Pre-AP Biology Summer Assignment 2017-18

Paradise High School, Mrs. Wood, lwood@pisd.net or laura.wood8118@gmail.com

Welcome to Pre-AP Biology! I am excited to get a jump on the upcoming school year. These assignments will help us get a head start on the curriculum and lay the foundation before school starts. If you have any questions, please email me.

Supplies – bring first day of school
Composition notebook (no spirals) – left in class
Folder
Pencils/Pens
Map pencils or markers or colored pens
2 packages of notecards

1 – Create an account on EDPuzzle and watch 5 videos and answer questions. Go to edpuzzle.com, sign up as a student and use code – jawselk – to join the summer biology class. ***Due the first day of school.***

2 - Read 3 selected articles and take notes on each one using Cornell note taking style. The student must handwrite the notes and turn them in the ***first day of school.*** You can find links on my webpage to help you with the method of Cornell note taking.

3 - Studying the language of science is like learning a new language. Biology is largely comprised of Latin, so you will need to learn the following prefixes, suffixes, and roots from the next two pages. Study the attached list. Pay particular attention to the words used in the videos. These are a part of our first unit. There will be a ***Prefix, Suffix, and Vocab Test the second week of school.***

4. Using the list from the following two pages, construct 20 words by combining prefixes and suffixes. Each word must be followed by a definition of what the word means. Your words do not have to be real words. You can have as many prefixes/suffixes in the word as you like. Example: Chlorophobia- fear of the color green. ***Due the first day of school***.

Scientific Root Words, Prefixes, And Suffixes

a-, an-	not, without, lacking, deficient
ab-	away from, out from
-able	capable of
ac-	to, toward
-aceous	of or pertaining to
acou-, acous-	hear
ad-	to, toward
aden-	gland
adip-	fat
aero-	air
agri-	field, soil
-al	having the character of
alb-	white
alg-, -algia	pain
alto-	high
ambi-	both
ameb-	change, alternation
amni-	fetal membrane
amphi-, ampho-	both
amyl-	starch
ana-	up, back, again
andro-	man, masculine
anemo-	wind
ang-	choke, feel pain
angi-	blood, vessel, duct
ante-	before, ahead of time
anter-	front
antho-	flower
anti-	against, opposite
antrhopo-	man, human
-ap-, -aph-	touch
apo-, ap-	away from
aqu-	water
archaeo-	primitive, ancient
-ary, -arium	denotes a place for something
arteri-	artery
arthr-	joint, articulation
-ase	forms names of enzymes
aster-, astr-	star
-ate	verb form – the act of
anther-	fatty deposit
-ation	noun form – the act of
atmo-	vapor
audi-	hear
aur-	ear
auto-	self
bacter-, bactr-	bacterium, stick, club
barb-	beard
baro-	weight
bath-	depth, height
bene-	well, good
bi- (Latin)	two twice
bi-, bio- (Greek)	life, living
-blast-	sprout, germ, bud
brachi-	arm
brachy-	short
brady-	slow
branchi-	fin
brev-	short
bronch-	windpipe
cac-.	bad
calor-	heat
capill-	hair
capit-	head
carcin-	cancer
cardi-	heart
carn-	meat, flesh
carp-	fruit
carpal-	wrist
cata-	breakdown, downward
caud-	tail
-cell-	chamber, small room
cen-, cene-	now, recent
cente-	pierce
centi-	hudredth
centr-	center
cephal-	head
cerat-	horn
cerebr-	brain
cervic-	neck
chel-	claw
chem-	dealing with chemicals
chir-	hand
chlor-	green
chondr-	cartilage
chrom-, -chrome	color
chron-	time
-chym-	juice
-cid-, -cis-	cut, kill, fall
circa-, circum-	around, about
cirru-	hairlike curls
co-	with, together
cocc-	seed, berry
coel-	hollow
coll-	glue
coni-	cone
contra-	against
corp-	body
cort-, cortic-	outer layer
cosmo-	world, order, form
cotyl-	cup
counter-	against
cranl-	skull
cresc-, cret-	begin to grow
crypt-	hidden, covered
-cul-, -cule	small, diminutive
cumul-	heaped
cuti-	skin
cyan-	blue
-cycle, cycl-	ring, circle
-cyst-	sac, pouch, bladder
cyt-, -cyte	cell, hollow container
dactyl-	finger
de-	away from, down
deca-	ten
deci-	tenth
deliquesc-	become fluid
demi-	half
dendr-	tree
dent-	tooth
derm-	skin
di-, dipl- (Latin)	two, double
di-, dia- (Greek)	through, across, apart
dia- (Latin)	day
digit-	finger, toe
din-	terrible
dis-	apart, out
dorm-	sleep
dors-	back
du-, duo-	two
-duct	lead
dynam-	power
dys-	bad, abnormal, difficult
ec-	out of, away from
echin-	spiny, prickly
eco-	house
ecto-	outside of
-elle	small
-emia	blood
en-, endo-, ent-	in, into, within
-en	made of
encephal-	brain
enter-	intestine, gut
entom-	insects
-eous	nature of, like
epi-	upon, above, over
-err-	wander, go astray
erythro-	red
-escent	becoming
eso-	inward, within, inner
eu-	well, good, true, normal
eury-	widen
ex-	out of, away from
extra-	beyond, outside
-fer-	bear, carry, produce
ferro-	iron
fibr-	fiber, thread
-fid, fiss-	split, divided into
-flect, -flex	bend
flor-	flower
flu-,fluct-,flux	flow
foli-	leaf
fract-	break
-gam-	marriage
gastr-	stomach
geo-	land, earth
-gen, -gine	producer, former
-gene-	origin, birth
-gest-	carry, produce, bear
-glen-	eyeball
-glob-	ball, round
gloss-	tongue
gluc-, glyc-	sweet, sugar
glut-	buttock
gnath-	jaw
-gon	angle, corner
-grad-	step
-gram, graph	record, writing
grav-	heavy
-gross-	thick
gymno-	naked, bare
gyn-	female
gyr-	ring, circle, spiral
-hal-, -hale	breathe, breath
halo-	salt
hapl-	simple
hector-	hundred
-helminth-	worm
hem-	blood
hemi-	half
hepar-, hepat-	liver
herb-	grass, plants
hetero-	different, other
hex-	six
hibern-	winter
hidr-	sweat
hipp-	horse
hist-	tissue
holo-	entire, whole
homo- (Latin)	man, human
homo- (Greek)	same, alike
hort-	garden
hydr-	water
hygr-	moist, wet
hyper-	above, beyond over
hyph-	weaving, web
hyphno-	sleep
hypo-	below, under, less
hyster-	womb, uterus
-iae	person afflicted with disease
-iasis	disease, abnormal condition
-ic	(adjective former)
-chthy-	fish
ign-	fire
in-, il-, im-, ir-	not
in-, il-, im-, ir-	to, toward, into
in-	very, thoroughly
-ine	of or pertaining to
infra-	below, beneath
inter-	within, inside
intra-	between
-ism	a state or condition

iso-	equal, same
-ist	person who deals with
-it is	inflammation, disease
-ium	refers to a part of the body
-kary-	cell nucleus
kel-	tumor, swelling
kerat-	horn
kilo-	thousand
kine-	move
lachry-	tear
lact-	milk
lat-	side
leio-	smooth
-less	without
leuc-, leuk-	white, bright, light
lign-	wood
lin-	line
lingu-	tongue
lip-	fat
lith-, -lite	stone, petrifying
loc-	place
-log-	word, speech
-logist	one who studies
-logy	study of
lumin-	light
-lys, -lyt, -lyst	decompose, split, dissolve
macr-	large
malac-	soft
malle-	hammer
mamm-	breast
marg-	border, edge
mast-	breast
med-	middle
meg-	million, great
mela-, melan-	black, dark
-mer	part
mes-	middle, half, intermediate
met-, meta-	between, along, after
-meter, -metry	measurement
micro-	small, millionth
milli-	thousandth
mis-	wrong, incorrect
mito-	thread
mole-	mass
mono-	one, single
mort-	death
mot-	move
morph-	shape, form
multi-	many
mut-	change
my-	muscle
myc-	fungus
mycel-	threadlike
myriad-	many
moll-	soft
nas-	nose
necr-	corpse, dead
nemat-	thread
neo-	new, recent
neprho-	kidney
-ner-	moist, liquid
neur-	nerve
noct-, nov-	night
-node	knot
-nom-, -nomy	ordered knowledge, law
non-	not
not-	back
nuc-	center
ob-	against
ocul-	eye
oct-	eight
odont-	tooth
-ond	form, appearance
olf-	smell
oligo-	few, little
-oma	abnormal condition, tumor
omni-	all
onc-	mass, tumor
oo-	egg
opthalm-	eye
opt-	eye
orb-	circle, round, ring
-orium, -ory	place for something
ornith-	bird
orth-	straight, correct, right
oscu-	mouth
-osis	abnormal condition
oste-	bone
oto-	ear
-ous	full of
ov-	egg
oxy-	sharp, acid, oxygen
pachy-	thick
paleo-	old, ancient
palm-	broad, flat
pan-	all
par-, para-	beside, near, equal
path-, -pathy	disease, suffering
-ped-	foot
-ped-	child
pent-	five
per-	through
peri-	around
permea-	pas, go
phag-	eat
pheno-	show
-phil-	loving, fond of
phon-, -phone	sound
-phore,, pher-	bear, carry
photo-	light
phren-	mind, diaphragm
phyc-	seaweed, algae
phyl-	related group
-phyll	leaf
physic-	nature, natural qualities
phyt-, phyte	platn
pino-	drink
pinni-	feather
plan-	roaming, wandering
plasm-, -plast-	form, formed into
platy-	flat
pleur-	lung, rib, side
pneumo-	lungs, air
-pod	foot
ply-	many, several
por-	opening
port-	carry
post-	after, behind
pom	fruit
pre-	before, ahead of time
prim-	first
pro-	forward, favoring, before
p[roto-	first, primary
pseudo-	false, deceptive
psych	mind
pter-	having wings or fins
pulmo-	lung
puls-	drive, push
pyr-	heat, fire
quadr-	four
quin-	five
radi-	ray
re-	again, back
rect-	right, correct
ren-	kidney
ret-	net, made like a net
rhag-, -rrhage	burst forth
rhe-, rrhea	flow
rhin-	nose
rhiz-	root
rhodo-	rose
roto-	wheel
rubr-	red
sacchar-	sugar
sapr-	rotten
sarc-	flesh
saur-	lizard
schis-, schiz-	split, divide
sci-	know
scler-	hard
-scop-	look, device for seeing
-scribe, -script	write
semi-	half, partly
sept-	partition, seven
-septic	infection, putrefaction
sess-	sit
sex-	six
-sis	condition, state
sol-	sun
solv-	loosen, free
som-, somat-, -some	body
somn-	sleep
son-	sound
spec-, spic-	look at
-sperm-	seed
-spher-	ball, round
spir-, -spire	breathe
-spor-	seed
stat-, -stasis	standing, placed, staying
stell-	stars
sten-	narrow
stern-	chest, breast
stom-, -stome	mouth
strat-	strat
stereo-	solid, 3-dimensional
strict-	drawn tight
styl-	pillar
sub-	under, below
super-, sur-	over, above, on top
sym-, syn-	together
tachy-	quick, swift
tarso-	ankle
tax-	arrange, put in order
tele-	far off, distant
telo-	end
terr-	earth, land
tetr-	four
thall-	young shoot
-the-, -thes-	put
-thel-	cover a surface
therm-	heat
-tom-	cut, slice
toxico-	poison
top-	place
trache-	windpipe
trans-	across
tri-	three
trich-	hair
-trop-	turn, change
-troph-	nourishment, one who feels
turb-	whirl
-ul-, -ule	diminutive, small
ultra-	beyond
uni-	one
ur-	urine
-ura	tail
vas-	vessel
vect-	carry
ven-, vent-	come
ventr-	belly, underside
-verge	turn, slant
vig-	strong
vit-, viv-	life
volv-	roll, wander
-vor-	devour, eat
xanth-	yellow
xero-	dry
xyl-	wood
zo-, -zoa	animal
zyg-	joined together
zym-	yeast

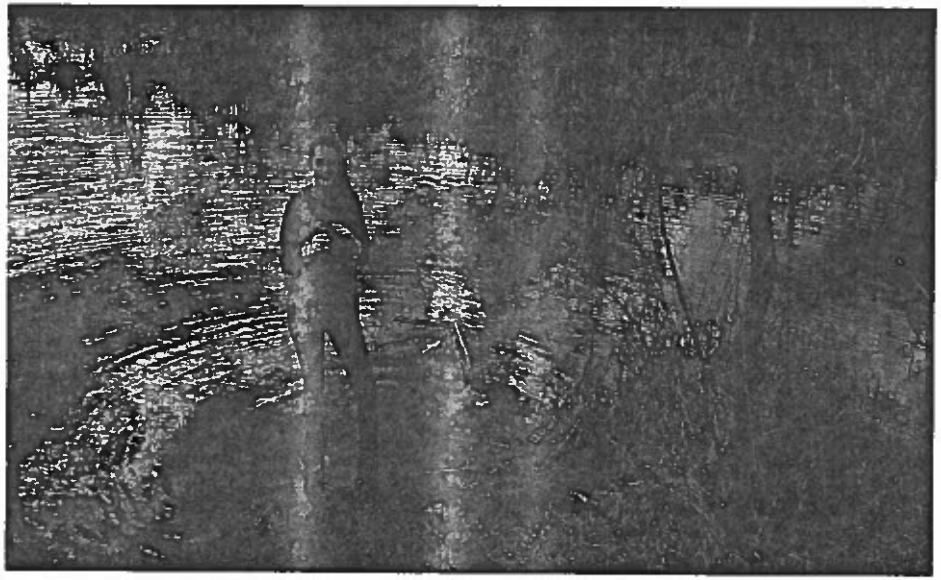
ScienceNews for Students

ENVIRONMENT YOUNG SCIENTISTS ALGAE & FUNGI SUSTAINABILITY

Fighting big farm pollution with a tiny plant

A teen tackles lake pollution with local duckweed

BY BETHANY BROOKSHIRE JUN 15, 2016 — 7:00 AM EST



Julia Hunckler collects local duckweed for her experiments. The teen studied whether the tiny plants could sop up fertilizer pollution.
J. Hunckler

PHOENIX, Ariz. — Sometimes a tap water ban can prove a scientific wakeup call.

When Toledo, Ohio told (http://www.nytimes.com/2014/08/05/us/lifting-ban-toledo-says-its-water-is-safe-to-drink-again.html) its residents not to drink tap water in 2014, Julia Hunckler, 17, took notice. This Marian High School junior lived across the state line in Mishawaka, Ind. The Ohio ban was due to toxins in Lake Erie. A summer bloom (http://www.nytimes.com/2013/03/15/science/earth/algae-blooms-threaten-lake-erie.html?version=meter+at+0&module=meter-Links&pgtype=article&contentId=&mediaId=&referrer=https%3A%2F%2Fwww.google.com%2&links-click) of algae had tainted the lake, which was used as a source of drinking water. Chemical fertilizers that washed off of nearby farms had been running into the lake. There, aquatic toxin-makers got a growth boost from the fertilizer. Julia decided to scout for something that might remove that algae booster. Her solution: a tiny freshwater plant.

Called duckweed, it indeed slurped up fertilizer. Later, that duckweed can be harvested as feed for local cows, Julia says.

The teen presented her findings, here, last month at the 2016 Intel International Science & Engineering Fair. Created by Society for Science & the Public and sponsored by Intel, this competition brought together more than 1,700 students from 75 countries to show off their science fair projects. (The Society also publishes *Science News for Students*.)

Farmer's and gardeners fertilize their plants by feeding them extra growth-boosting *nitrogen* and *phosphorus*. But not all of the fertilizer stays in the plants or the soil around their roots. Some runs off in the rain, flowing into streams, rivers and lake — including Lake Erie.

Scientists Say: Eutrophication (https://student.societyforscience.org/blog/eureka-lab/scientists-say-eutrophication)

Those extra nutrients will fuel the growth of water organisms, too. Especially algae. Water rich in nutrients can cause these aquatic organisms to reproduce rapidly, or *bloom*. Because the algae float on the surface, those blooms can cut off sunlight to plants living below, causing some to die. Underwater plants produce oxygen. So their dying can cut oxygen levels in the water. As algae on the water surface also eventually die, bacteria will break them down. These microbes may then use up the remaining oxygen in the water. This oxygen-depleting cycle is known as *eutrophication*. And where it occurs there may be little oxygen left over for animals, such as fish.

But that may not be the only problem. Some types of algae are toxic (https://student.societyforscience.org/article/eating-toxic-algae-makes-plankton-speedy-swimmers). They produce one or more poisons that can harm fish. Those same toxins can poison people in the towns that rely on the lake for drinking water. That's why Toledo had to warn residents not to drink their tap water.

"When I heard about the algae blooms in Lake Erie, I wanted to do something," Julia says. She decided to focus on the source of the problem: the fertilizer. And it occurred to her that the tiny duckweed might be up to the job.

Turning to duckweed

Each plant is very small. Its tiny fronds run only 2 to 5 millimeters (0.08 to 0.2 inch) long. That's less than half the length of a grain of rice. Each set of fronds has a single root that extends down into the water. Duckweed tends to grow in clusters that form dense mats at the surface.

This plant needs nitrogen and phosphorus, just as the algae do. Julia reasoned that duckweed might soak up some of phosphorus from fertilizer *runoff* before it reached the algae.

To test this, she filled nine glass containers with water and then added phosphorus. To figure out just how much phosphorus to add, Julia used a test kit from her local pet store. Adding the kit's chemicals to a water sample will turn it blue when phosphorus is present. Light blue signals a tiny amount. Dark blue points to a lot.

In three glasses, Julia added enough phosphorus to create the darkest blue possible. In three more, she added only enough to create the slightest blue tint. Then she added 50 duckweed plants from her local pond to each of the glasses. Three final glasses served as her *controls*. One had duckweed, but no phosphorus. The other two had no duckweed at all, just high or low levels of phosphorus.

After waiting 25 days, Julia carefully counted the number of fronds on each duckweed plant. She also measured the length of each plant's root. Her goal was to tally how much each had grown. She also tested how much phosphorus remained in each glass of water.

Duckweed pulled the phosphorus out of both the high- and low-phosphorus water samples. In the process, the plants also "grew really, really fast," Julia says. "I realized that this could cause a problem in the future if all of a sudden Lake Erie had a ton of duckweed." After all, surface mats of duckweed can block out sunlight just as the algae can.

So the teen did more reading. She soon learned that duckweed is a nutritious food for cattle. All farmers would need to do is scoop it off the water. "Since it is easy to harvest, farmers could use the duckweed to feed to their cattle," she concludes.

So far, the teen has data only from those nine cups of water. Eventually, she'd like to do experiments in Lake Erie itself. But first, she says, she's got to get more data — and more duckweed.

Power Words

(for more about Power Words, click here (https://student.societyforscience.org/power-words-aid-stem-literacy))

algae Single-celled organisms, once considered plants (they aren't). As aquatic organisms, they grow in water. Like green plants, they depend on sunlight to make their food.

bloom (in microbiology) The rapid and largely uncontrolled growth of a species, such as algae in waterways enriched with nutrients.

control A part of an experiment where there is no change from normal conditions. The control is essential to scientific experiments. It shows that any new effect is likely due only to the part of the test that a researcher has altered. For example, if scientists were testing different types of fertilizer in a garden, they would want one section of it to remain unfertilized, as the *control*. Its area would show how plants in this garden grow under normal conditions. And that give scientists something against which they can compare their experimental data.

eutrophication The process by which a body of water becomes full of nutrients, which then stimulates the excessive growth of plants and algae. When these organisms die, bacteria break them down. But this bacterial activity can temporarily use up much of the water's dissolved oxygen. Without too little oxygen, animals can suffer — even suffocate. In short order, a eutrophic ecosystem can collapse.

frond A leaf or leaf-like structure that itself consists of many almost-leaf-like appendages. Good examples include the leafy structures of palms and ferns.

fertilizer Nitrogen, phosphorus and other plant nutrients added to soil, water or foliage to boost crop growth or to replenish nutrients that removed earlier by plant roots or leaves.

nitrogen A colorless, odorless and nonreactive gaseous element that forms about 78 percent of Earth's atmosphere. Its scientific symbol is N. Nitrogen is released in the form of nitrogen oxides as fossil fuels burn.

nutrient A vitamin, mineral, fat, carbohydrate or protein that a plant, animal or other organism requires as part of its food in order to survive.

phosphate A chemical containing one atom of phosphorus and four atoms of oxygen. It is a component of bones, hard white tooth enamel, and some minerals such as apatite.

phosphorus A highly reactive, nonmetallic element occurring naturally in phosphates. Its scientific symbol is P. It is an important part of many chemicals and structures that are found in cells, such as membranes, and DNA.

runoff The water that runs off of land into rivers, lakes and the seas. As that water travels over land, it picks up bits of soil and chemicals that it will later deposit as pollutants in the water.

toxic Poisonous or able to harm or kill cells, tissues or whole organisms. The measure of risk posed by such a poison is its toxicity.

toxin A poison produced by living organisms, such as germs, bees, spiders, poison ivy and snakes.

Readability Score:

6.2

NGSS:

- MS-LS2-2
- MS-LS2-3
- MS-ESS3-3
- MS-ESS3-4
- HS-ESS3-3
- MS-LS2-1
- MS-ETS1-1
- HS-LS2-6
- HS-LS2-7
- HS-ESS3-1
- HS-ESS3-4
- HS-ETS1-2

Source URL: https://www.sciencenewsforstudents.org/article/fighting-big-farm-pollution-tiny-plant

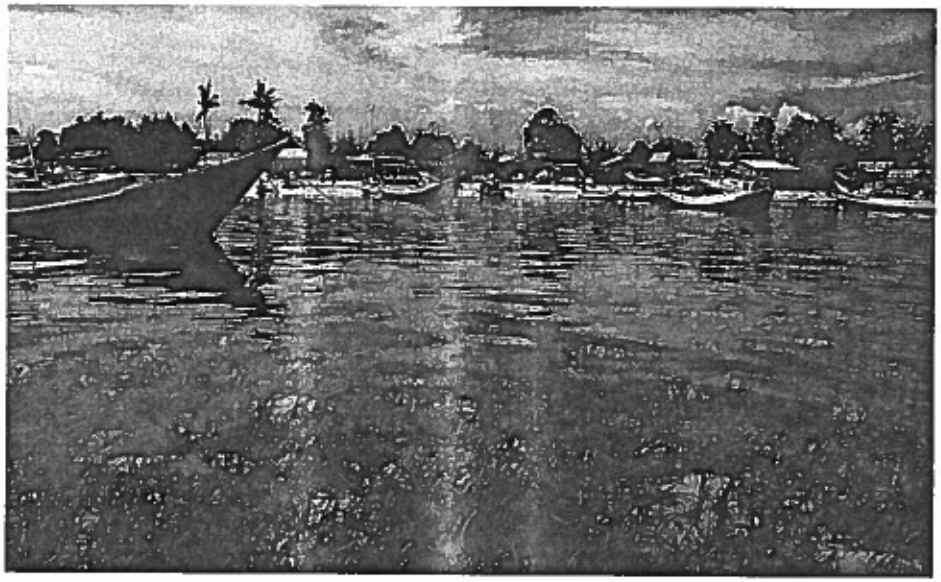
ScienceNews for Students

ECOSYSTEMS OCEANS MICROBES

Underwater meadows appear to fight ocean germs

Seagrasses limit near-shore bacteria to help keep aquatic neighbors healthy, new data show

BY LAUREL HAMERS FEB 19, 2017 — 12:52 PM EST



Seagrasses, like those seen here, grow in shallow seas. They also help the environment by reducing the level of harmful germs in the surrounding water.

Joleah Lamb

BOSTON, Mass. — Want a lawn that needs no mowing and helps the environment? Look no further than the coastal ocean. Meadows of underwater seagrasses lower the amounts of harmful bacteria that can be found in coastal waters. That's the finding of a new study reported here, February 16, at the annual meeting of the American Association for the Advancement of Science.

The findings suggest that nurturing healthy seagrass beds throughout coastal waters could make the whole ecosystem healthier — from corals and fish to people.

Seagrasses are not truly grasses. They are flowering plants with long, narrow leaves. Found in shallow ocean waters, they can spread to form vast underwater lawns. These plants are "a marine powerhouse, almost equal to the rainforest," says says Joleah Lamb, an author of the study. "They're one of the largest stores of carbon in the ocean," the ecologist says. "But they don't get a lot of attention," she adds. Lamb works at Cornell University, in Ithaca, N.Y.

It's no secret that seagrasses improve water quality, says James Fourqurean. He's a biologist at Florida International University in Miami and wasn't involved in the research.

Scientists had known these plants are great at removing excess nitrogen and phosphorus from coastal waters. Those are nutrients that often run off of the land, polluting coastal waters. Now, it seems, seagrasses might take away harmful germs, too. Lamb's team describes its findings in the February 17 *Science*.

What pointed them to the value of these plants

A few years ago, Lamb's colleagues became ill while studying coral reefs in Indonesia. This archipelago nation straddles the Indian and Pacific oceans. When a city or village on one of the country's thousands of islands dumps raw sewage into the ocean, shoreline bacteria populations can spike to dangerous levels. So dangerous, in fact, that they gave Lamb's colleagues a serious diarrheal disease known as amoebic (Uh-MEE-bik) dysentery.

Water sampled close to the shore off of four small and densely populated islands there had 10 times as many *Enterococcus* bacteria as the U.S. Environmental Protection Agency deems an acceptable limit. These germs can cause illness in people. Moreover, their presence often signals the likelihood that other disease-causing germs also may be around. But water collected from *tidal flats* and coral reefs that hosted healthy seagrass beds had far lower levels of the bacteria than did similar sites fewer than 20 meters away. The difference between these sites? The germy ones had no seagrasses!

The water where seagrasses grew also had lower levels of numerous bacterial species that can make fish and marine *invertebrates* (such as corals) sick. And surveys of more than 8,000 coral heads showed that those growing next to or inside seagrass beds had fewer diseases than those growing farther away.

(*Story continues below image*)

Corals that live near seagrasses showed less disease than did those farther away. The water also contained lower levels of bacteria that could sicken fish and other marine animals.
Margaux Hein

It's unclear how far from seagrass beds this cleaner water extends. But the plants' benefits can ripple through the entire ecosystem, Lamb said at the news conference at the AAAS meeting. What's more, healthier corals help protect nearby islands from erosion. And fish hosting fewer bacteria make a healthier source of food for people.

Lamb is now planning follow-up studies. She hopes they will show her exactly how these ocean plants clean the water. Like a shag carpet, seagrasses can trap small drifting *particulates*. This trapping can keep those pollutant bits from flowing on. The plants might ensnare bacteria in the same way, building up *biofilms* on their blades. Or, she suggests, the leaves could be giving off some germ-killing compounds.

The new findings are one more reason to conserve seagrasses, study coauthor Jeroen van de Water said at the meeting. He's an ecologist at the Scientific Center of Monaco. Globally, seagrass beds are declining by 7 percent each year. Both pollution and habitat loss are contributing to their loss. Efforts are underway in some areas to restore these underwater lawns. Still, Lamb argues, "it's better to stop what we're doing to the meadows than to try to replant them." Indeed, she points out: "It's hard to start doing restoration projects if the environment isn't exactly what the seagrass prefers."

Power Words

(for more about Power Words, click here (https://student.societyforscience.org/power-words-aid-stem-literacy))

annual Adjective for something that happens in every year. (In botany) A plant that lives only one year, so it usually has a showy flower and produces many seeds.

archipelago A group of islands, many times forming in an arc across a broad expanse of the oceans. The Hawaiian Islands, the Aleutian Islands and the more than 300 islands in the Republic of Fiji are good examples.

bacterial Having to do with bacteria, single-celled organisms. These dwell nearly everywhere on Earth, from the bottom of the sea to inside animals.

biofilm A gooey community of different types of microbes that essentially glues itself to some solid surface. Living in a biofilm is one way microbes protect themselves from stressful agents (such as poisons) in their environment.

carbon The chemical element having the atomic number 6. It is the physical basis of all life on Earth. Carbon exists freely as graphite and diamond. It is an important part of coal, limestone and petroleum, and is capable of self-bonding, chemically, to form an enormous number of chemically, biologically and commercially important molecules.

coauthor One of a group (two or more people) who together had prepared a written work, such as a book, report or research paper. Not all coauthors may have contributed equally.

colleague Someone who works with another; a co-worker or team member.

compound (often used as a synonym for chemical) A compound is a substance formed from two or more chemical elements united in fixed proportions. For example, water is a compound made of two hydrogen atoms bonded to one oxygen atom. Its chemical symbol is H_2O.

conserve To protect, as from loss or degradation.

coral Marine animals that often produce a hard and stony exoskeleton and tend to live on the exoskeletons of dead corals, called reefs.

ecology A branch of biology that deals with the relations of organisms to one another and to their physical surroundings. A scientist who works in this field is called an **ecologist.**

ecosystem A group of interacting living organisms — including microorganisms, plants and animals — and their physical environment within a particular climate. Examples include tropical reefs, rainforests, alpine meadows and polar tundra.

environment The sum of all of the things that exist around some organism or the process and the condition those things create for that organism or process. Environment may refer to the weather and ecosystem in which some animal lives, or, perhaps, the temperature, humidity and placement of components in some electronics system or product.

Environmental Protection Agency (or EPA) An agency of the U.S. government that is charged with helping create a cleaner, safer and healthier environment in the United States. Created on Dec. 2, 1970, it reviews data on the possible toxicity of new chemicals (other than food or drugs, which are regulated by other agencies) before they are approved for sale and use. Where such chemicals may be toxic, it sets rules on how much may be used and where it may be used. It also sets limits on the release of pollution into the air, water or soil.

erosion (v. erode) The process that removes rock and soil from one spot on Earth's surface, depositing it elsewhere. Erosion can be exceptionally fast or exceedingly slow. Causes of erosion include

wind, water (including rainfall and floods), the scouring action of glaciers and the repeated cycles of freezing and thawing that occur in many areas of the world.

germ Any one-celled microorganism, such as a bacterium, fungal species or virus particle. Some germs cause disease. Others can promote the health of higher-order organisms, including birds and mammals. The health effects of most germs, however, remain unknown.

habitat The area or natural environment in which an animal or plant normally lives, such as a desert, coral reef or freshwater lake. A habitat can be home to thousands of different species.

invertebrate An animal lacking a backbone. About 90 percent of animal species are invertebrates.

marine Having to do with the ocean world or environment.

nitrogen A colorless, odorless and nonreactive gaseous element that forms about 78 percent of Earth's atmosphere. Its scientific symbol is N. Nitrogen is released in the form of nitrogen oxides as fossil fuels burn.

nutrient A vitamin, mineral, fat, carbohydrate or protein that a plant, animal or other organism requires as part of its food in order to survive.

Pacific The largest of the world's five oceans. It separates Asia and Australia to the west from North and South America to the east.

phosphorus A highly reactive, nonmetallic element occurring naturally in phosphates. Its scientific symbol is P. It is an important part of many chemicals and structures that are found in cells, such as membranes, and DNA.

rainforest Dense forest rich in biodiversity found in tropical areas with consistent heavy rainfall.

reef A ridge of rock, coral or sand. It rises up from the seafloor and may come to just above or just under the water's surface.

seagrass The name is a misnomer because these are not grasses, but flowering underwater plants. Like land plants, seagrasses use photosynthesis to power the production of food and the release of oxygen. Some 60 different species can be found around the world. How deeply they can grow tends to depend on how clear the water is, and therefore how far down the sunlight can penetrate.

sewage Wastes — primarily urine and feces — that are mixed with water and flushed away from homes through a system of pipes for disposal in the environment (sometimes after being treated in a big water-treatment plant).

species A group of similar organisms capable of producing offspring that can survive and reproduce.

survey (v.) To ask questions that glean data on the opinions, practices (such as dining or sleeping habits), knowledge or skills of a broad range of people. Researchers select the number and types of people questioned in hopes that the answers these individuals give will be representative of others who are their age, belong to the same ethnic group or live in the same region. (n.) The list of questions that will be offered to glean those data.

tidal flat A broad and flat area that usually has a muddy or rocky bottom. It gets its name from the fact that it becomes covered by sea water every time the tide comes in — then drains again when the tide goes out.

Readability Score:
8.1
NGSS:

ScienceNews for Students

ECOSYSTEMS ANIMALS PLANTS

Under blanket of ice, lakes teem with life

There's more going on under frozen lakes than researchers once believed

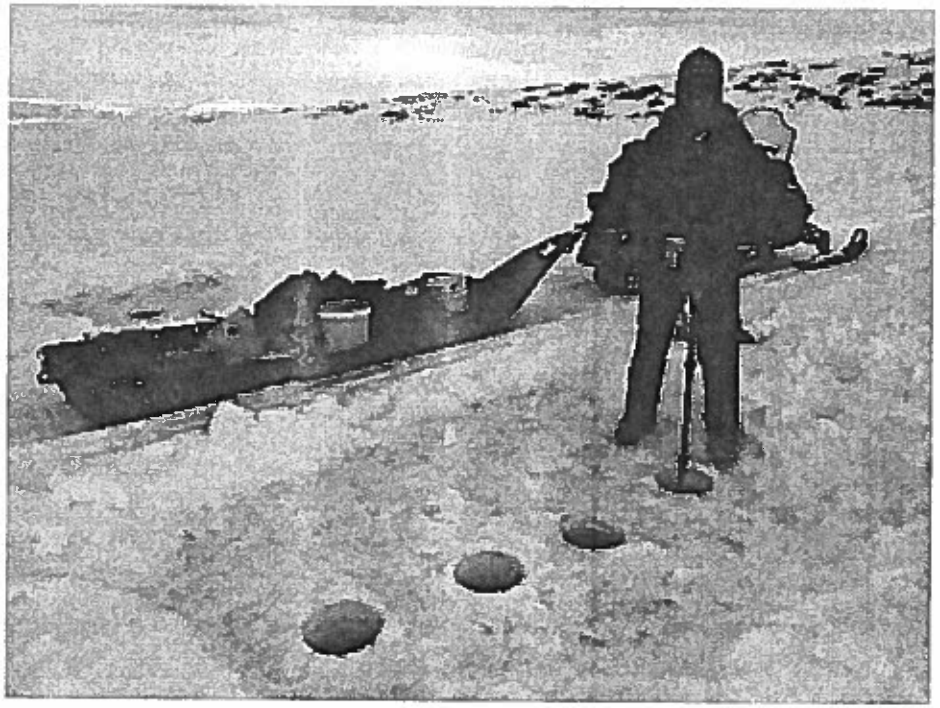
BY SHARON OOSTHOEK FEB 14, 2017 — 7:10 AM EST

The brownish tinge that looks a lot like mud on the ice here, in Lake Erie, is something else. That "mud" is in fact billions of microscopic algae living on the underside of the ice. They're a crucial part of the lake's food web.

Michael Twiss

Frozen lakes are quiet places. Snow muffles sound. Boaters stay home. Animals do not visit for a drink. For a long time, scientists also thought nothing much was going on below the ice.

Turns out they were wrong.



For a study led by aquatic ecologist Stephanie Hampton, some researchers pulled their sampling equipment on sleds and snowmobiles. This researcher is sampling ice in Toolik Lake, Alaska.
Steve Sadro

Many plants, animals and other forms of life hibernate or go dormant in winter. But new research shows that a surprising number remain active in cold months. In fact, some organisms only spring to life once a lake freezes over. Many others survive only by clinging to the ice's underside.

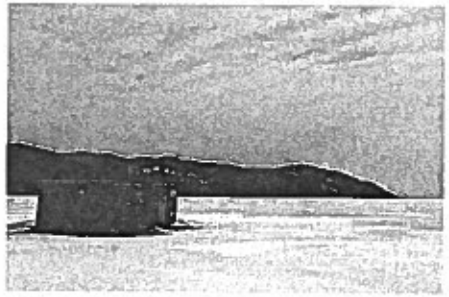
To probe what goes on in these cold worlds, Stephanie Hampton gathered a team of more than 60 scientists from around the world who study freshwater (not salty) lakes. Hampton works at Washington State University in Pullman. As an aquatic ecologist there, she studies how water organisms relate to each other and to their surroundings.

Together, Hampton and her team analyzed more than 100 lakes during several recent winters. These bodies of water were scattered across the Northern Hemisphere and Antarctica. Their work represents the first in-depth survey of a large group of ice-covered freshwater lakes. And what they found surprised even them.

"None of us," Hampton says, "expected life under the ice to be as abundant and diverse as it is."

Scientists braved tough conditions

Gathering the new data wasn't easy. The researchers braved the cold and risked plunging through frozen lakes to collect their data. Some scientists towed rowboats behind them as they trudged across lakes, so they could hop in if the ice started to crack. Others camped out in temporary huts that they built on very thick ice. Still others ventured out onto frozen lakes on snowmobiles or aboard icebreaker boats. (The good news: No one fell through the ice, notes Hampton.)



You can't see them, but there are researchers huddled inside these huts on Lake Baikal in Russia. They have drilled a hole in the ice floor of the hut, where they can take samples while staying out of the wind.
Ted Ozersky

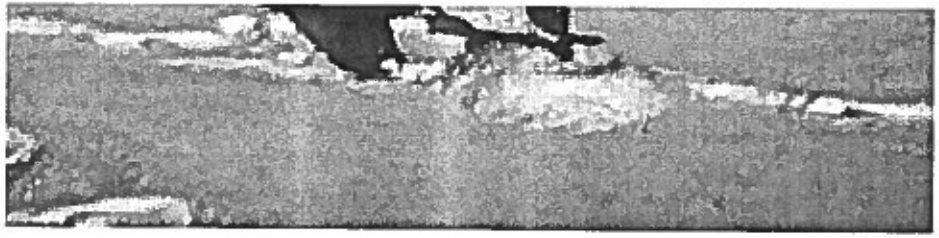
The researchers carried augers to drill holes through the ice, bottles for collecting the frigid water underneath and buckets for storing chunks of ice. They brought all of these lake samples back to their labs for study.

From there, they calculated how much algae and zooplankton had been growing beneath the winter ice. Algae are aquatic organisms. Zooplankton are tiny aquatic animals that eat algae. (Fish and other lake animals, in turn, eat zooplankton.)

In some lakes, researchers found winter concentrations of algae and zooplankton were higher than what had been present in summer. But those were rare cases. While each lake differed, the average amount of algae growing under the ice tended to be less than one-sixth of summer levels. And much of that algae had been clinging to the underside of the ice.

Winter zooplankton levels were, on average, about a third of summertime levels. Unlike algae, zooplankton float freely within the frigid ice-capped water.

The winter levels "may not sound like a lot," Hampton says. Still, it was higher than expected and "shows lakes are still alive under the ice," she says. This matters because many freshwater lakes are losing their ice cover. Climate change has been warming Earth's air and water. Lakes no longer freeze as much as they did in the past. The ice also may not be as thick or last as long.



A researcher uses an auger to drill through the ice in Lake Erken, Sweden.
Gesa Weyhenmeyer

What happens if there is no ice for algae to cling onto? Does that mean less winter food for the zooplankton? And could that mean fewer zooplankton for fish to dine on during the winter?

Hampton's team can't say yet. So far, they know only what current conditions are. But that information gives them a baseline — a starting point — against which they can compare future conditions.

"No one is sure how having less ice will affect lakes. But having this baseline will help us be better prepared," says Hampton.

Understanding how climate change affects lakes is important because people rely on these bodies of water for many things, such as drinking and irrigating crops. Fish that make these lakes their home also can be an important local source of food.

Hampton and her team described their new data in the Nov. 27, 2016 *Ecology Letters*.

Ocean research offers clues to what is at stake

That new work follows in the footsteps of *marine* researchers. These are scientists who study oceans. Marine scientists started to examine life under ocean ice a few decades ago. They were the first to discover that some algae live by clinging to the bottom of floating ice.

Unlike freshwater researchers, marine scientists also discovered that a lot of ocean algae live in water trapped between ice crystals. The salt water from the ocean freezes at a lower temperature than freshwater. Tiny salt water channels form in the ice. "These channels are perfect places for algae to hang out," explains Warwick Vincent. He is an aquatic researcher at Laval University in Quebec City, Canada. He has studied both freshwater and marine ice.

"You don't see these channels in freshwater," he notes, "because there isn't enough salt in the water."

A few years after the discovery of sea-ice algae, research showed that these organisms are crucial to the ocean food web. Just as in freshwater lakes, sea-ice algae are an important food for zooplankton. Zooplankton in turn feed larger ocean creatures, such as fish and some whales.

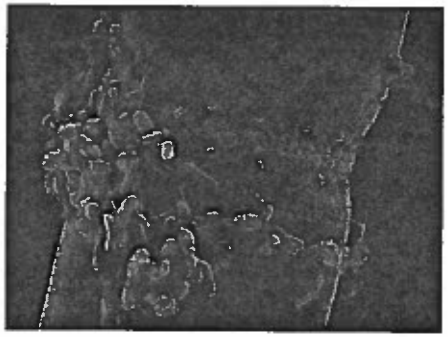
Marine researchers learned that the critical time for sea algae to grow runs from late winter to early spring. Temperatures at this point begin to rise and ice starts to thin. That thinning ice lets in more light, which the algae use to produce food from carbon dioxide and water. Through this process, called *photosynthesis*, sunlight stimulates the growth of algae.

The timing is perfect, because this is also when zooplankton begin to reproduce. It means baby zooplankton have a banquet of algae on which to feed.

But because of global warming, spring — and its balmy temperatures — has begun arriving earlier in the year. This leads to an earlier melting of the sea ice. Marine researchers worry that algae may start growing too early — before zooplankton start to reproduce. Then when zooplankton are ready for their algal feast, many of those algae may have finished growing and fallen to the bottom of the ocean.

Marine scientists don't know yet if this is happening: "I don't think there is good enough data to test this at present," says Vincent.

With early melting and less ice, zooplankton may face big troubles. That, in turn, might mean that zooplankton-loving predators — such as seabirds, fish and whales — will go hungry. For now, the scientists can't predict how losing sea-ice algae might affect zooplankton and the larger creatures that feed on them.



Researchers found this strand of cold-loving microscopic freshwater algae — known as *Stephanodiscus* — living under the ice in Lake Erie. Bacteria can be seen clinging to its surface.
Nigel D'Souza

Something similar could be happening in lakes, the freshwater scientists worry. Hampton and her team hope their baseline data will help them find out. Still, they have good reason to suspect that what happens in the winter can affect lake life the rest of the year.

This is especially true for lakes that let a lot of sunlight in through ice. This happens when frozen lakes are not covered in snow (which blocks the light.) As in the ocean, sunlight stimulates the growth of algae — which are food for zooplankton.

Until the ice melts in the spring, cold-loving algae and zooplankton are an important food source for newly hatched fish. Later, when spring arrives, the young fish can turn to algae and zooplankton that grow in warmer water.

The concern, right now, is what may happen if there is less ice throughout the winter months.

'Unusual' Lake Erie

Hampton's study is important for another reason: It is the first to compare winter and summer conditions for so many lakes, notes Stuart Jones. He works for University of Notre Dame in South

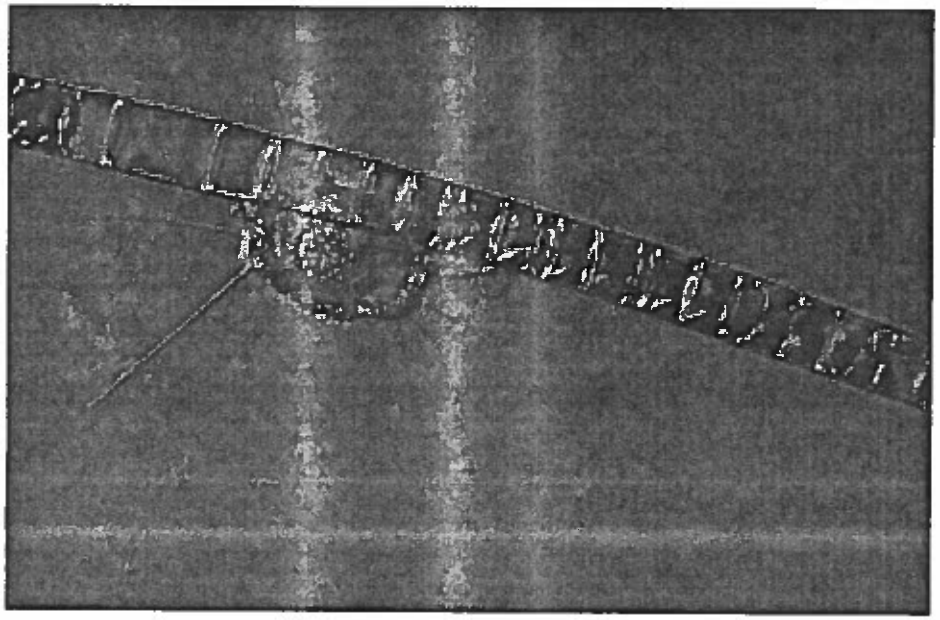
Bend, Ind. There ,he studies aquatic ecosystems. The global lakes study was able to glean "a surprisingly large amount of data through cooperation and communication across many, many research groups in many areas of the world," notes Jones.

One participant was Maggie Xenopoulos. She's an aquatic ecologist in Canada at Trent University in Peterborough, Ontario. Xenopoulos analyzed water and ice samples from Lake Erie. One of the Great Lakes, it borders both Canada and the United States.

"Lake Erie is unusual because it has a lot of winter algae," says Xenopoulos. Those algae cling to the underside of the ice, tinging it brown. This ice may look like mud and sand, she says, "but it's teeming with life."

In fact, Xenopoulos found that the amount of algae in Lake Erie during the winter can be similar to what's there in summer. This happened mostly in areas where snow rarely blankets ice.

In one 2012 study, another team showed that concentrations of winter algae can be higher than those in summer. The most common algae was a species called *Aulacoseira*. It blooms only in the winter. (A bloom is a rapid growth of something — in this case, algae.)



The empty cells in this tube-shaped algae are all that's left after the round, spiny zooplankton hovering nearby stopped by for a snack. The algae — known as *Aulacoseira* — and the hungry zooplankton were among many such types of microscopic life that researchers found under the ice in Lake Erie.
Nigel D'Souza

Previous research showed wintertime algae play an important role in Lake Erie. They consume nutrients, such as nitrogen and phosphorus. Lake Erie has unnaturally high levels of both. That's mostly because of runoff from farmers' fields. Farmers fertilize their fields to boost crop growth and yields. But crops do not absorb all of those nutrients. When it rains, the unabsorbed nitrogen and phosphorus wash (https://www.sciencenewsforstudents.org/article/ditching-farm-pollution-literally) into waterways that feed the lake.

If Lake Erie's ice declines significantly, Xenopoulos worries, so too might winter algae. Then the algae won't be around to consume their share of the lake's excess nitrogen and phosphorus. This risks boosting summer levels of those nutrients.

This is a problem because a type of photosynthetic bacteria called *cyanobacteria* springs to life as the water warms. Like algae, these bacteria feed on nitrogen and phosphorous. When there is a lot of these nutrients in the water, the bacteria can bloom, creating huge patches of blue-green scum. Some cyanobacteria produce a toxin (https://www.sciencenewsforstudents.org/article/water-sensor-quickly-detects-algal-poison) that can poison fish — and people.

Such blooms can have big consequences. Many towns and cities that surround Lake Erie get their drinking water from the lake. In August 2014, there was a very large, toxin-producing cyanobacteria bloom (https://www.sciencenewsforstudents.org/article/will-water-woes-leave-americans-thirsty) near Toledo, Ohio. To protect people, the city shut down for three days the supply of drinking water to more than 400,000 Toledo-area residents. Scientists worry that incidents like this could become more common if the winter algae decline.

"This is starting to look like a really bad story," says Xenopoulos. "If the ice isn't there, nutrients stick around to create even bigger summertime cyanobacteria blooms."

Hampton says Xenopoulos and the other team members will continue their studies. In a few years, they hope to be able to predict better the impacts of declining lake ice.

"We are losing ice very quickly right now," she says. "We really need to understand how climate change will affect lake food webs and water quality."

Power Words

(for more about Power Words, click here (https://student.societyforscience.org/power-words-aid-stem-literacy))

algae Single-celled organisms, once considered plants (they aren't). As aquatic organisms, they grow in water. Like green plants, they depend on sunlight to make their food.

Antarctica A continent mostly covered in ice, which sits in the southernmost part of the world.

aquatic An adjective that refers to water.

average (in science) A term for the arithmetic mean, which is the sum of a group of numbers that is then divided by the size of the group.

bloom (in microbiology) The rapid and largely uncontrolled growth of a species, such as algae in waterways enriched with nutrients.

carbon The chemical element having the atomic number 6. It is the physical basis of all life on Earth. Carbon exists freely as graphite and diamond. It is an important part of coal, limestone and petroleum, and is capable of self-bonding, chemically, to form an enormous number of chemically, biologically and commercially important molecules.

carbon dioxide (or CO_2) A colorless, odorless gas produced by all animals when the oxygen they inhale reacts with the carbon-rich foods that they've eaten. Carbon dioxide also is released when organic matter (including fossil fuels like oil or gas) is burned. Carbon dioxide acts as a greenhouse gas, trapping heat in Earth's atmosphere. Plants convert carbon dioxide into oxygen during photosynthesis, the process they use to make their own food.

climate The weather conditions prevailing in an area in general or over a long period.

climate change Long-term, significant change in the climate of Earth. It can happen naturally or in response to human activities, including the burning of fossil fuels and clearing of forests.

concentration (in chemistry) A measurement of how much of one substance has been dissolved into another.

crystal (adj. crystalline) A solid consisting of a symmetrical, ordered, three-dimensional arrangement of atoms or molecules. It's the organized structure taken by most minerals. Apatite, for example, forms six-sided crystals. The mineral crystals that make up rock are usually too small to be seen with the unaided eye.

cyanobacteria A type of bacteria that can convert carbon dioxide into other molecules, including oxygen.

ecology A branch of biology that deals with the relations of organisms to one another and to their physical surroundings. A scientist who works in this field is called an ecologist.

ecosystem A group of interacting living organisms — including microorganisms, plants and animals — and their physical environment within a particular climate. Examples include tropical reefs, rainforests, alpine meadows and polar tundra.

fertilizer Nitrogen, phosphorus and other plant nutrients added to soil, water or foliage to boost crop growth or to replenish nutrients that removed earlier by plant roots or leaves.

food web (also known as a food chain) The network of relationships among organisms sharing an ecosystem. M ember organisms depend on others within this network as a source of food.

freshwater A noun or adjective that describes bodies of water with very low concentrations of salt. It's the type of water used for drinking and making up most inland lakes, ponds, rivers and streams, as well as groundwater.

Great Lakes A system of five interconnected lakes — Superior, Michigan, Huron, Erie and Ontario — the Great Lakes constitute the largest freshwater source in the world (based on surface area). They hold an estimated 6 quadrillion gallons of water, or about a fifth of the world's fresh surface water. To give some perspective on that amount, the lakes' water would, if spread evenly, cover the 48 touching U.S. states to a depth of about 2.9 meters (9.5 feet) deep.

marine Having to do with the ocean world or environment.

nitrogen A colorless, odorless and nonreactive gaseous element that forms about 78 percent of Earth's atmosphere. Its scientific symbol is N. Nitrogen is released in the form of nitrogen oxides as fossil fuels burn. Nitrogen also is an important crop nutrient (and often apoplied to fields as a fertilizer).

nutrient A vitamin, mineral, fat, carbohydrate or protein that a plant, animal or other organism requires as part of its food in order to survive.

organism Any living thing, from elephants and plants to bacteria and other types of single-celled life.

photosynthesis (verb: photosynthesize) The process by which green plants and some other organisms use sunlight to produce foods from carbon dioxide and water.

predator (adjective: predatory) A creature that preys on other animals for most or all of its food.

resident Some member of a community of organisms that lives in a particular place. (Antonym: visitor)

runoff The water that runs off of land into rivers, lakes and the seas. As that water travels over land, it picks up bits of soil and chemicals that it will later deposit as pollutants in the water.

sea An ocean (or region that is part of an ocean). Unlike lakes and streams, seawater — or ocean water — is salty.

survey (v.) To ask questions that glean data on the opinions, practices (such as dining or sleeping habits), knowledge or skills of a broad range of people. Researchers select the number and types of people questioned in hopes that the answers these individuals give will be representative of others who are their age, belong to the same ethnic group or live in the same region. (n.) The list of questions that will be offered to glean those data.

toxin A poison produced by living organisms, such as germs, bees, spiders, poison ivy and snakes.

zooplankton Small organisms that drift in the sea. Zooplankton are tiny animals that eat other plankton. They also serve as an important food source for other marine creatures.

Readability Score:

7.2

NGSS:

- MS-LS1-5
- MS-LS2-2
- MS-LS2-3
- MS-LS2-4
- HS-LS2-1
- HS-LS2-2
- HS-LS2-6
- HS-LS2-7
- HS-ESS3-5
- HS-ESS3-6

Citation

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Journal: D. Kohlbach et al. The importance of ice algae-produced carbon in the central Arctic Ocean ecosystem: Food web relationships revealed by lipid and stable isotope analyses (http://onlinelibrary.wiley.com/doi/10.1002/lno.10351/full). . *Limnology and Oceanography*. Published online July 8, 2016. doi: 10.1002/lno.10351.

Journal: M.R. Twiss et al. Diatoms abound in ice-covered Lake Erie: An investigation of offshore winter limnology in Lake Erie over the period 2007 to 2010 (http://www.sciencedirect.com/science/article/pii/S0380133011002619). . *Journal of Great Lakes Research*. Vol. 38, March 2012, p. 18. doi:10.1016/j.jglr.2012.03.007.