

DRAFT
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Technologies and Methodologies for the Detection of Harmful Algae and their Toxins
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TABLE 1. The arsenal of existing methodological approaches that have been employed for detection (presence/absence) and quantification of HA species and their toxins. *includes all detection systems as well as MS/MS. r denotes relative quantification. Lab / Field denotes primary application with (F) indicating engineering refinements needed to make field compatible or remote deployable. See Paul et al. 2007 and Scholin et al 2008 for detailed assessments of these technologies.

Base Technology	Method	Target	Reporter	Detect / Quantify	Standard	Lab / Field
<i>Microscopy</i>						
	Light	Cell morphology, pigmentation	image	D, Q	Voucher specimens, taxonomic keys	L
	SEM/TEM	ultrastructure	image	D	“	L
<i>Analytical</i>						
	HPLC methods*	Toxins, metabolites, pigments	Chromatogram, mass information	D, Q	Specific analytes	L
	Mouse Bioassay	toxin	toxicity	D, Qr	“	L
	UV-VIS spectroscopy	Toxins, pigments	absorption spectra	D, Q	“, spectral libraries	L, F
	Fluorescence spectroscopy	pigments	fluorescence spectra	D, Qr	“, “	L, F
<i>Molecular</i>						
	FISH	Nucleic acid (NA) sequence in cells – gDNA, RNA	Fluorescence with cell morphology	D, Q	Reagent controls, voucher samples	L
	Sandwich Hybridization	NA sequence – gDNA, RNA	Colorimetric, chemiluminescence, fluorescence	D, Qr	“	L, F
	Microarrays	Multiple NA targets (species) – gDNA, RNA	Spatially indexed fluorescence	D, Qr	“	L, F
	NASBA – nucleic acid sequence based amplification	NA sequence – RNA, ssDNA	Fluorescence kinetics - isothermal amplification	D, Qr	“	L, F
	PCR – polymerase chain reaction	NA sequence – gDNA, cDNA from RNA	Fluorescence kinetics - thermal cycling amplification	D, Qr	“	L, F
	ELISA	toxin	Colorimetric, fluorescence	D, Q	Toxin standards	L

	Lateral Flow ELISAs 'dip sticks'	toxin	Colorimetric	D, Qr	Toxin standards	L, F
	RBA –Receptor Binding Assay	toxin	isotopic	D, Q	Toxin standards	L
	SPR – Surface Plasmon Resonance	Toxin Nucleic acid sequence	Refractive index dynamics associated with molecular binding	D, Q	Toxin standards, reference sequences	L, (F)
	Fiber Optic Bead Microarrays	Nucleic acid sequence (cells)	Spatially indexed fluorescence	D, Qr		L,(F)
	Optical					
	In situ fluorescence	Chlorophyll or other taxonomically informative pigments	Relative fluorescence	D, Qr		F
	In situ absorbance	Inherent optical properties of water mass	Attenuation and scattering spectra	D, Qr		F
	Inverse modeling	IOPs	Characterization of phytoplankton community	D	Cell specific spectra	F
	4 th derivative analysis	Cell specific spectra	Identification of characteristic absorbance or fluorescence peaks	D, Qr	Cell specific spectral features	L+ F
	Remote Sensing					
	SeaWiFs	Ocean color	Chlorophyll distributions	Dr	Ground verification	F
	MODIS	Fluorescence line height	“ and proxy for photosynthesis	Dr	“	F
	MODIS	Remote sensing reflectance	Spectral inputs for inverse modeling	Dr	“ and IOPs	F
	Hyperspectral imagers, aircraft	Meter scale Rrs	“	Dr	“	F

TABLE 2. Field ready derivative systems designed for specific detection of HA species and/or their associated phycotoxins in water or tissue samples. All have undergone extensive field testing. See Paul et al. 2007 and Scholin et al 2008 for detailed assessments of these technologies. # indicates commercially available.

Analytical Package / Vendor	Target	Reporter	Detect / Quantify	Primary Application Lab / Field
Abraxis Kits [#]	Cyanotoxins, Brevetoxin, DA, Okadaic Acid, STX	Colorimetric ELISA - microtiter plate	D, Q	Water quality and shellfish testing, lab based
BioSense Kits [#]	DA, Okadaic Acid, STS, YTX	Colorimetric ELISA - microtiter plate	D, Q	Shellfish testing, lab
Mercury Biosciences [#]	DA	Colorimetric ELISA - microtiter well strips	D, Q	Water quality, shellfish testing, lab based, field format in beta
Jellet Rapid Tests [#]	DA, STX	Colorimetric lateral flow ELISA	D, Qr	Shellfish testing, lab and field
<i>Environmental Sample Processor</i> 1G & 2G - MBARI	Cells –multiple species, toxins – DA, Sample archiving	SH, ELISA, PCR	D, Qr	Remote or pier based deployments, data telemetry along with WQ context, sample archiving possible
<i>Autonomous Microbial Genosensor</i> USF-COTS	<i>Karenia brevis</i> - can be extended to other taxa	NASBA	D, Qr	Remote or pier based deployment, handheld version for spot surveys
<i>Breve-buster</i> Mote Marine Lab	<i>Karenia brevis</i>	Spectral matching to <i>K. brevis</i> Potential to extend to other taxa	D, Qr	Glider/AUV pier based deployments
Sequoia Scientific - LISST	Particles	Particle scattering distributions (cell size, shape, abundance)	D	Variety of deployment options and portable versions for lab or field use
Fluid Imaging Technologies - <i>FlowCam</i>	cells	Images and abundance – automated particle classification	D, Q	Lab, dock, pier and moored deployments FW and marine
<i>Flow CytoBot</i> - WHOI	cells	Images and abundance – automated taxon classification	D, Q	Lab, dock, pier and moored deployments, FW and marine