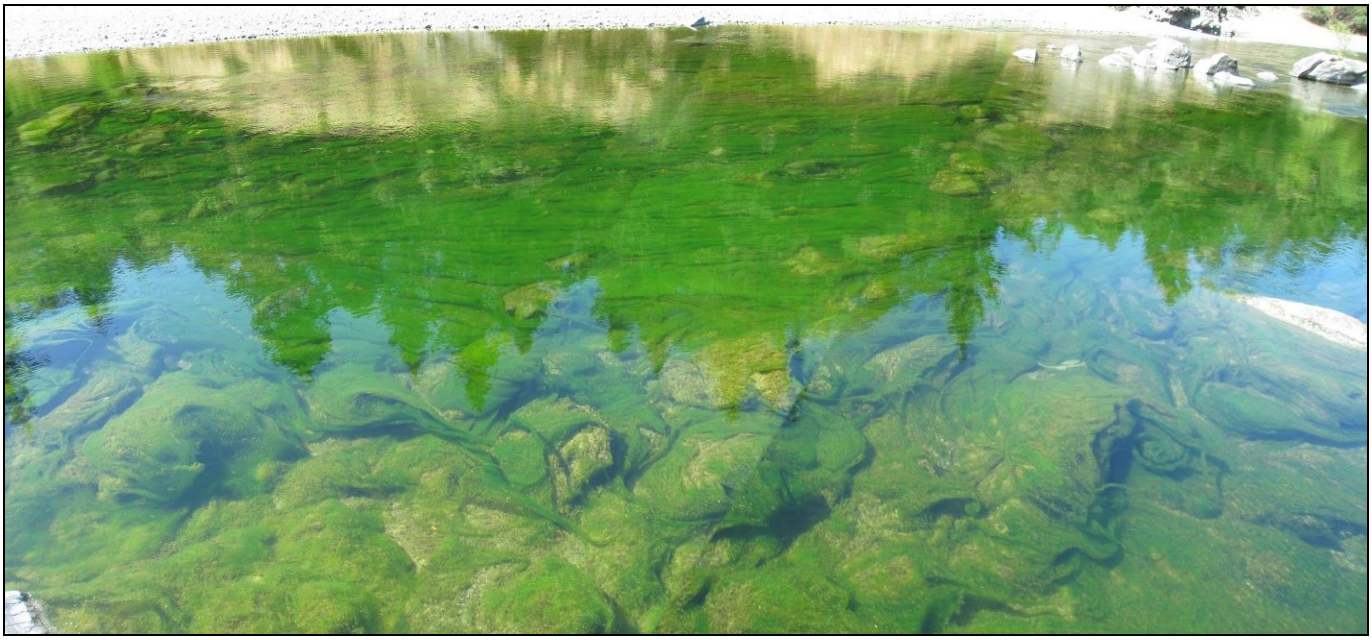

Figure 5. Filamentous green algae (Photograph: Rich Fadness)

Photographs of Green Algae (Continued)

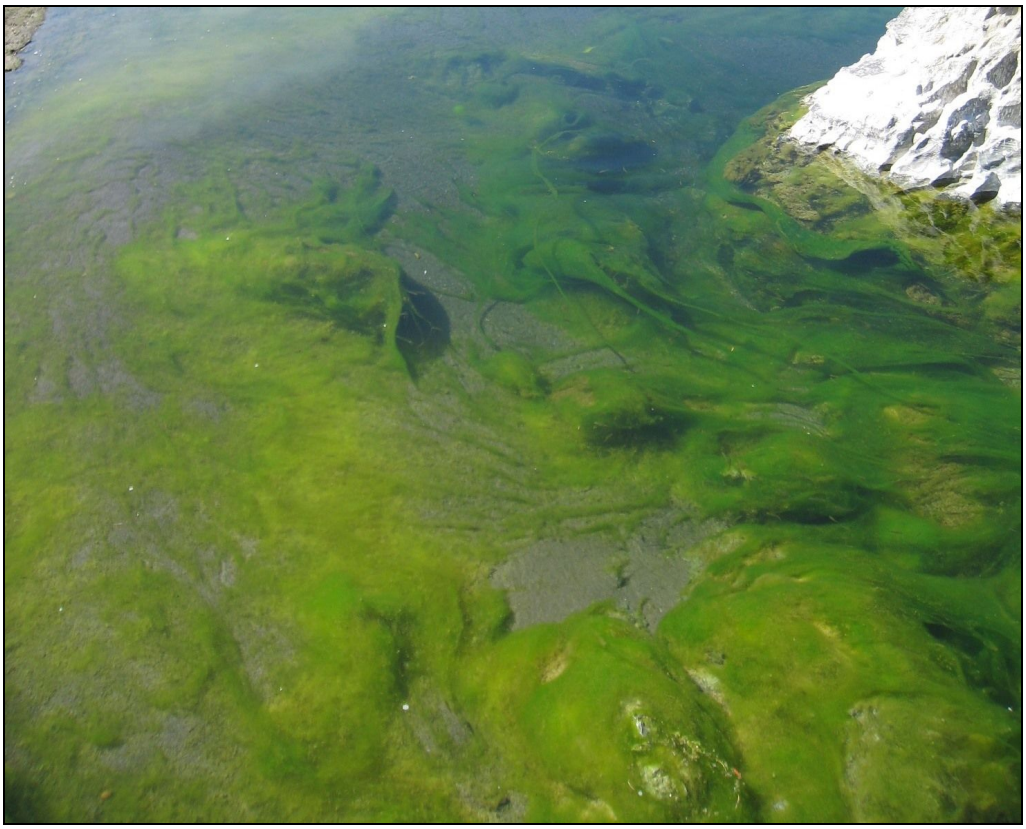

Figure 6. Filamentous green algae, detail (Photograph: Rich Fadness)

Figure 7. Filamentous green algae (Photograph: Rich Fadness)

Photographs of Green Algae (Continued)

Figure 8. Filamentous green algae (Photograph: Rich Fadness)

Photographs of Aquatic Plants

Figure 9. Rooted aquatic plants (Photograph: Ann St. Amand; Rosen et al., 2015)

Photographs of Aquatic Plants (Continued)

Figure 10. Rooted aquatic plants (Photograph: Ann St. Amand; Rosen et al., 2015)

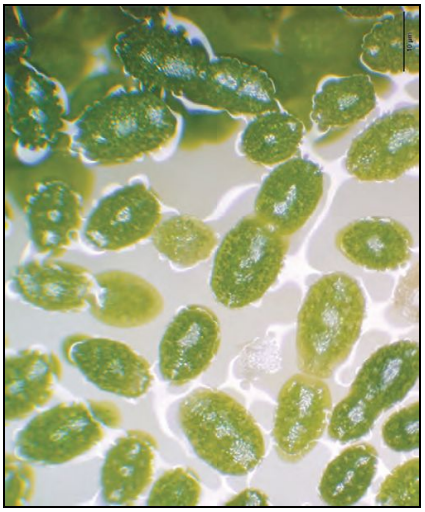

Figure 11. Left - *Wolffia columbiana* (duckweed) Right - *W. columbiana* (duckweed), magnified (Photographs: Ann St. Amand; Rosen et al., 2015)

Aquatic Organisms of Concern

Several types of aquatic organisms are of concern to humans and animals due to their ability to create toxins. This section includes images of *Euglena* and *Prymnesium*; groups of aquatic organisms that appear similar to green algae and cyanobacteria.

Euglena appear almost oily when found on the water surface. The group *Euglena* includes a species named *E. sanguinea* (fig 13) that is known to produce toxins that impact fish and mammals (Zimba et al., 2010). *Prymnesium* is often called “golden algae,” and is normally observed in other parts of the country, but has recently been found in southern California. Golden algae causes water to appear brownish or otherwise discolored as the organisms normally float near the surface. One species of golden algae, *Prymnesium parvum,* poses an acute risk to fish as the toxins it produces can critically injure their gills, as well as other aquatic organisms with gill structures (e.g. bivalves). While there is no evidence that *P. parvum* toxins harm humans, dead or dying fish in waterbodies should not be touched.

- Figures 12-13 (pp 10-11) show different *Euglena* that range from green to red.
- Figure 14 (p 11) shows *Prymnesium* or golden algae, both magnified and in open water.

Photographs of Aquatic Organisms of Concern

Figure 12. *Euglena sp.* (Photograph: Ann St. Amand; Rosen et al., 2015)

Photographs of Aquatic Organisms of Concern (Continued)

Figure 13. *Euglena sanguinea,* known toxin producer (Photograph: Barry Rosen; Rosen et al., 2015)

Figure 14. *Left - Prymnesium parvum* bloom resulting in fish kill (Photograph: Spoon, 2014)
Right - *Prymnesium sp.* magnified (Photograph: Baker et al., 2012)

Planktonic Cyanobacteria Blooms

This section includes images that show planktonic cyanobacteria blooms in order to help individuals recognize them among algae and other aquatic organisms. The term “planktonic” is used to describe free-floating aquatic organisms (e.g. cyanobacteria, algae) that can be found at various depths due to their buoyant characteristics. Whether or not these organisms are found on the surface of the water or below it can depend upon growth stage and other factors.

The following planktonic cyanobacteria images have been separated into two sections to provide examples of surface or subsurface genera. Note that some genera of cyanobacteria can grow at multiple depths and are considered under both of the following subsections.

Surface Accumulating Cyanobacteria

These images (figs 15-28) highlight the range of colors and textures of cyanobacteria when accumulating on the water surface and near shorelines.

- Figures 15-18 (pp13-14) show common *Microcystis* species. When *Microcystis* blooms are observed at low abundance (figs 15;p 13), the material can appear like small flakes of lettuce, while at higher abundance, this same genera can look like floating paint (fig 18;p 14).
- Figures 19-22 (pp 15-16) show a close-up of *Dolichospermum* (*Anabeana*) and the range of green shades the material can appear as in the field.
- Figure 23 (p 17) shows *Aphanizomenon flos-aquae*; the filamentous material appears like short grass clippings that can grow from individual filaments into dense, clumpy blooms.
- Figure 24 (p 17) shows *Woronichinia*; its material can appear gelatinous and ranges from blue-green to brown-green.
- Figures 25-27 (pp 18-19) show how mixed cyanobacteria blooms can appear in contrast to blooms characterized from a single dominant genera. Figure 25 shows how bloom material accumulates near the shoreline, or slow moving areas of a waterbody, and also causes water discoloration. Figures 26-27 show a lake bloom that consisted of over 10 abundant genera and appeared different shades of color near the shoreline and in open water. Dense, grayish surface mats are also shown (fig 27).
- Figure 28 (p 19) shows surface accumulation on the shoreline that decayed to release blue-green pigments from the cells.

Photographs of Surface Accumulating Cyanobacteria - *Microcystis*

Figure 15. *Microcystis aeruginosa* detail (Photograph: Ann St. Amand; Rosen et al., 2015)

Figure 16. *Microcystis aeruginosa* (Photograph: Ann St. Amand; Rosen et al., 2015)

Photographs of Surface Accumulating Cyanobacteria - *Microcystis* (Continued)

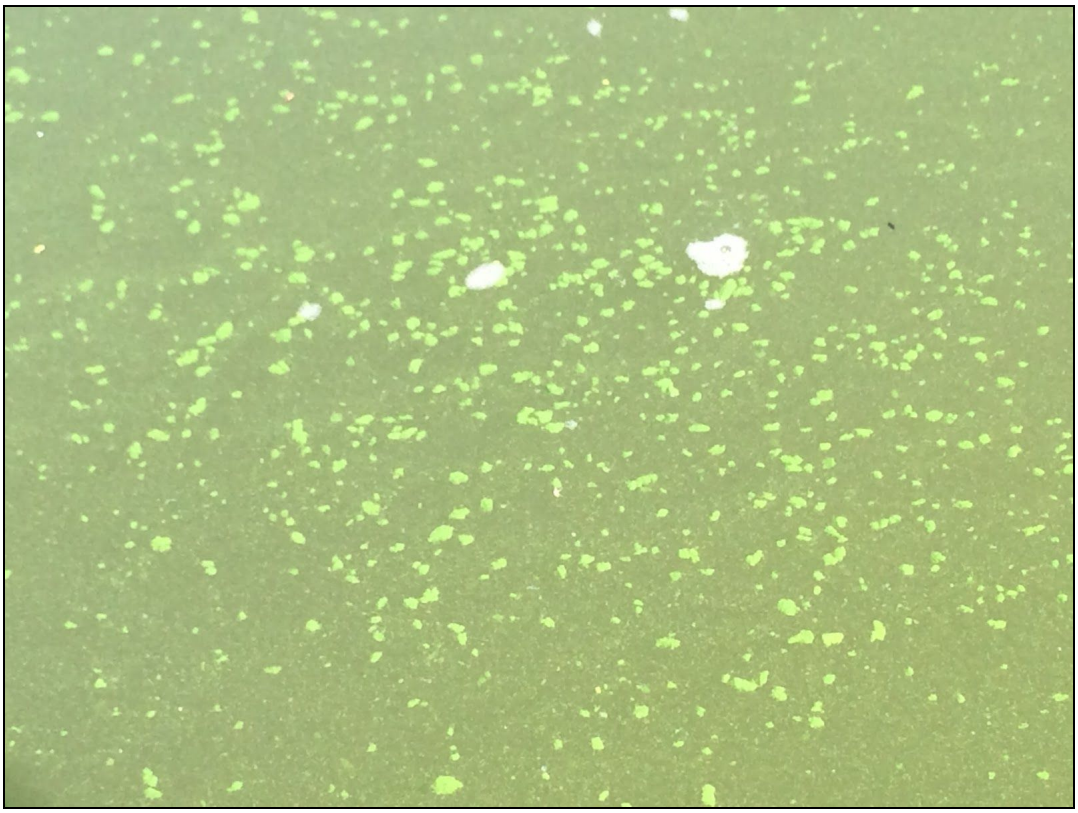

Figure 17. *Microcystis sp.* floating colonies (Photograph: SWAMP)

Figure 18. *Microcystis sp.* (Photograph: Jacob Kann)

Photographs of Surface Accumulating Cyanobacteria - *Dolichospermum*

Figure 19. *Dolichospermum lemmermannii* (Photograph: Ann St. Amand; Rosen et al., 2015)

Figure 20. *Dolichospermum lemmermannii* (Photograph: Ann St. Amand; Rosen et al., 2015)

Photographs of Surface Accumulating Cyanobacteria - *Dolichospermum* (Continued)

Figure 21. *Dolichospermum lemmermannii* (Photograph: Ann St. Amand; Rosen et al., 2015)

Figure 22. *Dolichospermum mendotae* (Photograph: Ann St. Amand; Rosen et al., 2015)

Photographs of Surface Accumulating Cyanobacteria - *Aphanizomenon flos-aquae*

Figure 23. *Aphanizomenon flos-aquae* (Photograph: Jacob Kann; Rosen et al., 2015)

Photographs of Surface Accumulating Cyanobacteria - *Woronichinia*

Figure 24. *Woronichinia naegeliana* (Photograph: Ann St. Amand; Rosen et al., 2015)

Photographs of Surface Accumulating Cyanobacteria - Mixed Cyanobacteria

Figure 25. Mixed genera CyanoHAB, slow moving channel (Photograph: SWAMP)

Figure 26. Mixed genera CyanoHAB, lake (Photograph: SCCWRP)

Photographs of Surface Accumulating Cyanobacteria - Mixed Cyanobacteria (Continued)

Figure 27. Mixed genera CyanoHAB, lake shoreline (Photograph: SCCWRP)

Figure 28. Decayed cell accumulation from CyanoHAB (Photograph: Mike Liane; Rosen et al., 2015)

Subsurface Accumulating Cyanobacteria

These images (figs 29-37) highlight how some cyanobacteria blooms alter the visual appearance of water while not forming obvious accumulations of material on the surface. The observer may view changes to the waterbody, ranging from buoyant bloom material beneath the surface to general discoloration of the waterbody (color change, darkened, or more opaque). It is important to be familiar with the waterbody to recognize visual changes that indicate bloom formation.

The following photographs show a range of water discoloration due to cyanobacteria accumulating well below the surface (figs 29-32) and other cases where the subsurface accumulation is easily visible (figs 33-37).

- Figure 29 (p 20) shows subsurface *Microcystis viridis* bloom.
- Figure 30 (p 21) shows subsurface *Dolichospermum lemmermannii* bloom.
- Figure 31 (p 21) shows subsurface *Cylindrospermopsis raciborskii* bloom. The discoloration of open water is difficult to observe, highlighting to need to routinely monitor waterbodies.
- Figure 32 (p 22) shows subsurface *Planktothrix agardhii/prolifica* bloom; note the reddish water color.
- Figure 33 (p 22) shows *Aphanizomenon flos-aquae* bloom; note the cloudy accumulation.
- Figure 34 (p 23) shows subsurface mixed cyanobacteria genera bloom flowing downstream.
- Figure 35 (p 23) shows subsurface *Gloeotrichia echinulata* bloom.
- Figure 36 (p 24) shows a *Plectonema wollei* (*Lyngbya*) bloom; note the light brown turbid appearance below the surface.
- Figure 37 (p 24) shows a subsurface *Lyngbya* bloom.

Photographs of Subsurface Accumulating Cyanobacteria

Figure 29. *Microcystis viridis* (Photograph: Ann St. Amand; Rosen et al., 2015)

Photographs of Subsurface Accumulating Cyanobacteria (Continued)

Figure 30. *Dolichospermum lemmermannii* (Photograph: Ann St. Amand; Rosen et al., 2015)

Figure 31. *Cylindrospermopsis raciborskii* (Photograph: Ann St. Amand; Rosen et al., 2015)

Photographs of Subsurface Accumulating Cyanobacteria (Continued)

Figure 32. *Planktothrix agardhii/prolifica* (Photograph: Richard Holmes; Rosen et al., 2015)

Figure 33. *Aphanizomenon flos-aquae* (Photograph: Ann St. Amand; Rosen et al., 2015)

Photographs of Subsurface Accumulating Cyanobacteria (Continued)

Figure 34. Subsurface mixed cyanobacteria genera, river (Photograph: SWAMP)

Figure 35. *Gloeotrichia echinulata* (Photograph: Midge Eliassen; Rosen et al., 2015)

Photographs of Subsurface Accumulating Cyanobacteria (Continued)

Figure 36. *Plectonema wollei* (*Lyngbya*) (Photograph: Ken Wagner; Rosen et al., 2015)

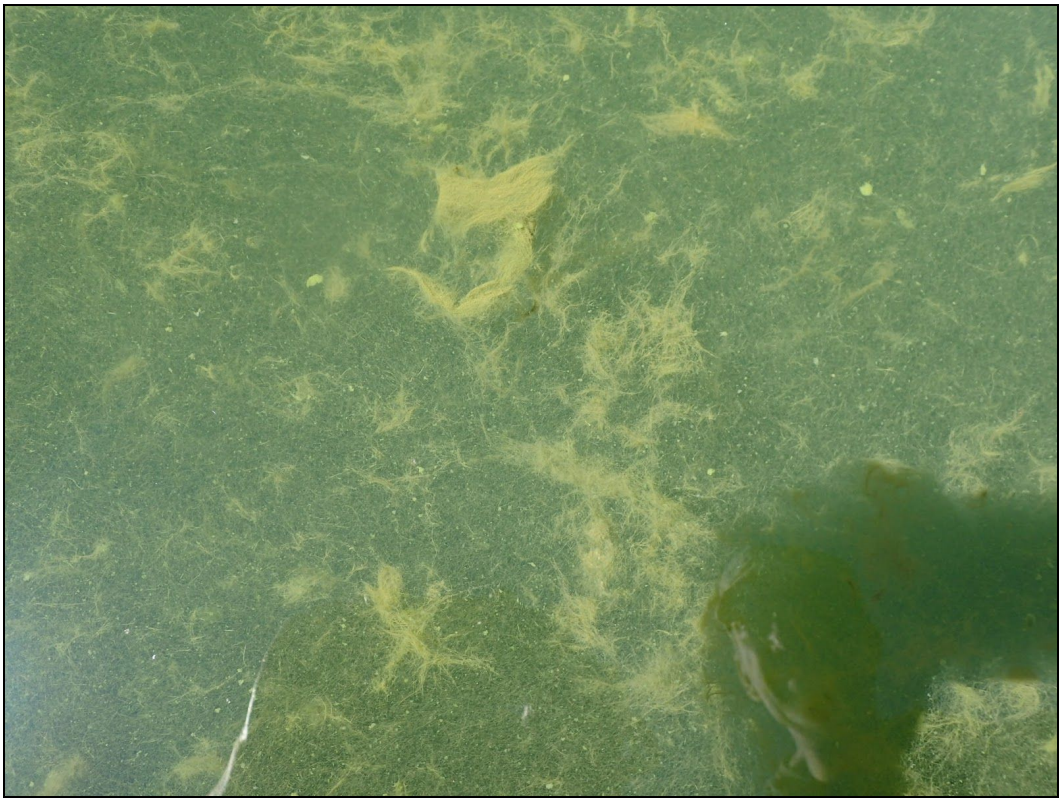

Figure 37. Planktonic *Lyngbya sp.* (Photograph: Rich Fadness)

Benthic Cyanobacteria Blooms

Cyanobacteria that predominantly grow on the bottom (benthos) of waterbodies are referred to as “benthic cyanobacteria.” These groups form dense material that can become quite extensive and appear as a film (biofilm), clumps of colonies, and mats that are attached to the bottom substrate. The color of the material is diverse, ranging from vibrant yellow-green and drab olive, to burgundy and dusky brown or black. The bloom material may also include non-toxic algae as many groups of cyanobacteria grow with algae - forming algal mats. The risk of exposure to benthic blooms increases significantly when the cyanobacteria mats dislodge from the bottom, become buoyant, and accumulate along shorelines, backwater channels, or eddies via wind or water current.

Common cyanobacteria genera responsible for benthic blooms in California are *Anabaena, Lyngbya*, *Nostoc, Oscillatoria*, and *Phormidium*. While mat forming CyanoHABs are frequently observed in northern California rivers and streams, a recent survey showed that these cyanobacteria are common across the state (Fetscher et al., 2015).

- Figures 38-41 (pp 26-27) shows multiple species of *Anabaena*. The algal mats range from vibrant to dark green, blue-green, and brown. Some *Anabaena* algal mats form unique spires (fig 39;p 26) that float towards the surface due to trapped oxygen bubbles produced by the organisms (Bouma-Gregson, 2015). Figure 40 (p 27) shows extensive *Anabaena* mats and highlights how fragile mats can become detached and float to the surface, eventually accumulating at various locations.
- Figures 42-45 (pp 28-29) shows *Cylindrospermum* species growing as mats on the bottom substrate and attached to submerged aquatic plants (fig 44;p29).
- Figures 46-47 (p 30) shows Geitlerinema growing among algal mats and a detailed view of the mat structure.
- Figure 48 (p 31) shows multiple *Nostoc* species that appear gelatinous as flattened or round shaped colonies and also oblong shapes. The accumulations can appear blue-green, beige, and brown (Bouma-Gregson, 2015). The large masses of colonies are often mistaken with brown kelp.
- Figures 49-50 (pp 31-32) shows various forms of *Oscillatoria* mats.
- Figures 51-57 (pp 32-36) shows multiple *Phormidium* blooms to highlight the range of colors and textures these organisms can exhibit. *Phormidium* appear green, blue-green, yellow, orange, brown, and black. The textures of the mats can appear velvety or feathery, and sometimes appear leathery with ‘veined’ texture (fig 56). Benthic cyanobacteria often grow among other submerged algae, Figure 54 highlights *Phormidium* growing among yellowish filamentous algae.
- Figure 58 (p 36) shows multiple types of detached algal mats accumulated on the shoreline.

Photographs of Benthic Cyanobacteria Blooms - *Anabaena*

Figure 38. *Anabaena sp*. detail (Photograph: Rich Fadness)

Figure 39. *Anabaena sp. "spires"* (Photograph: Keith Bouma-Gregson)

Photographs of Benthic Cyanobacteria Blooms - *Anabaena* (Continued)

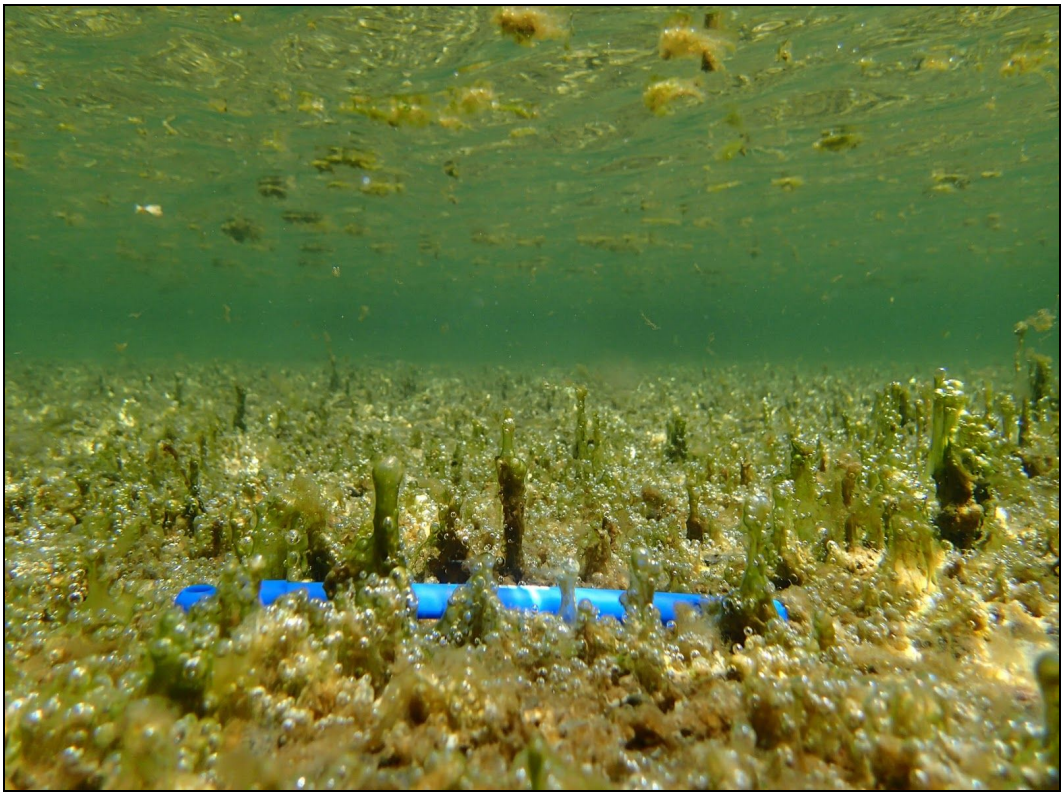

Figure 40. *Anabaena sp.* mats and floating detached mats (Photograph: Keith Bouma-Gregson)

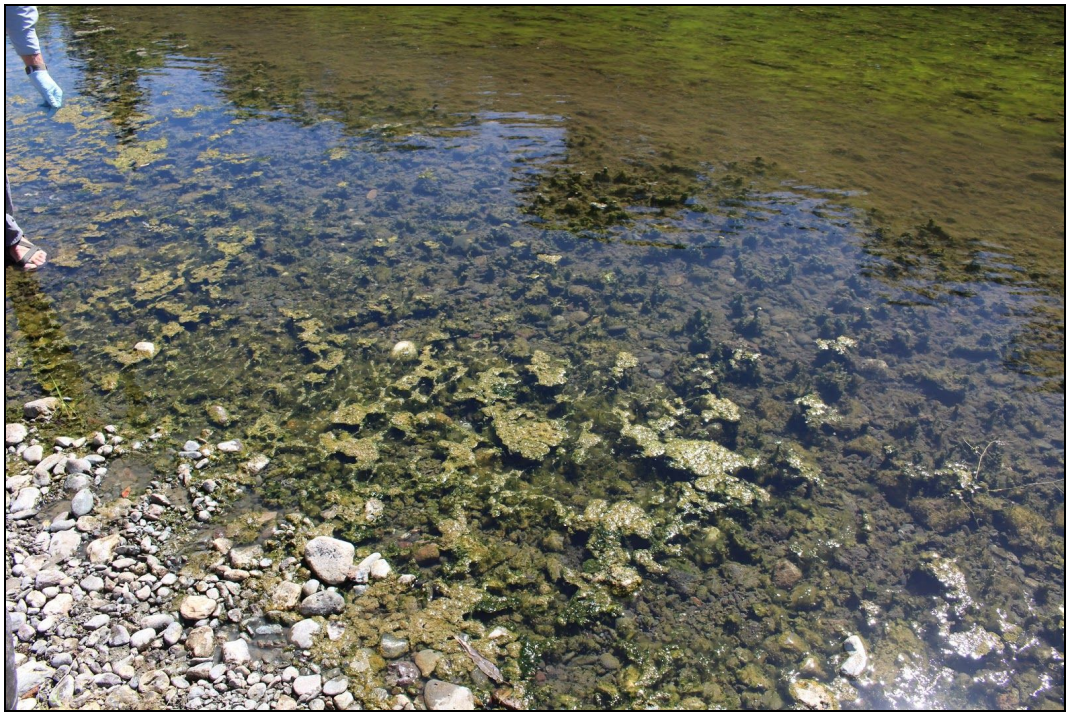

Figure 41. *Anabaena sp.* on shoreline (Photograph: Rich Fadness)

Photographs of Benthic Cyanobacteria Blooms - *Cylindrospermum*

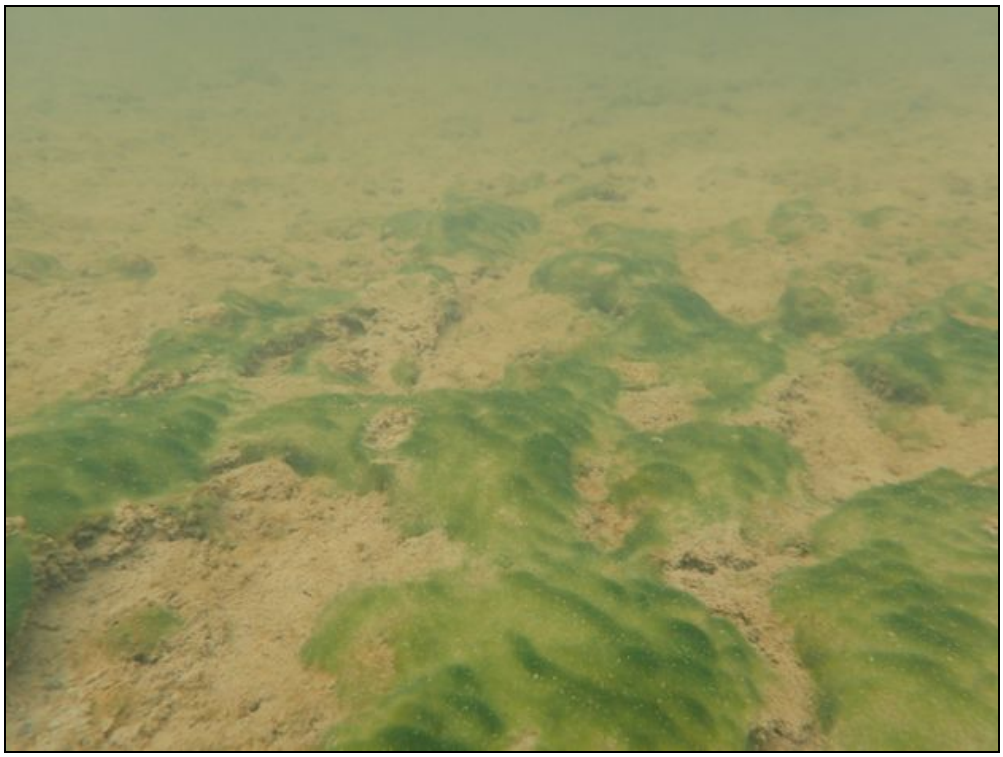

Figure 42. *Cylindrospermum sp.* (Photograph: Rich Fadness)

Figure 43. *Cylindrospermum sp.* (Photograph: Rich Fadness)

Photographs of Benthic Cyanobacteria Blooms - *Cylindrospermum* (Continued)

Figure 44. *Cylindrospermum sp.* growing on submerged aquatic plants (Photograph: Rich Fadness)

Figure 45. *Cylindrospermum sp.* mixed with algae mats (Photograph: Rich Fadness)

Photographs of Benthic Cyanobacteria Blooms - *Geitlerinema*

Figure 46. *Geitlerinema sp.* (Photograph: Rich Fadness)

Figure 47. *Geitlerinema sp.* detail (Photograph: Rich Fadness)

Photographs of Benthic Cyanobacteria Blooms - Nostoc

Figure 48. *Nostoc sp.* (Photographs: Bouma-Gregson, 2015)

Photographs of Benthic Cyanobacteria Blooms - *Oscillatoria*

Figure 49. *Oscillatoria sp.* detail (Photograph: Rich Fadness)

Photographs of Benthic Cyanobacteria Blooms - *Oscillatoria* (Continued)

Figure 50. Left - Submerged *Oscillatoria sp.* mats
Right - *Oscillatoria sp.* growing on submerged branches (Photographs: Rich Fadness)

Photographs of Benthic Cyanobacteria Blooms - *Phormidium*

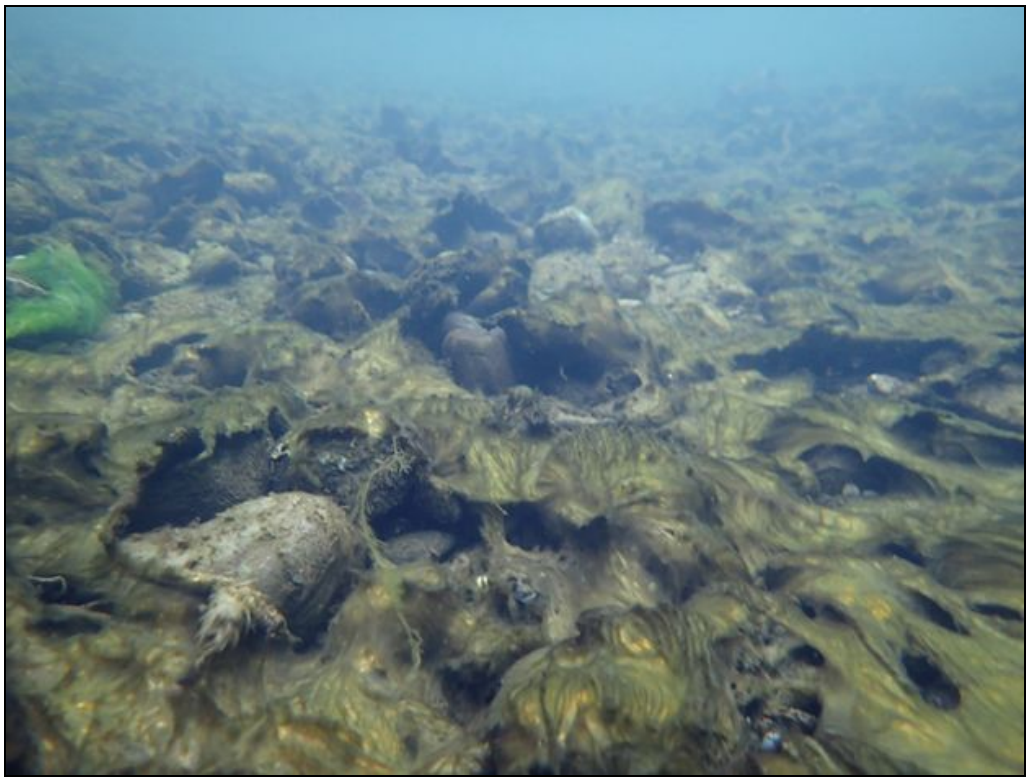

Figure 51. *Phormidium sp.* (Photograph: Rich Fadness)

Photographs of Benthic Cyanobacteria Blooms - *Phormidium* (Continued)

Figure 52. *Phormidium sp.* (Photograph: Rich Fadness)

Figure 53. *Phormidium sp.* blooms (Photographs: Rich Fadness)

Photographs of Benthic Cyanobacteria Blooms - *Phormidium* (Continued)

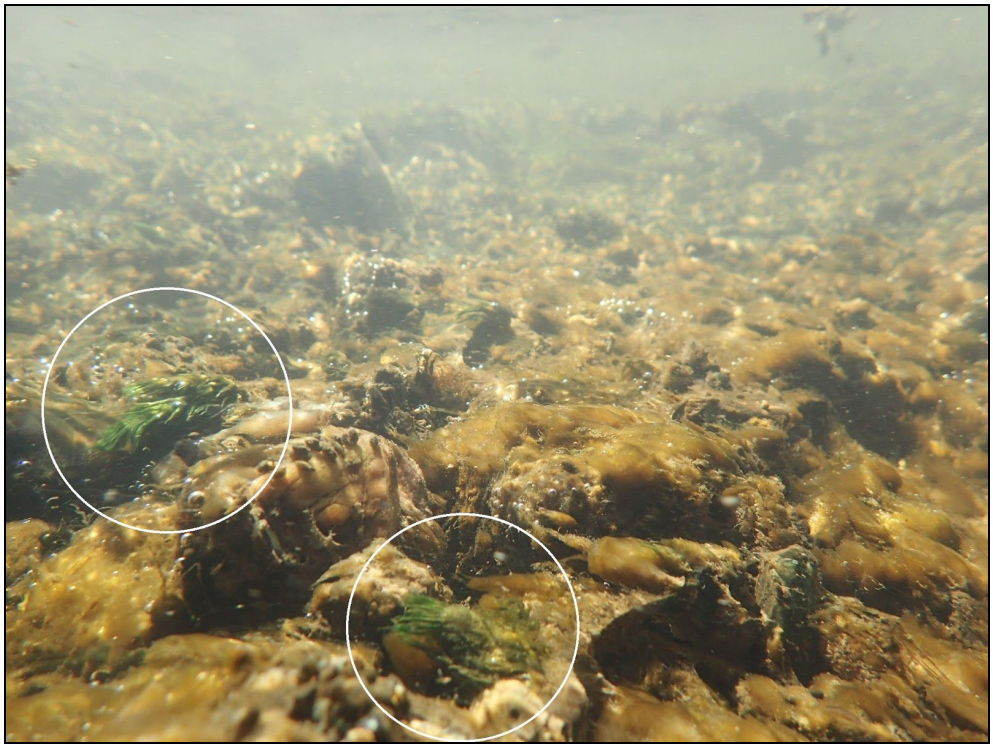

Figure 54. *Phormidium sp.* highlighted by circles (Photograph: Rich Fadness)

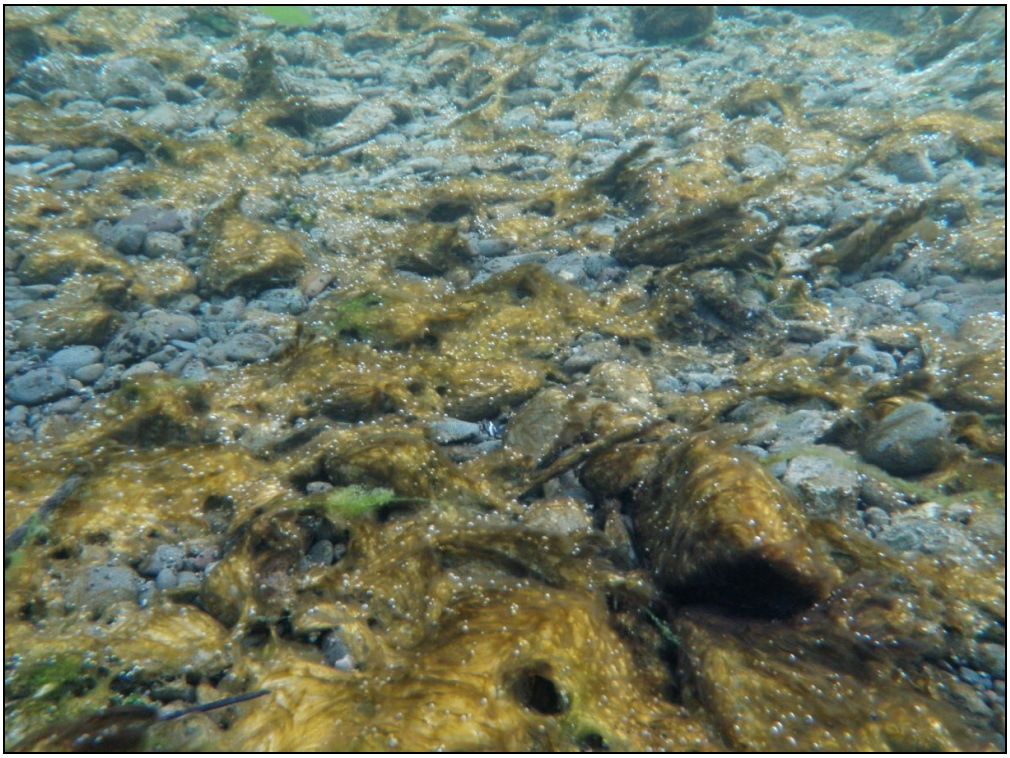

Figure 55. *Phormidium sp.* (Photograph: Keith Bouma-Gregson)

Photographs of Benthic Cyanobacteria Blooms - *Phormidium* (Continued)

Figure 56. *Phormidium* mat leathery 'veined' texture (Photograph: Rich Fadness)

Figure 57. *Phormidium sp.* bloom (Photograph: Rich Fadness)

Photographs of Benthic Cyanobacteria Blooms - Detached Algal Mats

Figure 58. Various detached benthic mats on shoreline (Photographs: Ministry, 2009)

References

In addition to this guide, several other resources exist for visually identifying and recognizing CyanoHABs. Some examples include the USGS Field and Laboratory Guide to Freshwater Cyanobacteria Blooms by Rosen and St. Amand and the Ohio HAB Characterization Guide.

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Zimba, PV., Moeller PD., Beauchesne, K., Lane, HE., Triemer, RE. et al. 2010. Identification of euglenophycin-a toxin found in certain euglenoids. Toxicon, v. 55, p. 100-104.