KDHE Fishkill Training 2010: Algae and Blue-Green Algae

Contributed By

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Our Vision – Healthy Kansans Living in Safe and Sustainable Environments

Dead Fish, Green Scum, Bad Smells, and You: Blue-Green Algae and Field Investigations

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Outline of Presentation

- Eutrophication: Definition and Process
- Impacts Due to Eutrophication and Algae Blooms, Current Lake Conditions
- Review of Nuisance Algae and Blooms
- On-Site Observational Cues
- Sampling Considerations
- Safety Considerations
- Unusual, Hazardous, or Invasive Organisms

Types of Impact

- Not Just Natural/Human, Black/White
- #1 Natural Impacts
  - Winterkill, High Temperatures, Lightning, Diseases
- #2 Human Impacts
  - Pesticides, Gasoline Products, VOCs, Spills
- #3 Natural Responses To Human Impacts
  - Eutrophication/Algae Blooms, Purposeful Species Introductions
  - The “Functional Impact” Can Be Secondary, Tertiary, Or Beyond From The “Initial Human Impact”
  - Does Not Mean The Impact Can Be “Written Off” As “Natural In Origin”

How Does A Lake Get To The State Of Producing Large Algae Blooms And Fish Kills?

Eutrophication

The process by which lakes become nutrient enriched, suffer increases In algal biomass, and then experience blooms and nuisance conditions.

Trophic State Classes

- Oligomesotrophic (Low Open-Water Production)
  - Exceptional Water Quality
- Mesotrophic (Moderately Productive)
  - Ideal Quality for All Beneficial Uses
- Eutrophic (Truly Productive)
  - Good for Most Uses
  - Sensitive Uses Begin to be Impaired
  - Mid-Range Probably Ideal for Warm Water Fisheries
- Hypereutrophic (Over Productive)
  - Most Uses Impaired
  - Blue-Green Bloom Risk, Toxin Risk, Increases
- Argillotrophic (Chronically Turbid)

Impacts On Beneficial Uses

- Increased Treatment Costs
- Loss of Recreation Revenues
- Impaired Aesthetic Uses and Lowered Property Values
- Reduced Biotic Integrity
  - Reduced Stability, Richness, Diversity, and Ability to Recover from Stresses
- Human Health Concerns

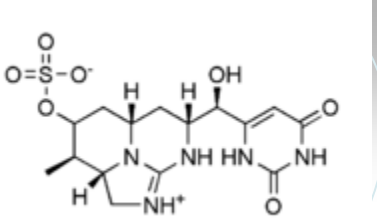
Expected-Baseline-Feasible Water Quality for Kansas Lakes?

- "Reference" versus "Minimally Impacted" versus "Least Impacted" Systems
- Least Impacted, or Better, Systems in Kansas Should Have…
  - <33 ug/L Total Phosphorus, on Average
  - <860 ug/L Total Nitrogen, on Average
  - <10 ug/L Chlorophyll-a, on Average
  - >155 cm Secchi Disk Clarity, on Average
  - Presence of a Reasonable Submersed Macrophyte Community (10-50% Presence), With Some Diversity (≥3 Species)

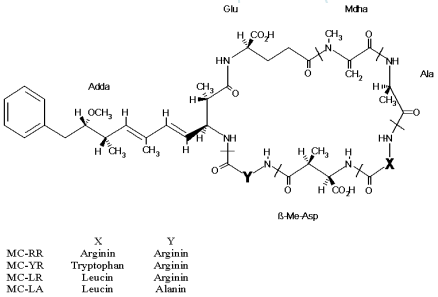
Current Lake Water Quality in Kansas

Trophic Class	Lakes	%	Acres	%
Mesotrophic	50	16%	12,635	7%
Low Eutrophic	49	16%	28,165	15%
Mid Eutrophic	66	21%	89,620	47%
Upper Eutrophic	44	14%	13,974	7%
Hypereutrophic	87	28%	3,546	2%
Argillotrophic	12	4%	42,098	22%

Toxicity Of Algae



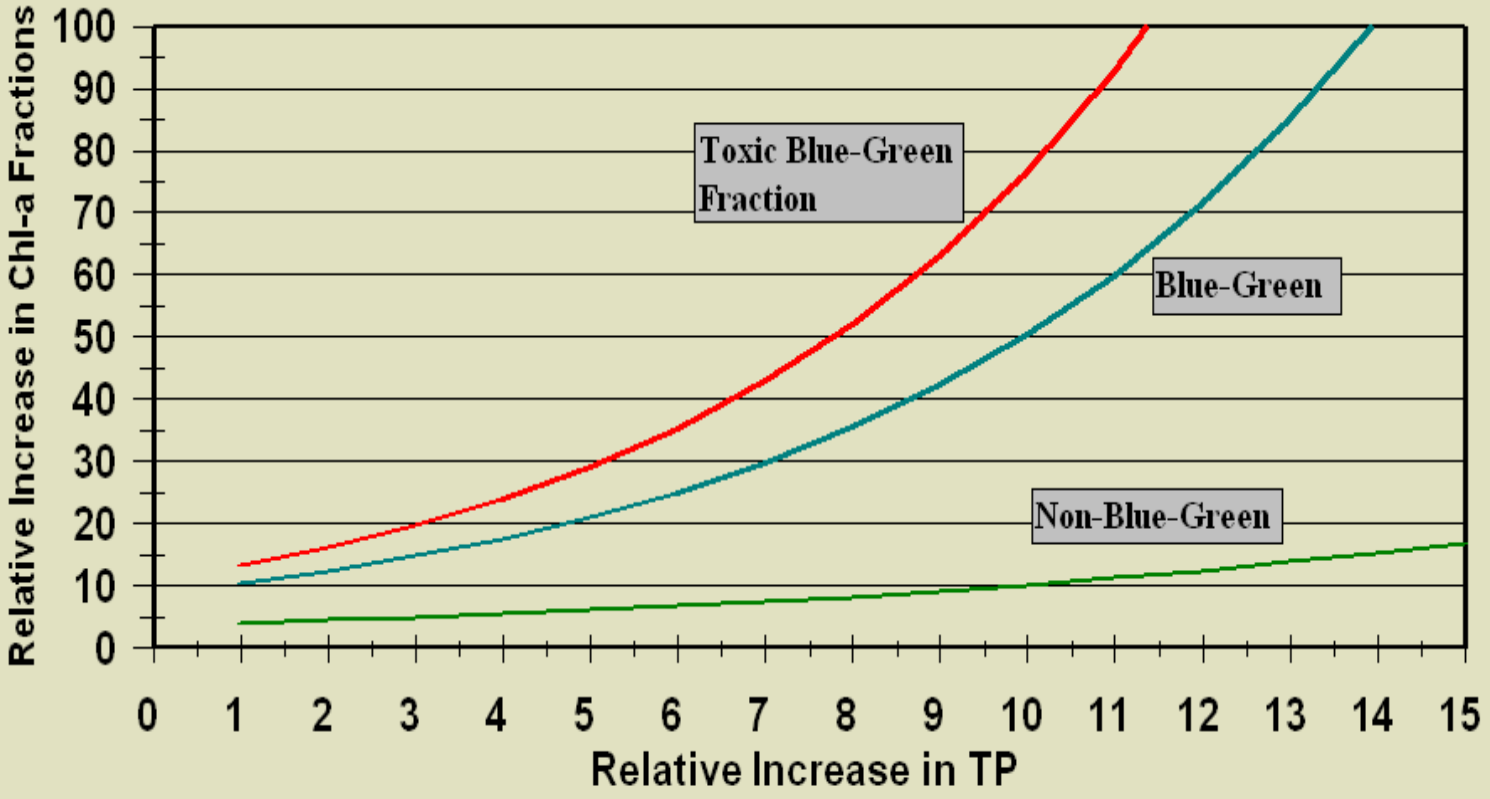
- Categories Of Algal Toxins
  - Neurotoxins (Anatoxins, Saxitoxins, Dimoic Acid)
  - Hepatotoxins (Microcystins, Cylindrospermopsin)
  - Cytotoxins (Cylindrospermopsin)
  - Dermatological (Lyngbyatoxins, LPS)
- Microcystins and Lyngbyatoxins
  - Linkages to Tumor Promotion
- Variability In Production And Types
  - Same Species, Different Blooms = Differences in Toxicity
  - Believed Linked to Sub-Species Instead of Just to Environmental Cues
  - Strong Ties to Nutrient Enrichment



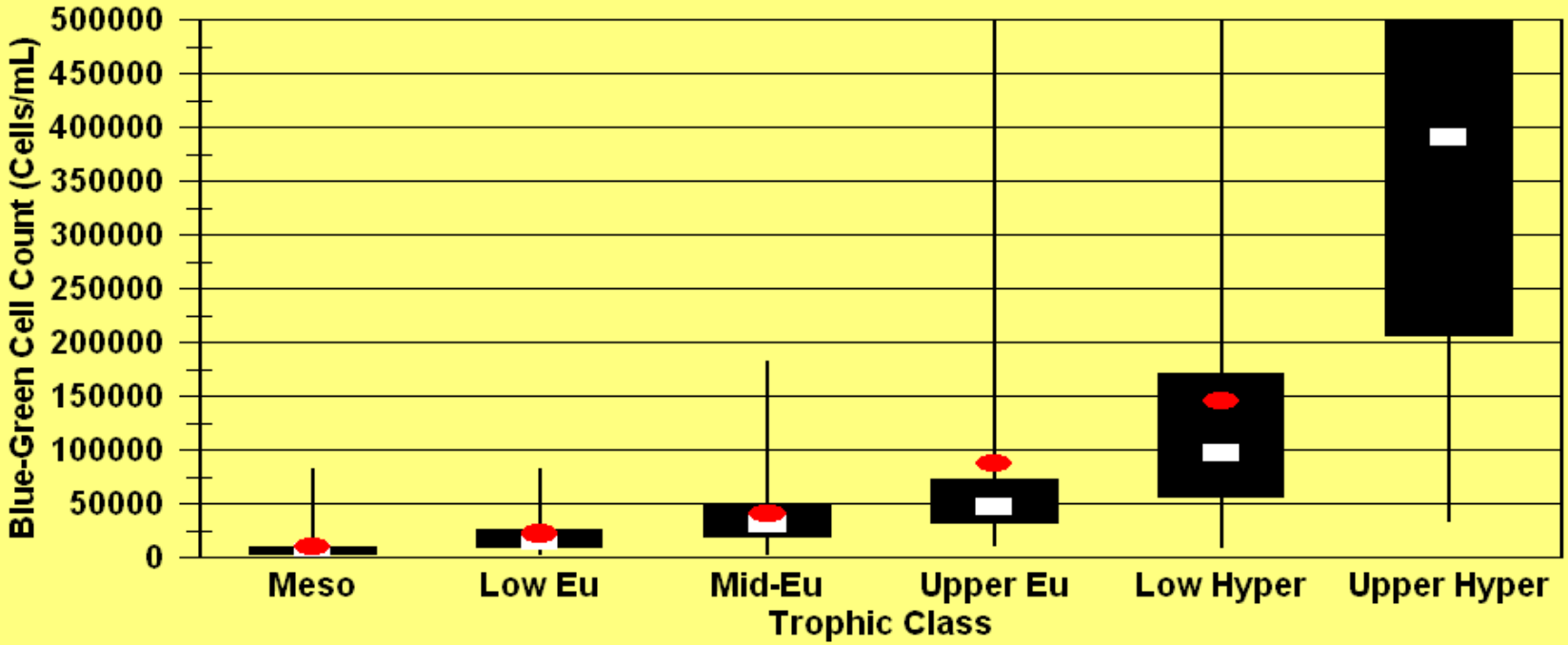
	X	Y
MC-RR	Arginin	Arginin
MC-YR	Tryptophan	Arginin
MC-LR	Leucin	Arginin
MC-LA	Leucin	Alanin

Relative Impacts

Based on Giani et al., 2005



Blue-Green Algae vs. Trophic Class



Why Do Some Algae Produce Toxins?

- Traditionally was thought to be for defense or to reduce competition, or simply a waste product
- Some algae are now known to use toxins in hunting for prey (*Pfiesteria piscicida*, *Karlodinium veneficum*)
- Microcystins have recently been shown to be a metabolic adaptation for photosynthetic efficiency under conditions of…
  - High pH (>9-10 units)
  - Extreme nutrient enrichment and very low free CO_2
  - Higher temperatures
  - The conditions common to most large summer blue-green blooms

Toxicity Comparisons

(LD50's from mice and rat studies)

Cyanide	6,000 ug/kg
Western Diamondback	540 ug/kg
King Cobra	250 ug/kg
Anatoxin-a	200 ug/kg
Microcystins	50 ug/kg
Anatoxin-a(s)	20 ug/kg
Microcystin LR	5 ug/kg
Ciguatera	<3.6 ug/kg
Botulism Toxin (Purified)	<0.01 ug/kg

What Algae Are Nuisance Types?

- Green Algae (Chlorophytes)
- Diatoms (Bacillariophytes)
- Golden Algae (Chrysophytes)
- Euglenoid Algae
- Dinoflagellates
- Blue-Green Algae (Cyanophytes)


Microcystis sp.
Melosira sp.


Anabaena sp.
Ceratium sp.

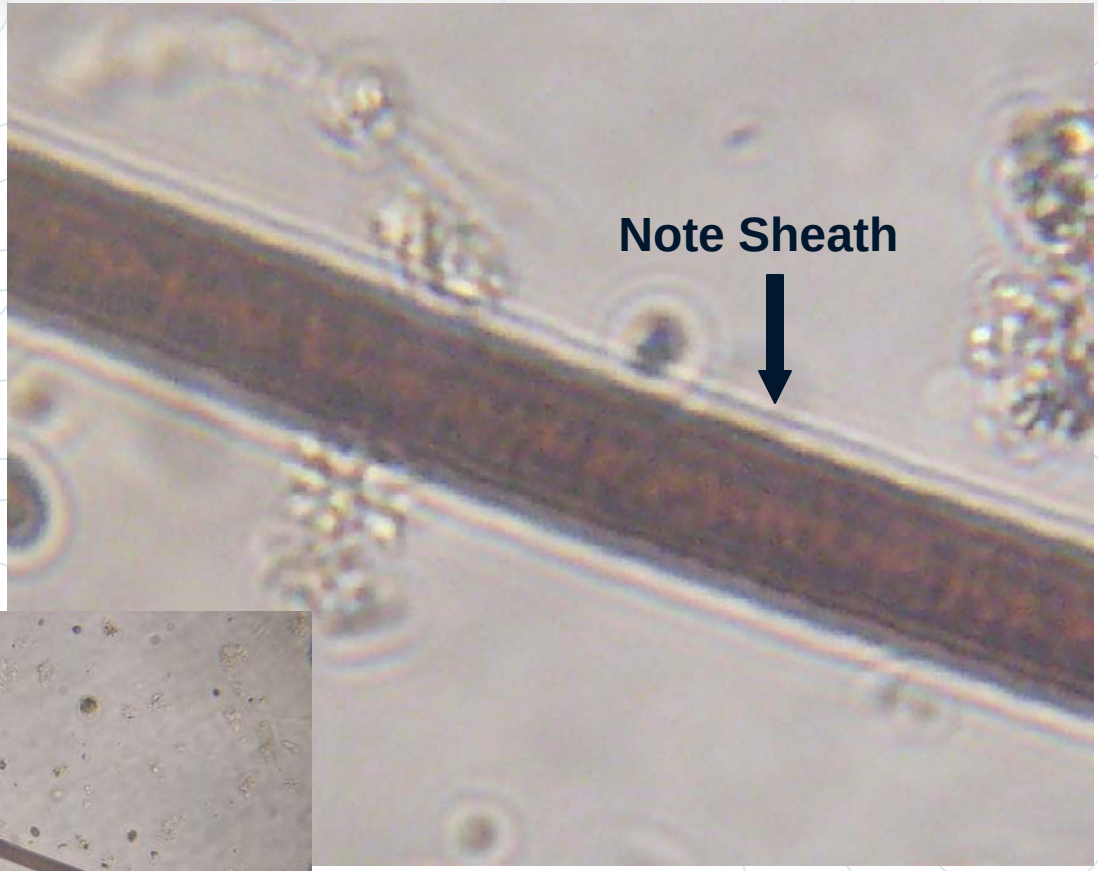

Gymnodinium acidotum

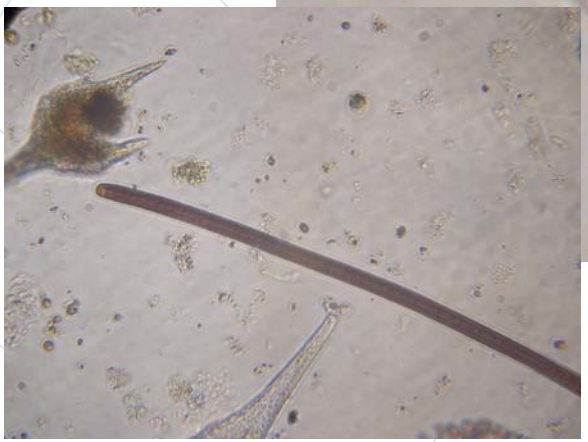

Aphanizomenon flos-aqua


Planktothrix rubescens

Lyngbya wollei

Somewhat similar to Planktothrix in appearance, but much larger





Forms tough, heavy, mats that turn yellow/orange in the sunlight and exude dark purple pigment

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Cylindrospermopsis raciborskii

An Invasive Algae

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Lowe’s Pond 1997

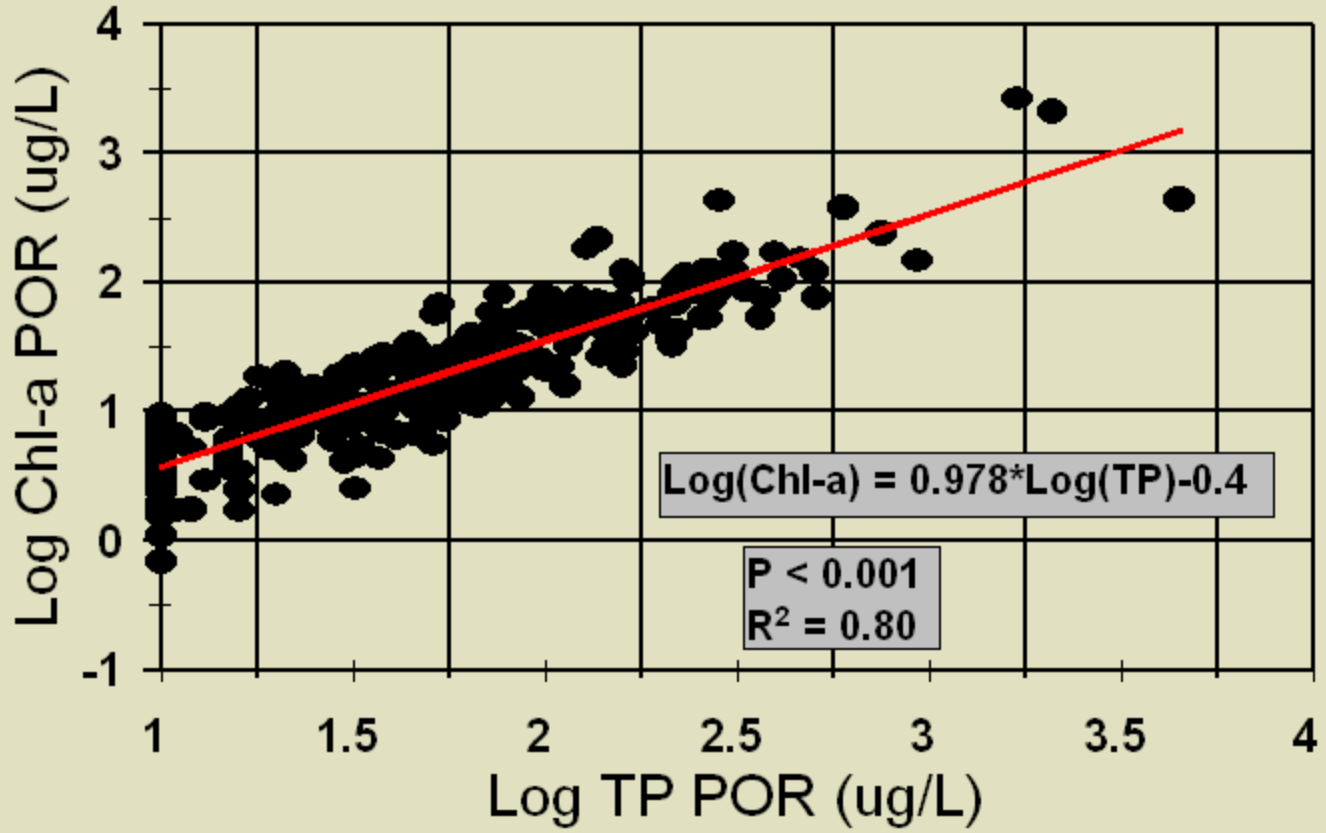
What Constitutes A "Bloom"?

- Rapid, Exponential Growth In Numbers And Biomass
- Thresholds Utilized
  - >10 ug/L Chlorophyll-a
  - >10,000 cells/mL Any Species
    - ~11 ug/L Chlorophyll-a (KDHE Models)
  - >20,000 cells/mL Total Blue-Greens
    - ~12 ug/L Chlorophyll-a (KDHE Models)
- Bloom Severity = Magnitude + Duration + Frequency

Triggers Of Algae Blooms

- Excessive Nutrients
  - Phosphorus Mainly But Nitrogen Too
  - >25 ug/L TP or >400 ug/L TN
  - >50 ug/L TP or >700 ug/L TN
  - 55 ug/L TP Breakpoint for Blue-Green Dominance
- Low Mixing (Summer Stratification)
- Higher Temperatures (Summer)

Phosphorus vs. Chlorophyll-a 1975-2007
Mean Values for 273 Lakes and Wetlands



Smith County Pond 2003

Wamego City Lake 2003

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Myers Lake 2001

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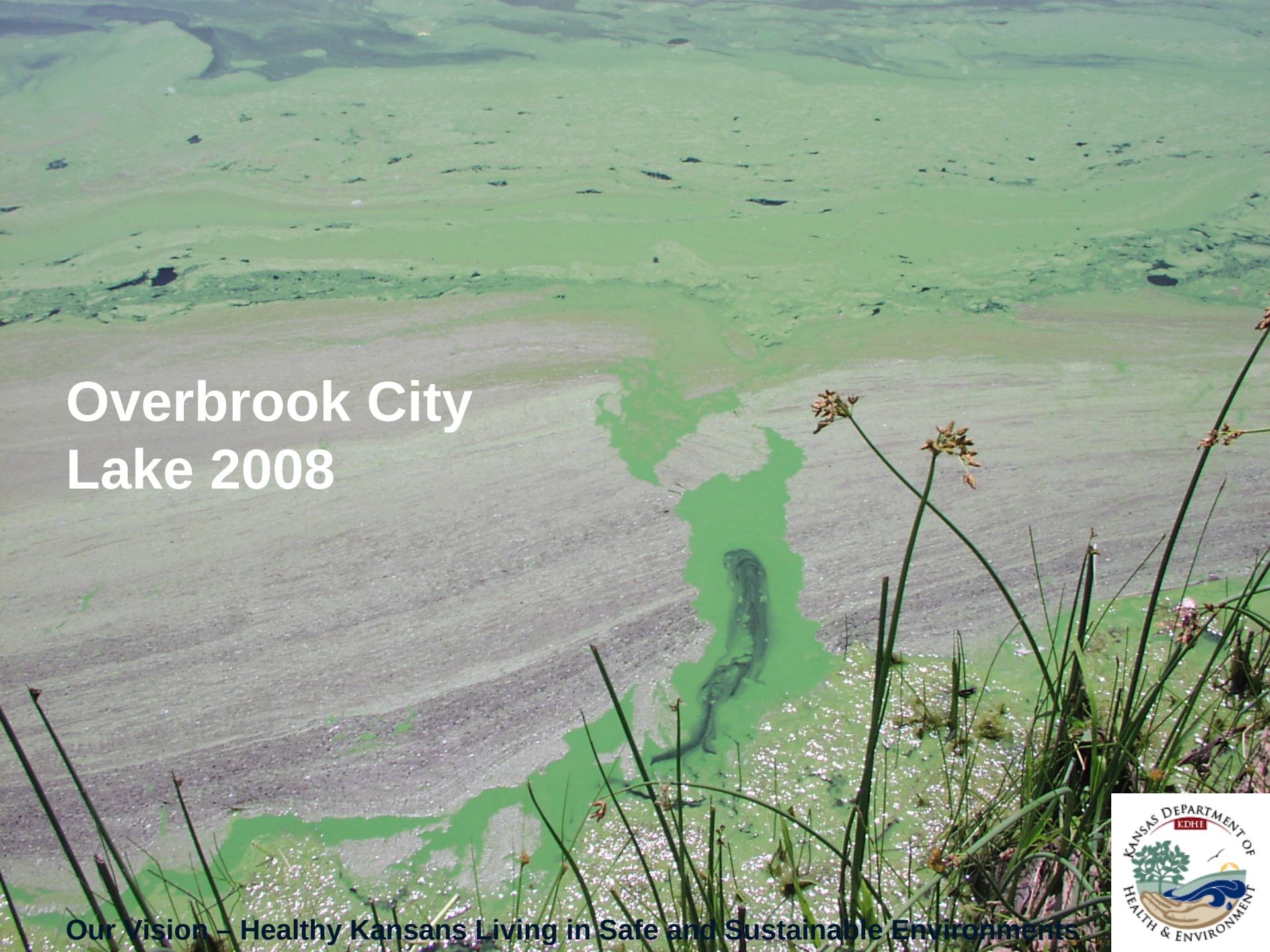
Cheney Lake 2004


Marion Lake 2004



Overbrook City Lake 2008

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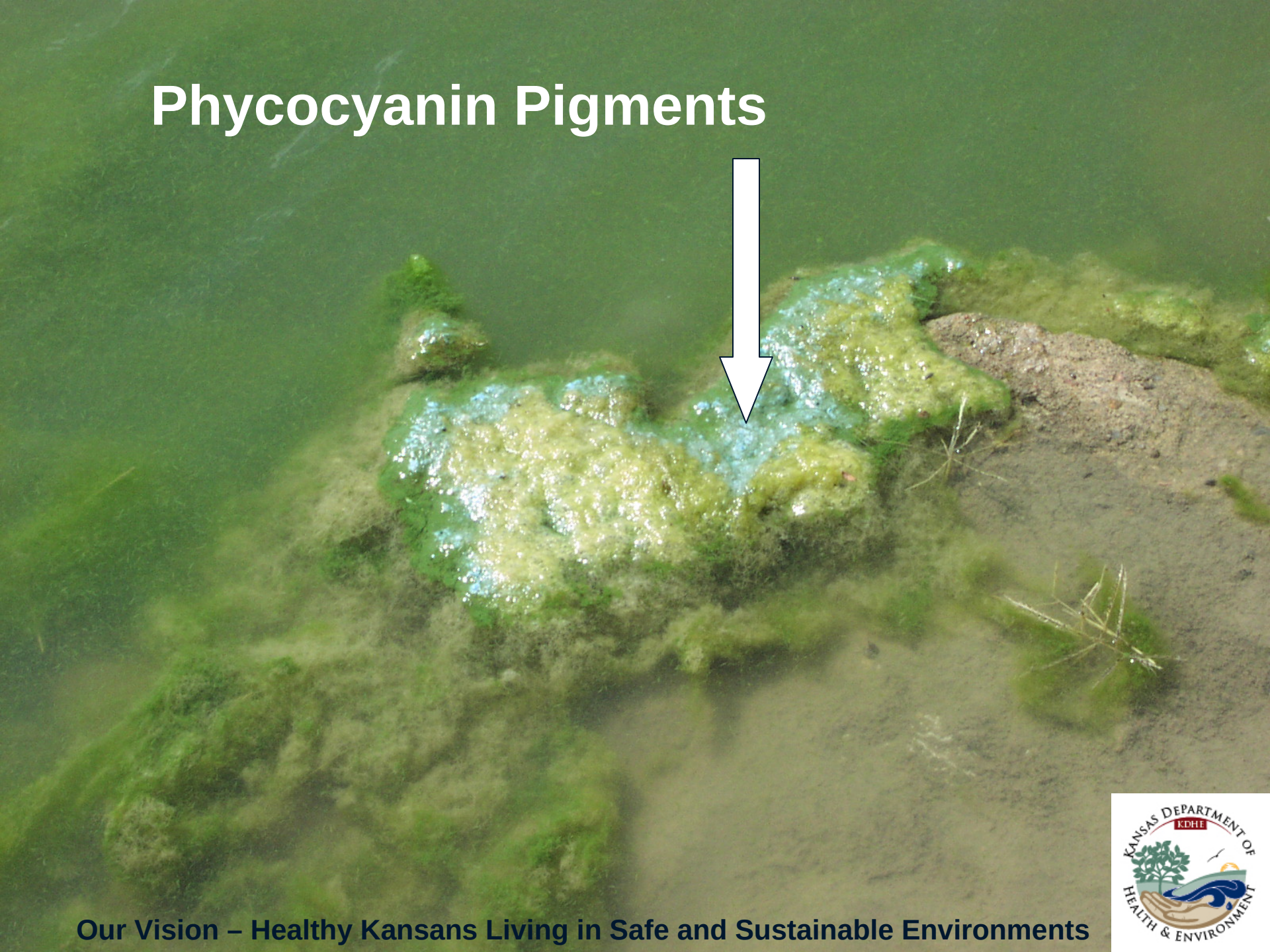
Phycocyanin Pigments



Vaquero Lake 2005

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Rimrock Park Lake 1995

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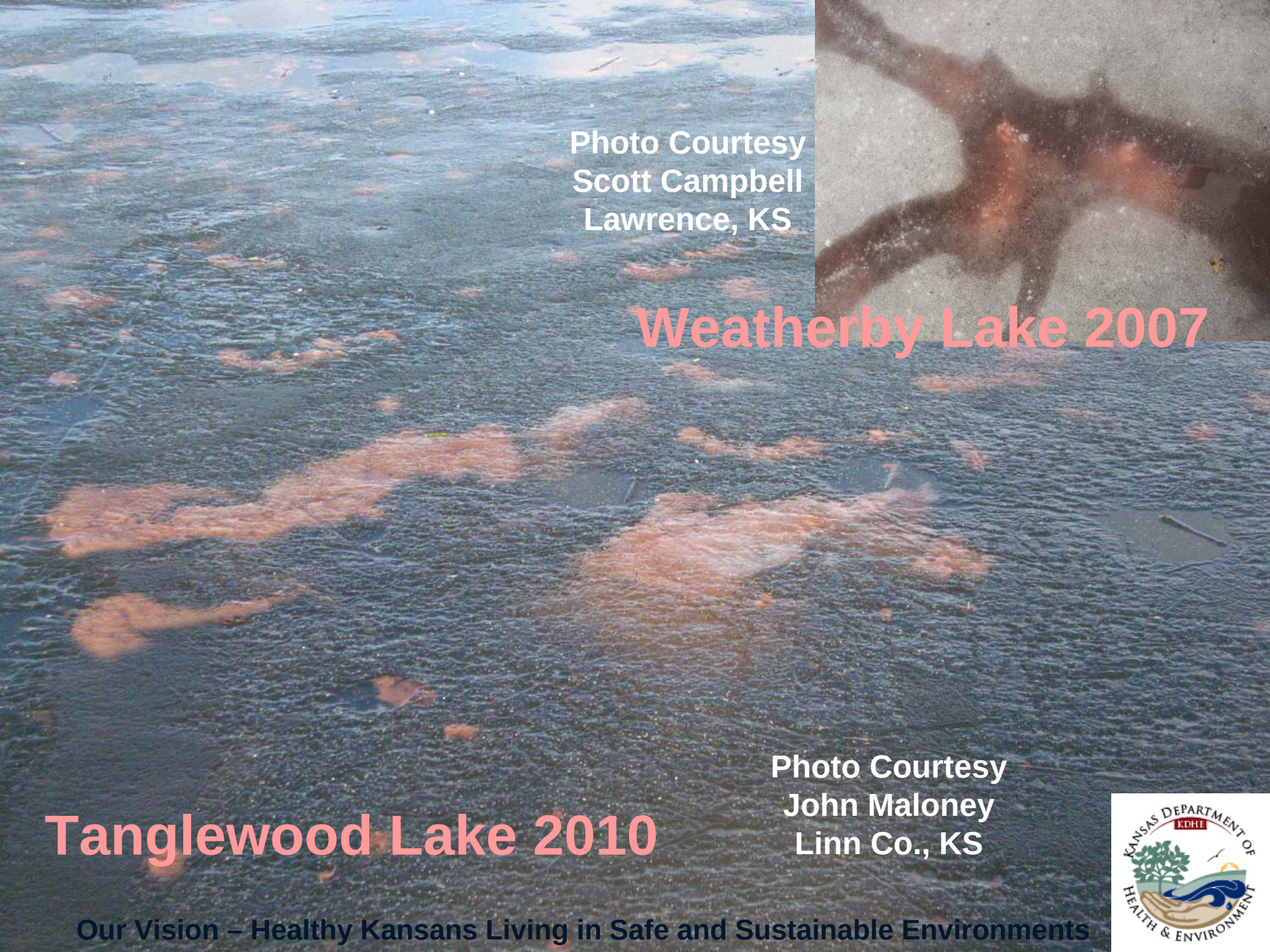

Photo Courtesy
Scott Campbell
Lawrence, KS

Weatherby Lake 2007

Photo Courtesy
John Maloney
Linn Co., KS

Tanglewood Lake 2010

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Riddle….

What is green…….
and smells like red paint?

What To Look For At A Fish Kill Or Other Complaint Investigation?

- Visual Clues
  - Colony Shapes
  - Color of the Water
  - “Paint Spill” Complaints
- Odors
  - Blooms Never Smell Like Paint
  - Fishy, Septic, Musty, or Bunker Oil

Sampling Considerations

- Where?: Open Water Versus Lee Shores
- How?: To Collect A Sample
- What?: Bottles and Preservatives
  - Unpreserved Preferred But Keep Cool
  - Cubetainers Preferred
- Why?: To Document Algal Versus Other Potential Causes


Note Air Space
Note Identifying Markings

Algae Sample Submission Form

Algae Sample Submission Form (Reproduce as needed for each sample)

Send this form with samples to:

Edward Carney
Bureau of Environmental Field Services
Kansas Department of Health and Environment
1000 SW Jackson Ave., Suite 430 (Curtis State Office Building)
Topeka, Kansas 66620

NOTE: Preserve samples with 1 mL of Lugol's Iodine per 125 mL brown plastic sample bottle.
It is advised that you collect one preserved and one unpreserved bottle per sample location.
Do not place algae samples on ice. Simply ship them ASAP at room temperature.

Check which type of problem is being investigated:

_____ Taste/Odor Incident
_____ Fishkill
_____ Aesthetic Complaint
_____ Livestock/Pet Kill
_____ _____ Other (briefly describe in space to left)

Check type of waterbody samples collected from:

_____ Lake/Pond
_____ Stream/River
_____ _____ Other (briefly describe in space to left)

If this is a taste/odor incident, please provide any additional data related to the treatment plant, weather, etc., including date and time of collection.

_____ Date and Time

Also check the boxes appropriate to the qualities of the "taste" and "odor" of the finished or raw water. ("raw" or "finished" can be put in the appropriate field)

Odor:		Taste:	
_____	Earthy/Musty	_____	Sour/Acidic
_____	Chlorinous	_____	Salty
_____	Grassy/Woody	_____	Bitter
_____	Marshy/Septic	_____	Sweet
_____	Fragrant/Flowery	_____	Mouthfeel _____
_____	Fishy/Aquarium		
_____	Medicinal		"Mouthfeel" covers a number of characterisitics
_____	Hydrocarbon/Chemical		of sensation, such as "powdery," "metallic," "burning," etc.
			Please indicate the type of mouthfeel to the right.

If this is not a taste/odor incident (fishkill, etc.), please indicate any other data or information related to the incident (including field conditions, other chemical data, preceding weather, etc.). If chemical data are sent to KHEL, please copy Edward Carney, BEFS, on these.

On the back of this form, please include a sketch map of the site.

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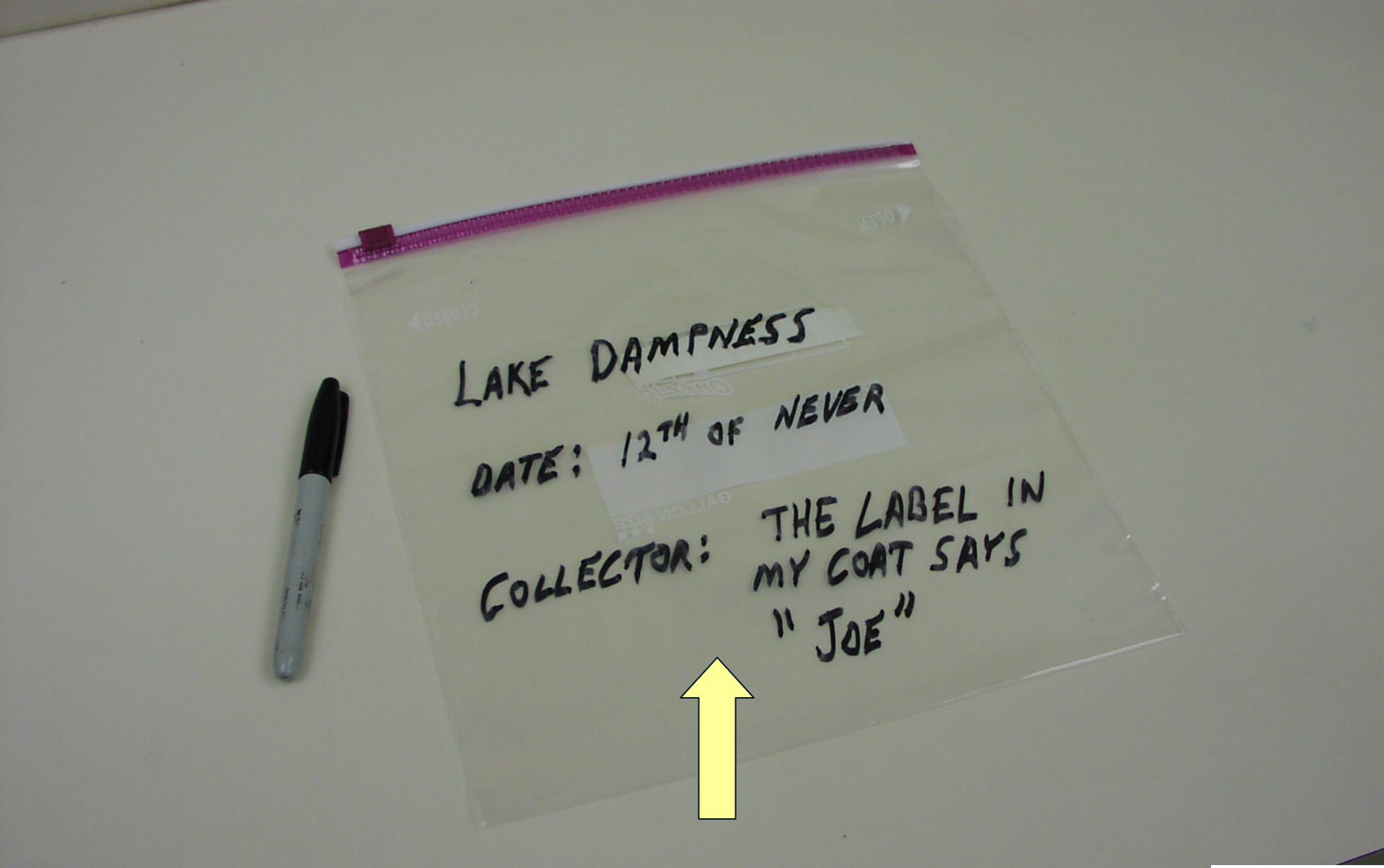
Macrophytes and Periphyton

- Periphyton (filamentous algae) can be submitted in a Cubetainer, just like phytoplankton
- Macrophytes should be submitted in a plastic bag that won't leak, with a couple tablespoons of water to maintain humidity, and kept cool in transport
- Enough plant material should be included (several stems to show branching, variety of leaf nodes, tips, flowers (if present), both floating and submersed leaves (Potamogetons / Pond Weeds))
- Use same sample submission form as for phytoplankton



Note Identifying Markings

Safety Considerations

- Algal Toxins
  - Exposure Risk = Duration + Frequency + Dose
  - Precautions (Gloves, Mask, Stay Upwind)
- General Safety
  - No Eating/Drinking Onsite During Investigation
  - Exposed Clothing
  - Washing Up After Investigation
  - Be Aware of Surroundings and Terrain

Other Organisms

- *Naeglaria fowleri*
- *Didymosphenia geminata* (Rock Snot)
- Avian Botulism and Bird Kills
- Largemouth Bass Virus (LMBV)
  - Lake Crawford, Big Hill, Gardner Lake, Lonestar Lake, Woodson Co. SFL
- Zebra Mussels (*Dreissena polymorpha*)
  - Perry, Cheney, Marion, El Dorado, Winfield City Lake, Lake Afton, Milford, Wilson
- Hydrilla (*Hydrilla verticillata*)
- Eurasian Watermilfoil (*Myriophyllum spicatum*)
- Bryozoans
- Freshwater Jellyfish (*Craspedacusta sowerbyi*)

Dreissena polymorpha
The Zebra Mussel

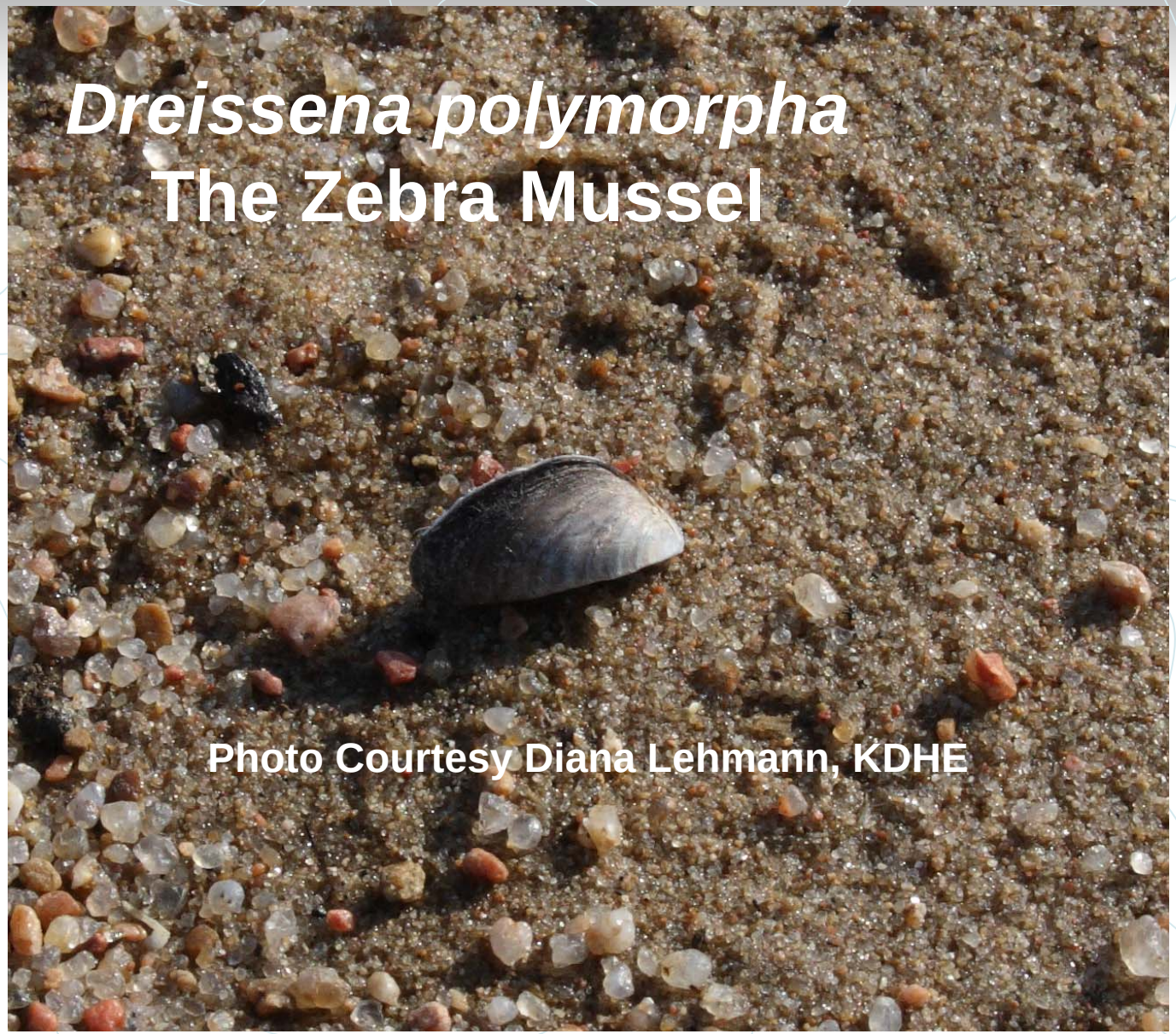


Photo Courtesy Diana Lehmann, KDHE

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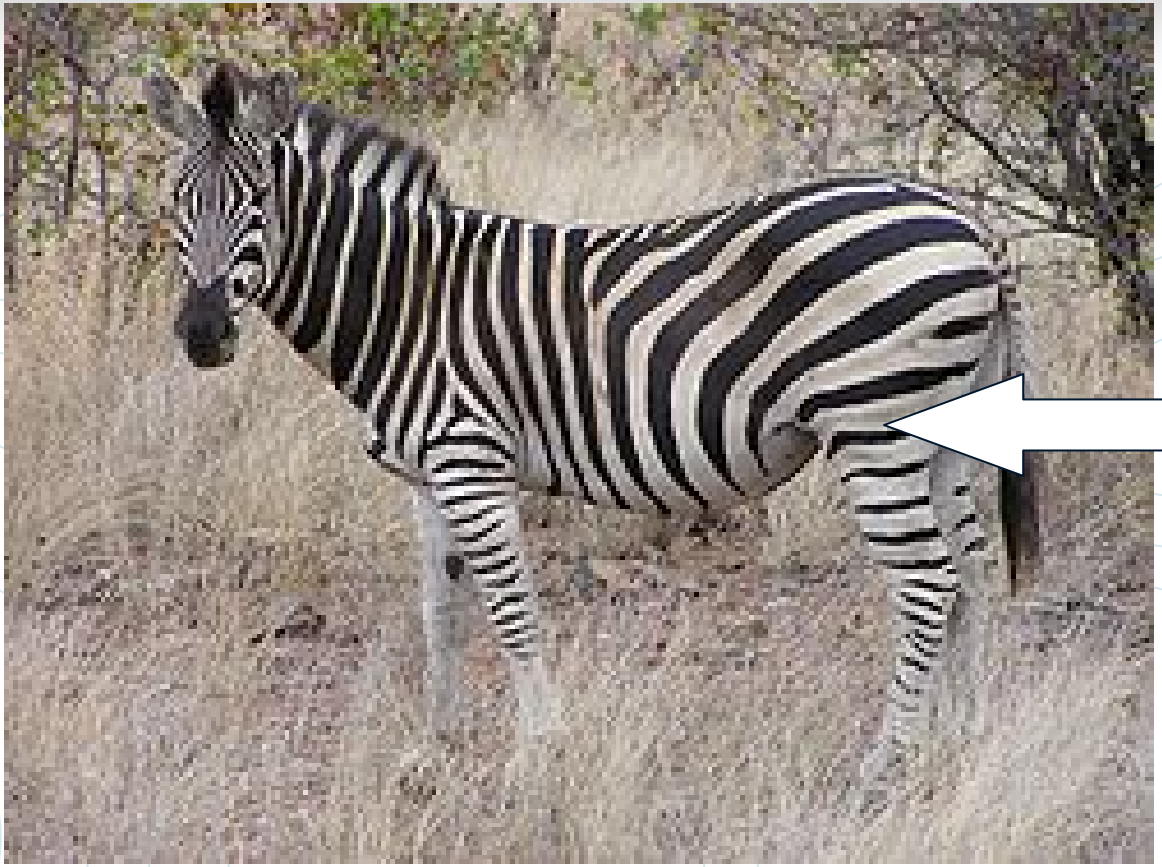

Not to be confused with Zebra Musculature

Photo Courtesy Wikipedia Commons

Hydrilla verticillata

Photo Courtesy
Wikipedia Commons

Hydrilla verticillata

Leaf whorls are in 4's or 5's typically

Keel of leaves have a rough/barbed Feel due to a row of spines on the midrib

Photos Courtesy Wikipedia Commons

Most Similar Native = *Elodea nuttallii*

Leaf whorls are in 3's typically

Keel of leaves feel smooth

Myriophyllum spicatum

Illustration Courtesy
Wikipedia Commons

Stems: reddish-brown to pinkish-white
Leaves: 15-25 leaflets each, 3-6/whorl
Leaf Tips: appear “clipped”

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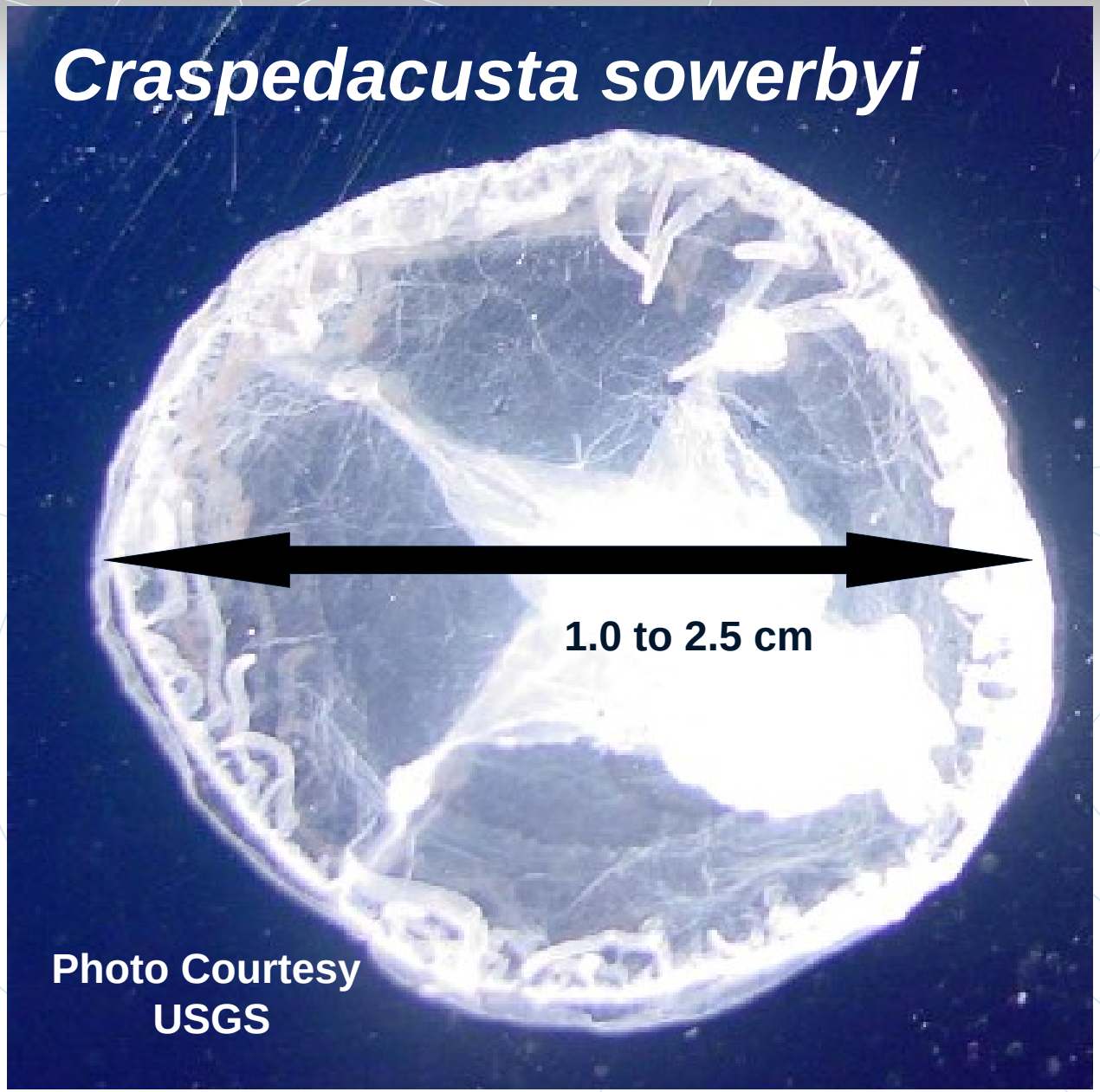
Bryozoan colony

Photo Courtesy
Chris Gnau, Topeka, KS


Craspedacusta sowerbyi
1.0 to 2.5 cm
Photo Courtesy
USGS

And…Last But Not Least….Alligators!

Have been found in 2010 at Wolf Creek Lake (Coffey Co. Lake)

And Now…The Riddle

Any Guesses?

What is green…….
and smells like red paint?

Edward Carney – Environmental Scientist
Lake and Wetland Monitoring Program
KDHE Bureau of Environmental Field Services
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785-296-5575

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