Getting to the heart of the matter:
Communicating Ocean Acidification

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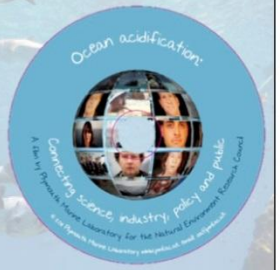
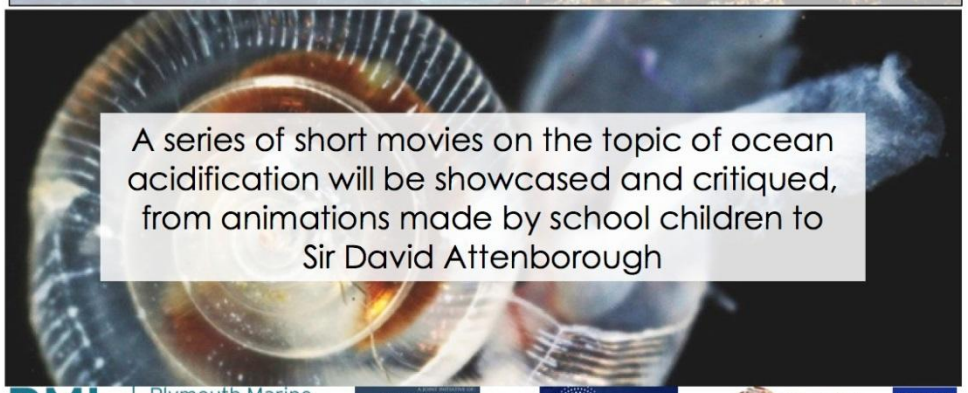
Sebastian Hennige, Heriot-Watt University: s.hennige@hw.ac.uk
Nina Bednaršek, NOAA: nina.bednarsek@noaa.gov

CEPA Fair
Music tent
10.10.2014
@ 10:00



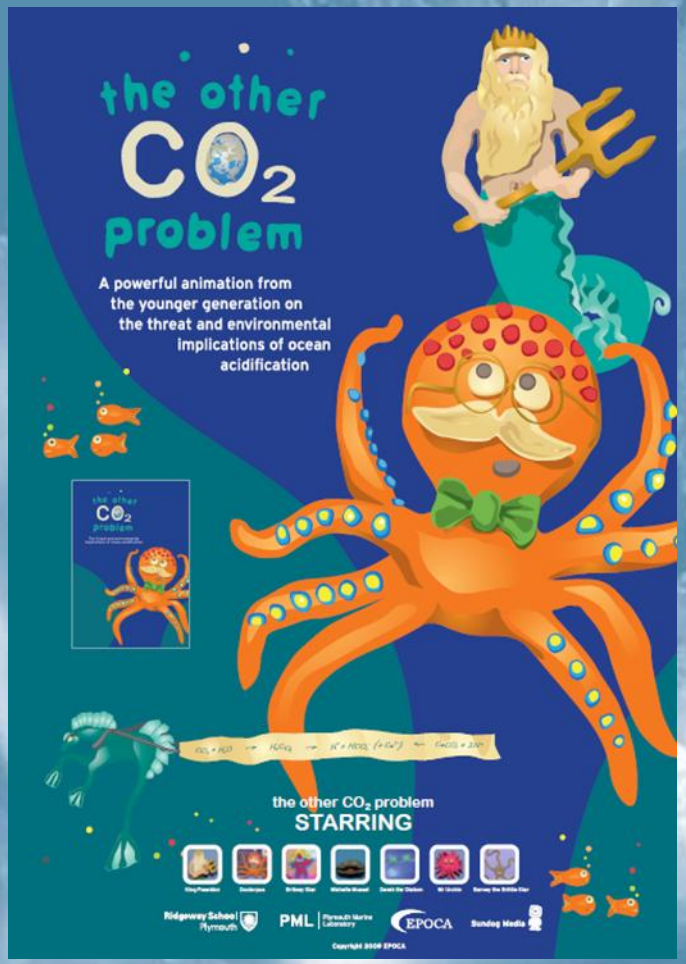


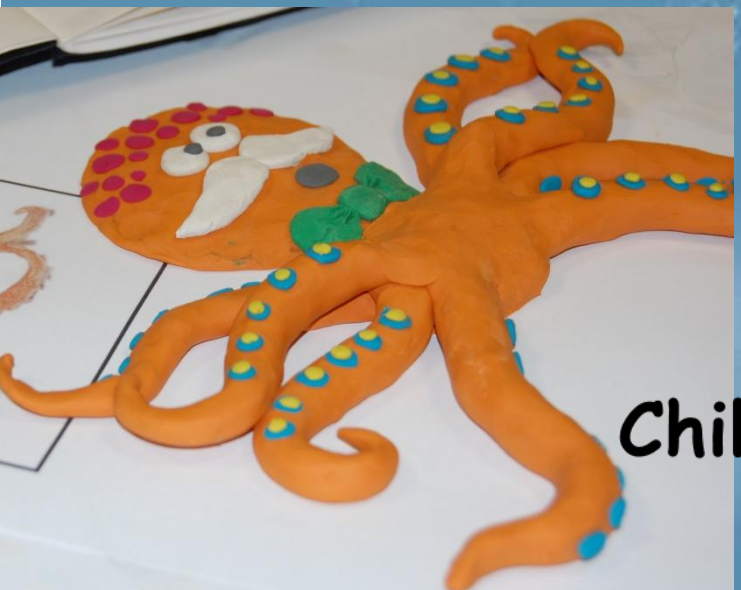
A series of short movies on the topic of ocean acidification will be showcased and critiqued, from animations made by school children to Sir David Attenborough

PML | Plymouth Marine Laboratory

The Making of the Animation ….

Dr Carol Turley
Plymouth Marine Laboratory
UK Ocean Acidification research programme





BBC RADIO 4
BBC RADIO FIVE LIVE
cbbc
BBC WORLD NEWS

Children – The Best Communicators!

The Ridgeway School Animation


Present and Future Aragonite Saturation States
Aragonite, a form of calcium carbonate (chalk), a mineral used by some organism to build their shells, others use calcite, another calcium carbonate mineral.
Year 2080
Aragonite Saturation State of Surface Waters
(Orr et al 2005)


IF YOU WISH TO USE THIS PRINTER, PLEASE SPEAK TO ONE OF THE TECHNICIANS (ROB OR GEORGE) IN HDC 317
PIERCED

Coral Reefs

Sea Turtles

Coral Reefs

Lobsters

Jemima the Squid / Jelly fish

carbon dioxide is produced by the burning of fossil fuels is absorbed by the ocean.

sea animals food chain can be effected by ocean acidification. Ocean acidification disturbs living organisms

Ocean acidification is surprisingly not to do with global warming

Shelly the Selfish

Taylor the Turtle

Ocean acidification

Ocean acidification is the name given to the ongoing decrease in the pH of the Earth's oceans caused by their uptake of anthropogenic carbon dioxide from the atmosphere. Between 1751 and 1994 surface ocean pH is estimated to have decreased from approximately 8.179 to 8.104 (a change of -0.0...

Notes from Lecture

- Mankind burns fossil fuels = CO^{*}_{2} = oceans taking up CO_2 (30%) = when CO_2 is added to water = acid.
- The more CO_2 in atmosphere, more acid.
- Scallops, mussels, oysters, corals ..... depend on carbonate.
- Plankton = fish food. Less fertilised eggs
- Corals, protect homes. Corals like warm
- 2040 = alot cooler.
- Cacification in the rain forests will
- 30%.
- Cold water corals, we are damaging
- 50% growth reduction for mussel
- White diffs of over are slowly re
- Reduced growth and re
- and life.
- In 10 years time, the Ant
- be reduced.
- Change in any part of th
- have consequences on the
- foodweb, ocean biogeo
- the whole system.
- 5 years ago politi
- about the problem.
- Oceans will become more
- Urgent reduction in CO_2
- We need to make sure
- http://ocean-acidifi

Ocean

approximately 1/3rd of the CO2 emitted to the
burning of fossil fuels. As CO2 dissolves in seawater, the
eases, which is called "acidification". Carbonic acid is
using seawater to become corrosive to the shells and
marine organisms.

ytoplankton, mussels, snails, sea urchins and other
calcium and carbonate in seawater to construct their
lls or skeletons. As the pH decreases, carbonate
. This can lead to lowered immune response,
nd behavioural depression affecting physical activity

temperature change. A 1–2° C change in local
ormal summer maximum can lead to a
ching', whereby the corals expel their vital algal
in the cells of the coral), leaving the coral tissues

event led to the loss of almost 20% of the world's
ver from these events but repeated episodes are
ecosystem, making them more susceptible to
of biodiversity.

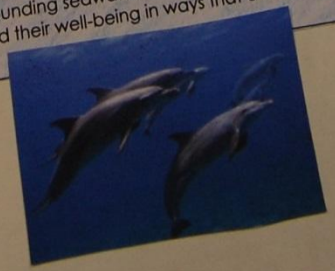
Acidification

Cephalopods

Cephalopods such as squid seem to be particularly sensitive to CO2 increases because their energy-demanding way of swimming requires a good supply of oxygen to the blood, which is impaired by lowered blood pH values.

Marine Mammals

Direct effect of CO2 on marine mammals (seals and whales) or birds are not expected because they breathe air, and thus will not be directly affected by acidification of the surrounding seawater. However changing food webs will affect these animals and their well-being in ways that are not fully understood.




H.D.C. 316
Acid Oceans
ANIMATION
STUDIO
A Ridgeway School
Production
PROPS
coral scene
-Coral. √ -Pink seaton?
-ambulance ✓
-waves.
-coughs.
doctorpus' lab
-tv Set.
-testtubes.
-fishbowls.
-bubbles
Britney star.
-microphone ✓
-Wheelchair. ✗
poseidon.
-trident. ✗
Poseidon +
Food chain -
Britney
Barrier Reef
Larry the lobst


Science!
DOCTOR OCTOPUS
mussel
Squid
Coral Reefs
FISH LIVE THERE
and they will be made homeless
FOCUS ON THE FOOD CHAIN
OCTOPUS
Seals
US
SHARKS
Squid
Little fish
Sea urchins
WHALE
brittle stars
plankton is important – IF SMALL ANIMALS DIE OUT IT HAS BIG EFFECTS everything is connected
H.D.C. 323
PRINT ROOM
H.D.C. 316
Acid Oceans
ANIMATION STUDIO
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PROPS
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- fishbowls.
- bubbles
Britney Star.
- microphone
- Wheelchair
- tride
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STORYLINES & CHARACTERS
OCEAN APOCALYPSE
Poseidon
KING OF THE SEA
SEA TV
EMERGENCY
DOCTOR OCTOPUS
CHARACTERS :
Acid Oceans
Here's the Science!
CHEMICAL REACTION
DOCTOR OCTOPUS
jelly fish
ACIDIFICATION MAKES THE CREATURES ILL
mussel
Sea anemone
Squid
Coral Reefs
FISH LIVE THERE
and they will be
FOCUS ON THE FOOD CHAIN
octopus
seals
Squid
Little fish
Sea urchin
brittle stars
plankton is important – IF SMALL ANIMALS DIE BIG EFFECTS everything
Acid Oceans
Britney Brittle Star tells her story!
FISH NIBBLE THEIR ARMS
she can't use her arms anymore as her muscles have been used up in making more of her skeleton as it keeps getting dissolved
less carbonations in the water cause animals to overcompensate on calcium production
the consortium
buying made easy
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The world's leading marine ecology journal
IR

Acid Oceans

Ocean Acidification due to increasing atmospheric carbon dioxide

the WORLD from space

OUR BEAUTIFUL PLANET

RAPID CHANGE

MILKY * CLOUDS at the poles

= big * algal blooms

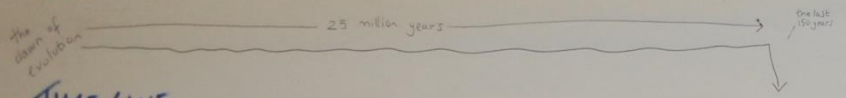
calcified plates fall off coccolithophorids

THAT'S WHAT YOU SEE FROM SPACE

Mostly water : 70%

our oceans are 4 km deep!

MESSAGE : we're making things change too quickly



TIMELINE

pH of sea water = 8.2 at the start of the Industrial Revolution (150 years ago)

pH of sea water = 8.1 NOW

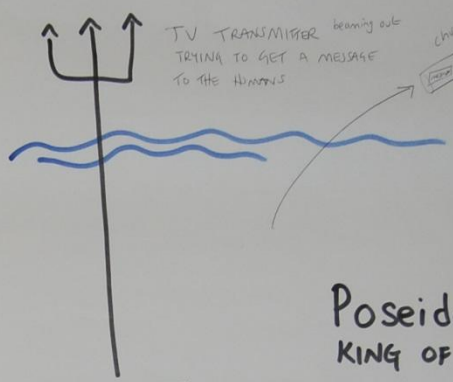
↑ that's a small increase (0.1)

BUT = 30% increase in Hydrogen H^+ ions

▶ the FUTURE pH will be 7.7 !

causes calcified plates [liths] to deteriorate, fray around the edges, and grow deformed

STORYLINES & CHARACTERS



OCEAN APOCALYPSE

SEA TV

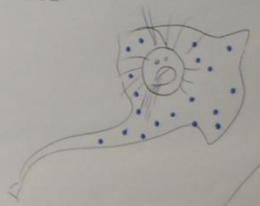
Poseidon
KING OF THE SEA (Greek)

— there's a problem being caused by the humans up above
— he's worried that his ocean of animals and plants is under threat

EMERGENCY

— calls on Dr O his chief adviser
— WHAT CAN WE DO?
— WHAT'S GOING ON ABOVE THE SURFACE (UP THERE)
— WE NEED THEIR HELP

DOCTOR OCTOPUS



CHARACTERS :

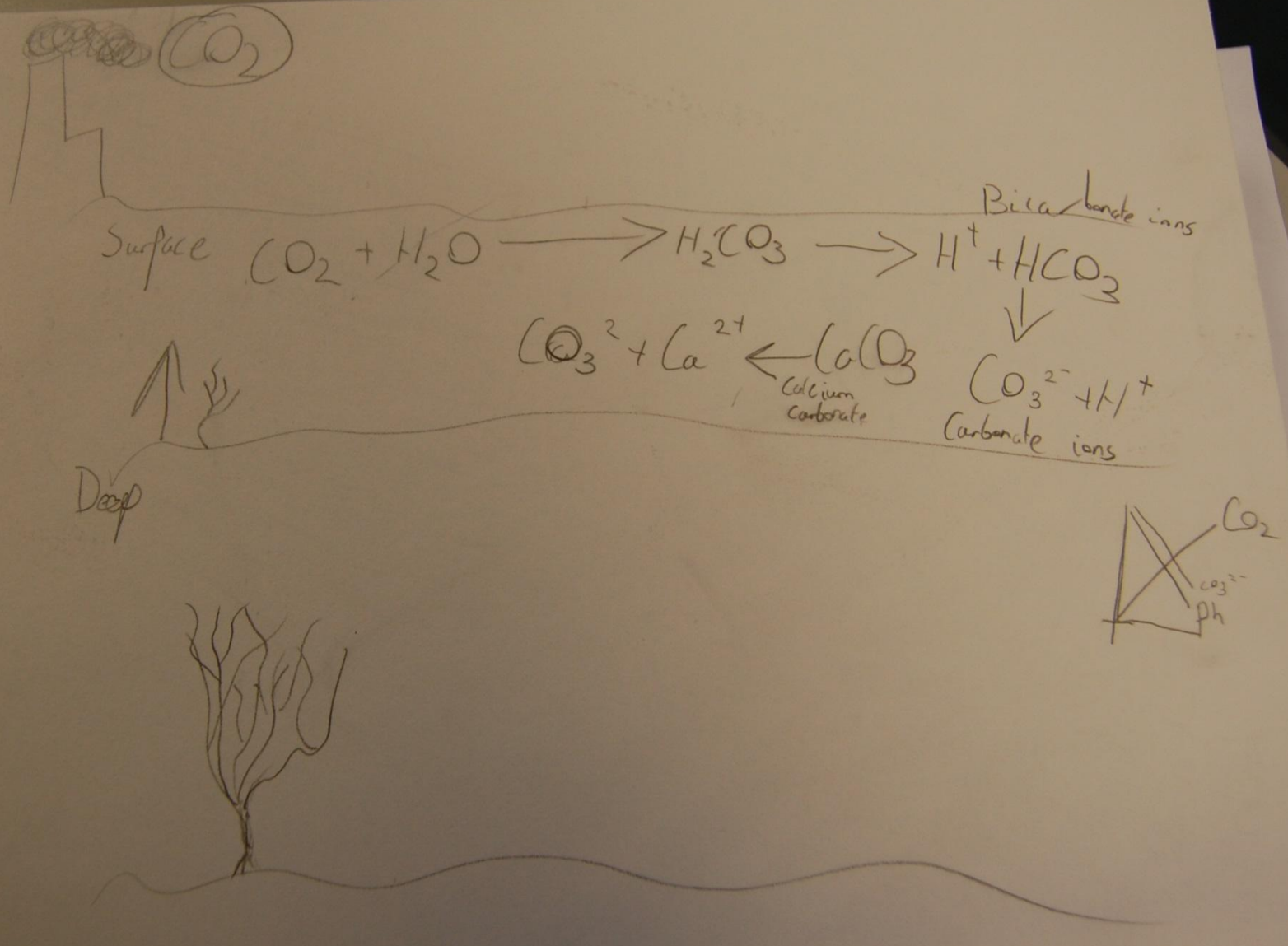
Britney Star
Paris Prawn
Lindsey Lobster
} BIG FISHY SCEBS CELEBRITY ANIMALS

DOLLY DOLPHIN

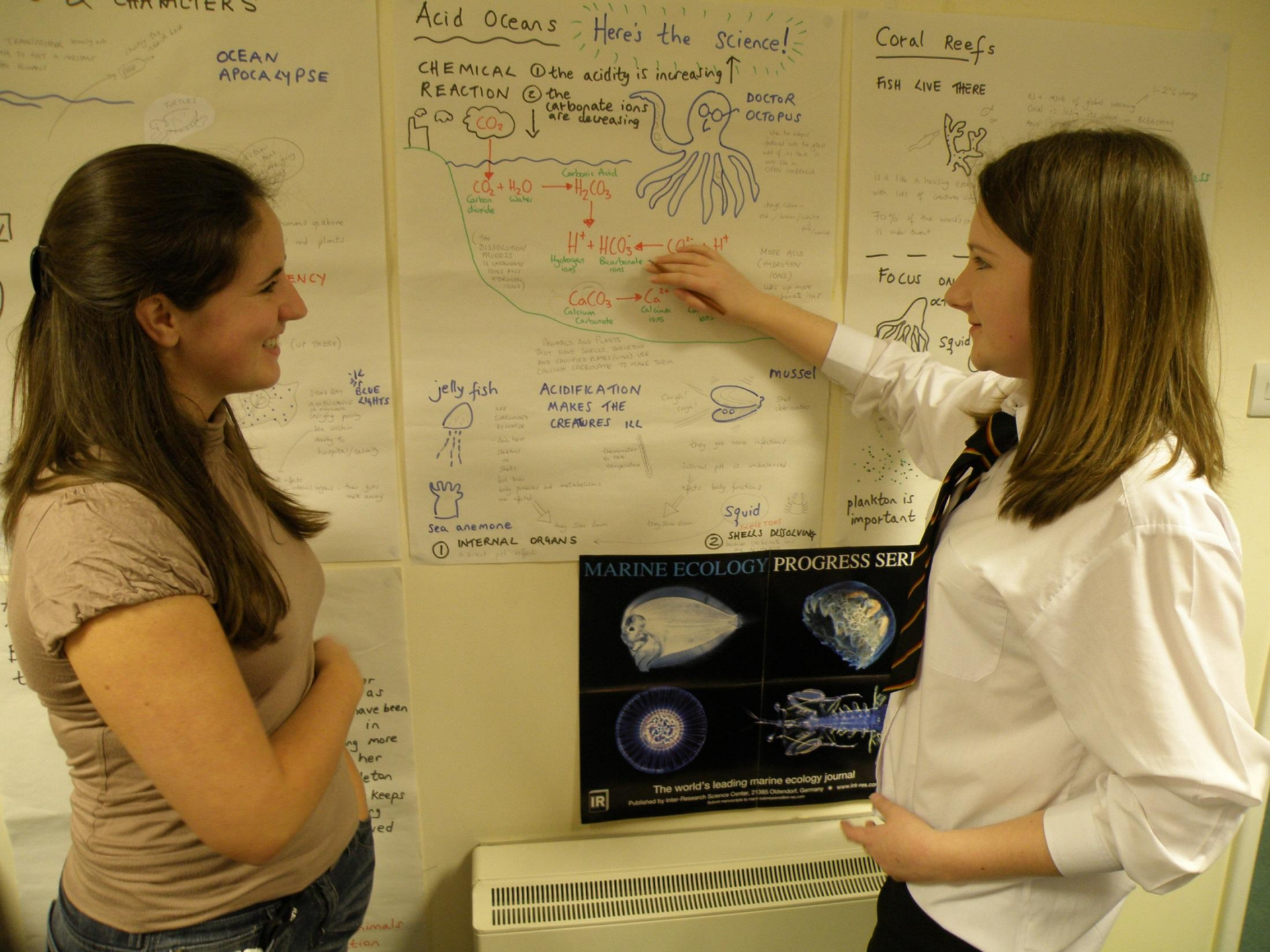
JEMIMA JELLYFISH

PARROT FISH — repeats the last word of each sentence or phrase

pH affects the internal organs - their guts melt away


CO_2
Surface
$CO_2 + H_2O \longrightarrow H_2CO_3 \longrightarrow H^+ + HCO_3$
Bicarbonate ions
$CO_3^{2-} + Ca^{2+} \leftarrow CaCO_3$
Calcium Carbonate
$CO_3^{2-} + H^+$
Carbonate ions
Deep
CO_2
CO_3^{2-}
ph


Acid Oceans
Here's the science!
CHEMICAL REACTION
① the acidity is increasing
② the carbonate ions are decreasing
DOCTOR OCTOPUS
CO2
Carbonic Acid
Carbon dioxide
Water
Hydrogen ions
Bicarbonate ions
Carbonate ions
Calcium Carbonate
Calcium ions
MORE ACID (HYDROGEN IONS) uses up more carbonate ions and makes Bicarbonate ions
ANIMALS AND PLANTS THAT HAVE SHELLS, SKELETONS AND CALCIFIED PLATES (LITHS) USE CALCIUM CARBONATE TO MAKE THEM.
jelly fish
ACIDIFICATION MAKES THE CREATURES ILL
mussel
Shell deteriorates
Cough! Cough!
they get more infections
internal pH is unbalanced
affects body functions
they slow down
Sea anemone
① INTERNAL ORGANS
Squid
SKELETONS
② SHELLS DISSOLVING
STORYLINES & CHARACTERS
OCEAN APOCALYPSE
Poseidon
KING OF THE SEA
SEA TV
EMERGENCY
DOCTOR OCTOPUS
BLUE LIGHTS
CHARACTERS:
Acid Oceans
RAPID CHANGE
MILKY CLOUDS at the poles
OUR BEAUTIFUL PLANET
THAT'S WHAT YOU SEE FROM SPACE
water = 8.1 NOW
FISH LIVE
is it like a housing estate? with lots of creatures living there
70% of the world's coral is under threat
FOCUS ON THE
OCTOPUS
squid
little fish
PHYTO PLANKTON are the plants of the ocean
ZOO PLANKTON are little animals
plankton is important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Coral Reefs
FISH LIVE THERE
Focus on
Squid
plankton is important
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STORYBOARD

NAME. Connor Pote & Jamie Couch

PROJECT.....

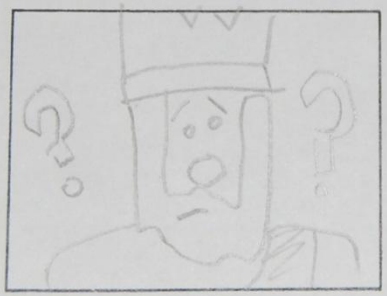
Poseidon is in his palace living room watching soaps on t.v.

Doctorpus tells him its important

Turns off TV. Poseidon gives in.

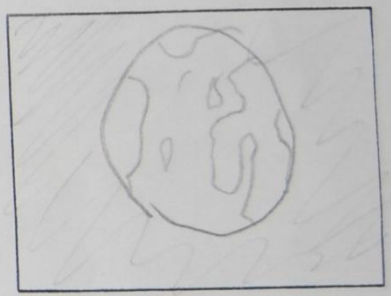
Regals paper full of explanations of the problem.

Long list comes up across screen lead by sea horses. Its got the equation on.



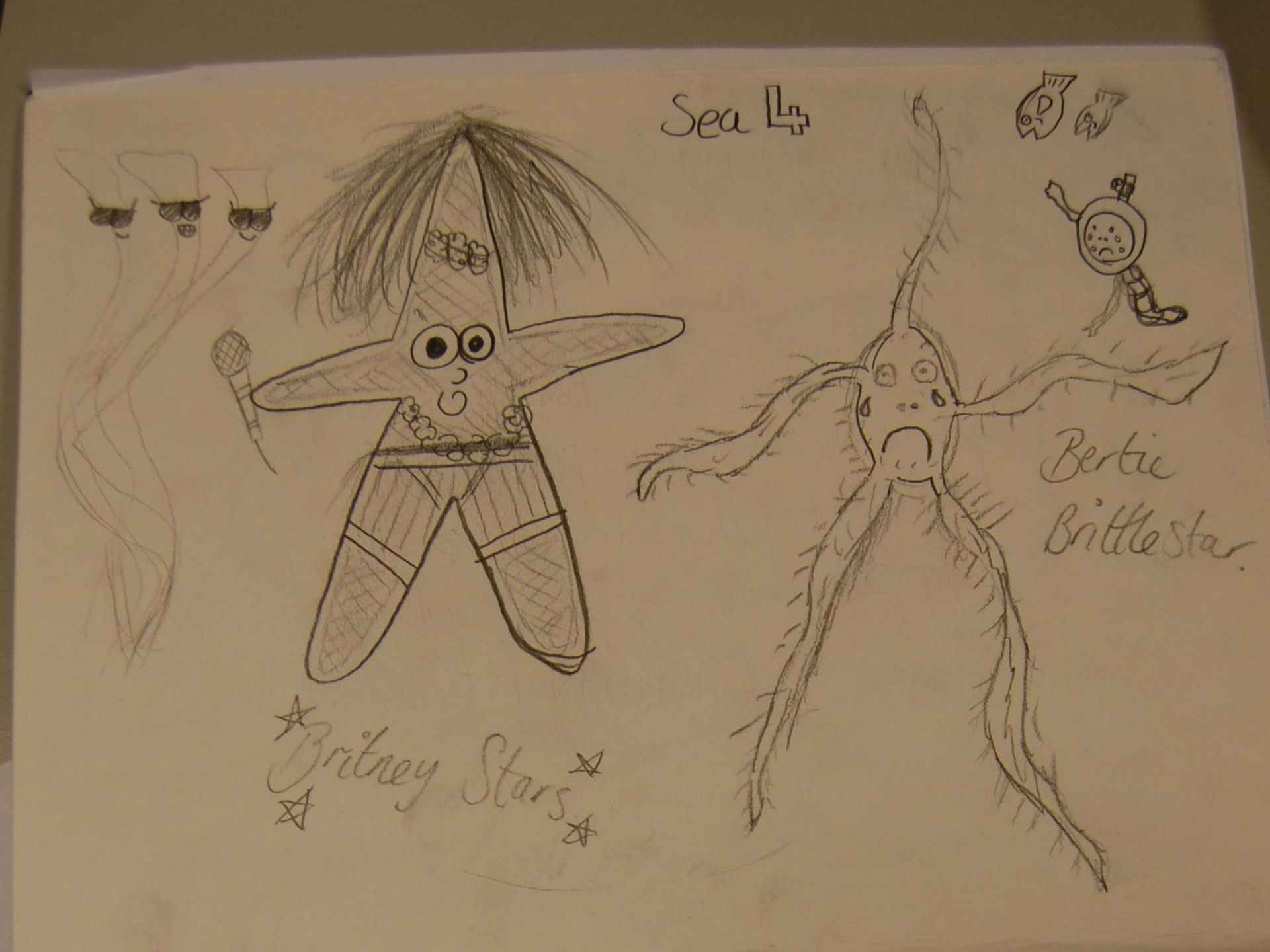
Puzzled. He just doesn't get it.

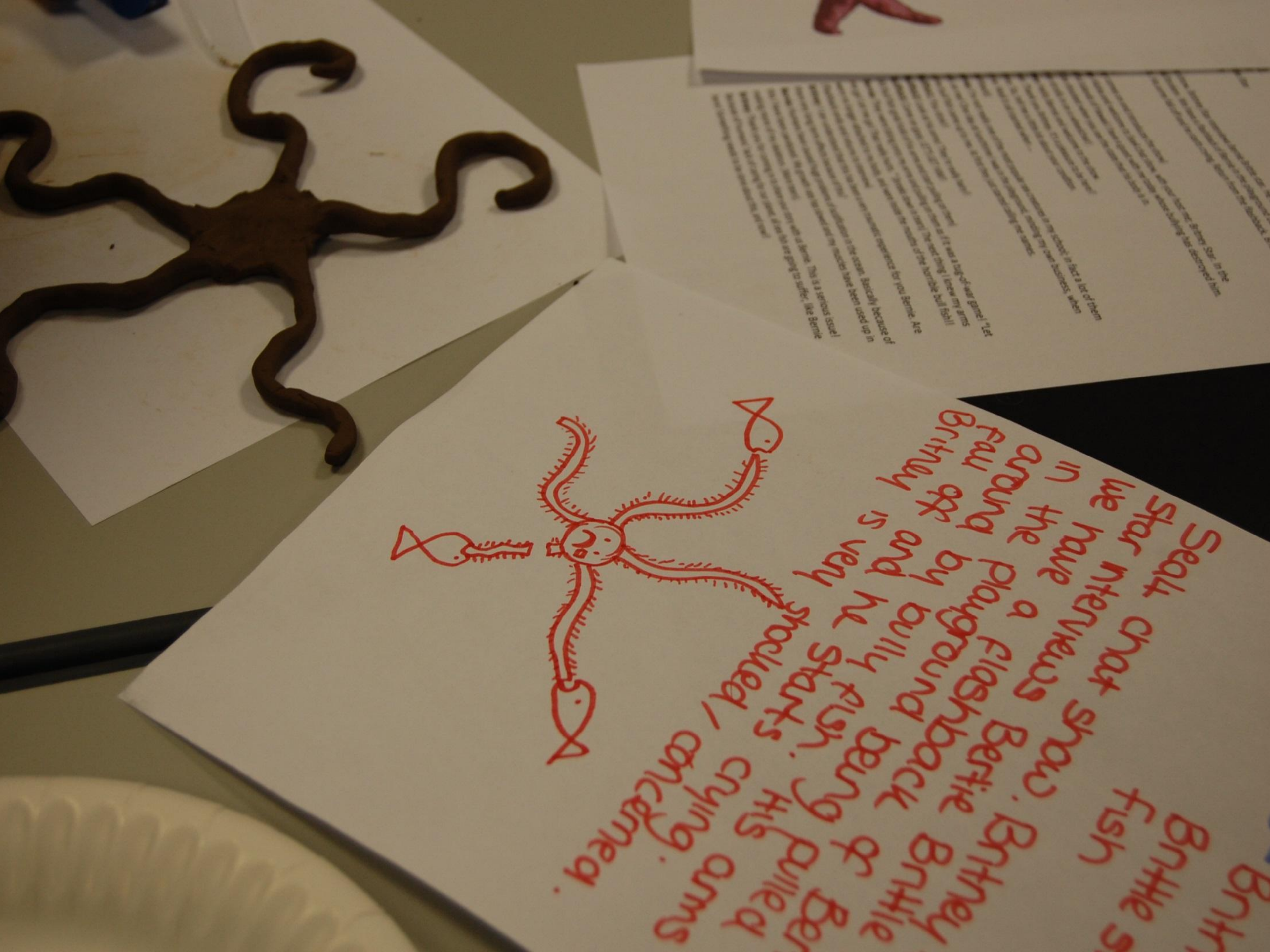
Idea! Look around world



Camera zooms out into space - zooms in again to ocean. Areas of where problems are occuring.


There were two fish down in there home in the coral reef. They were living very happily.
Fish 1: Did you hear that America has a new president?
Fish 2: Oh yes, I heard about that! Isn't he called Barrack Obama?
Fish 1: He is indeed.
Some time later back at the reefs the coral starts to dissolve but none of the fish noticed.
Fish 1: There seems to be some different about the reef but I'm not quite sure what. What do you think?
Fish 2: Yes it does seem that our homes are getting smaller each day.
The sea starts to get more acidic and the coral starts to dissolve even more and the fish start to notice now.
Fish 2: You were right about ou
DELL
HP Compaq


Sea 4
Britney Stars
Bertie Brittlestar.



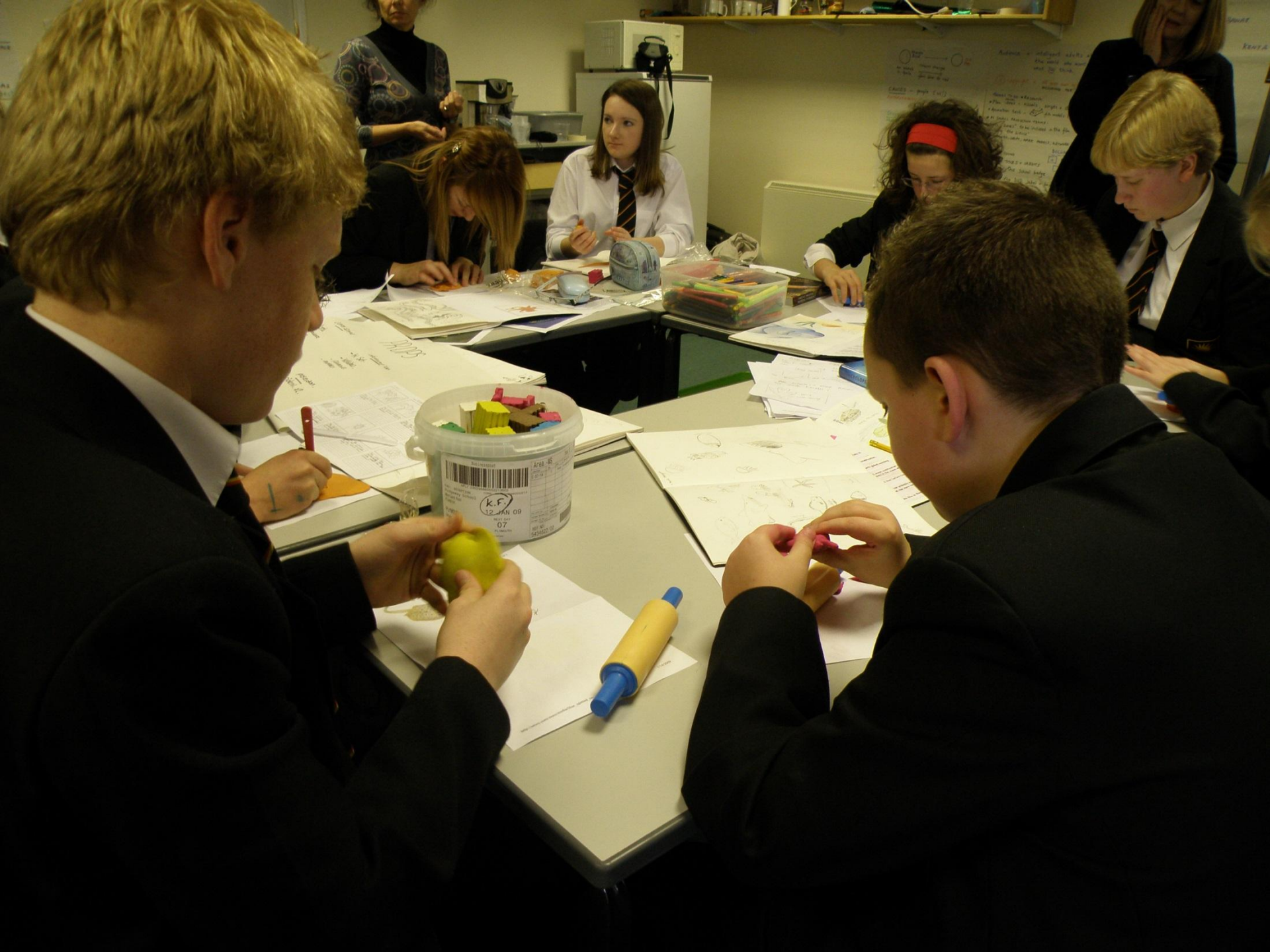
Brittle fish
Seal4 chat show. Britney
star interviews Bertie Brittle
we have a flashback
in the playground being pulled
around by bully fish. His arms
fall off and he starts crying.
Britney is very shocked / concerned.


Ocean acidification due to increasing atmospheric carbon dioxide
THE ROYAL SOCIETY
excellence in science
June 2005
The Royal Society
PAY HERE


GREAT BRITISH
MARINE ANIMALS
Paul Naylor
Oceans


GLOBAL VIEW
GREECE
N. POLE – ARCTIC
S. POLE – ANTARCTIC


GLOBAL VIEW
significant places:
HAWAII
KENYA
GREECE
N. POLE – ARCTIC
S. POLE – ANTARCTIC
EPSON
GLOSSY PAPER




Britney Star
Ocean Acidification
Acid Oceans
the consortium


GLOBAL VIEW


PLEASE MAKE SURE THAT COMPUTER IS TURNED OFF WHEN INSERTING AND REMOVING REMOVABLE HARD DRIVES
TO LOG IN, CLICK THE MEDIA STUDIES ICON, PASSWORD IS media (NO CAPITAL LETTERS)

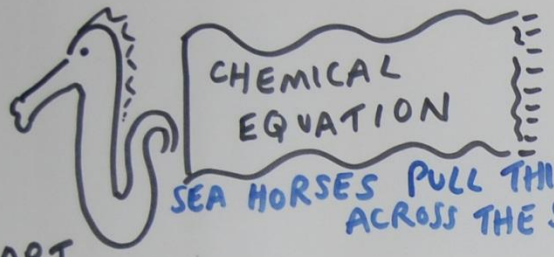

HAWAII
KENYA


GLOBAL VIEW
N. POLE - ARCTIC
W
E
S. POLE - ANTARCTIC
SAVE OUR SEAS
THE TITLE
RADIO WAVES
+ morse code
PLUS OUR FACES
SEA TV
CREDITS
TV BROADCAST
OH NO! WE CAN'T HELP WE NEED THE HUMANS!
FUTURE FLASH FORWARD TO A CLEAN PLANET
PRESENT DAY
ACID RED
blue to red
(us!)
telligent adults all around the world who want to know what YOU think
MUSIC
PHOTOS
VIDEO IF POSSIBLE
INCLUDING INTERVIEWS
box cover
including music

MOODOMETER – this is a plan of our story

SAVE OUR SEAS
THE TITLE

In the underwater court of King Poseidon.



START

S.O.S.

King P. talks to Dr. Pus BAD NEWS!
EVERYONE WILL DIE IF THIS DOESN'T GET SORTED OUT

REPORTS FROM AROUND THE WORLD

THEY REALISE WHAT HAS TO BE DONE

OH NO! WE CAN'T HELP WE NEED THE HUMANS!

SEA TV

RADIO WAVES + morse code (S.O.S.)

PLUS OUR FACES

CREDITS

THE FUTURE

TV BROADCAST

FUTURE FLASH FORWARD TO A CLEAN PLANET

+ THIS IS WHAT YOU/WE CAN DO TO HELP:

- TURN OFF LIGHTS
- DRIVE LESS
- BURN LESS CO2

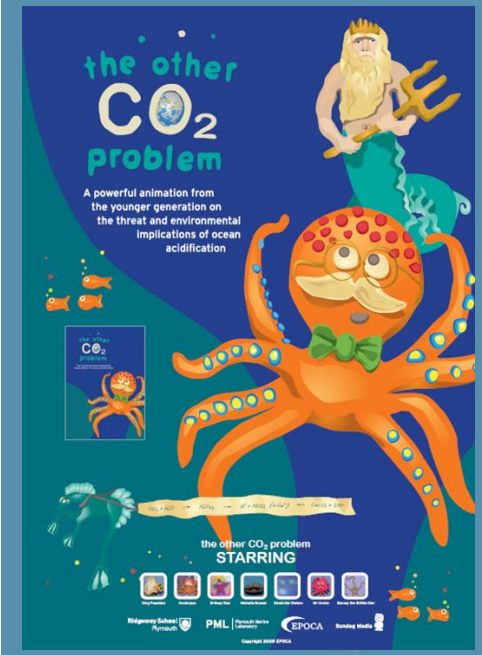
USE – RENEWABLE ENERGY solar tide/wind/wave/water....

INFORMATION GATHERED FROM THE SEA

Hawaii
Plymouth UK
Barrier Reef
Arctic Antarctic

PRESENT DAY

The Translation of the Animation



BBC RADIO 4

BBC RADIO FIVE LIVE

cbbc

BBC WORLD NEWS

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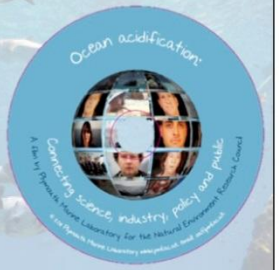

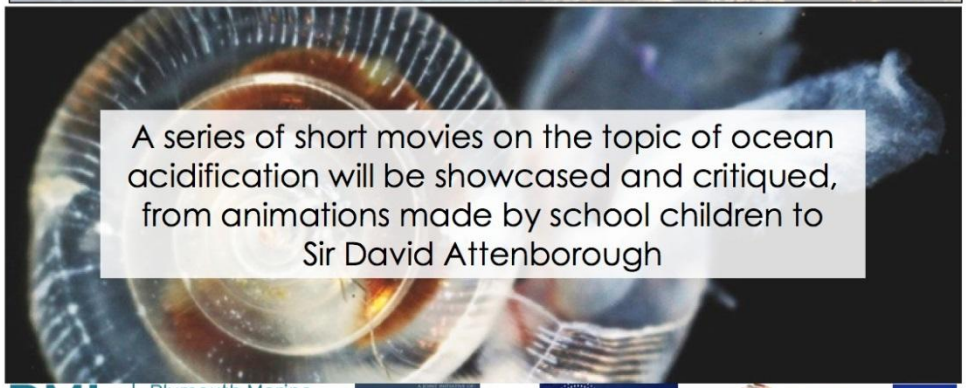

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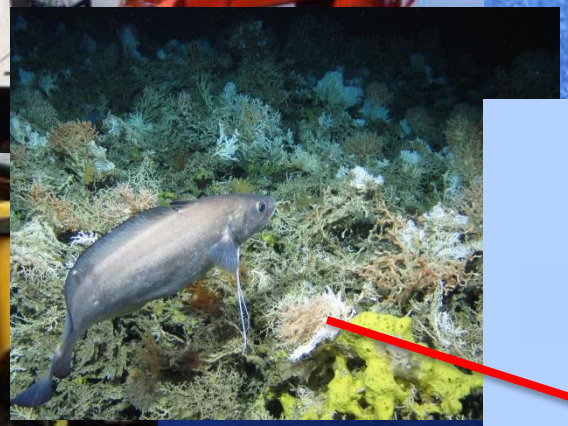
PML Plymouth Marine Laboratory

Ocean acidification research campaign in 2012 “Changing Oceans”



Impact of ocean acidification upon cold-water corals off Scotland

Ocean acidification research campaign in 2012 “Changing Oceans”

- Experienced “A day in the life of a scientist”
- Gave report back to the rest of their school via video-link
- Wrote an article on the dedicated research campaign blog
- Covered by BBC news

Changing Oceans

RRS James Cook 073

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Day 3: Science Communication Day

Today was a bit of a different day for everyone aboard James Cook. Eleven scientists were treated to a day on the Isle of Barra, to make way for a school group from Sgoil Lionacleit and a BBC team from 'The One Show'. It was nice for the scientists to talk about their research and show off their toys.

Calendar

August (1)

Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

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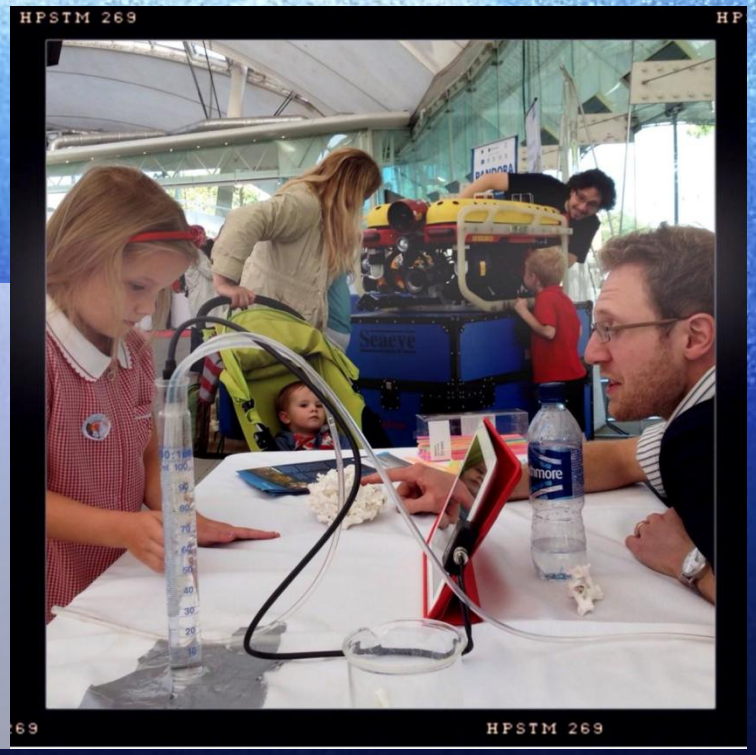
EXPLORATHON '14

ONE NIGHT • UNLIMITED DISCOVERY

Explorathon in Edinburgh

our dynamic earth



- Explorathon 2014
- 10 Different university exhibits
- Free event to the public
- Over 1500 visitors in 5 hours


© BBC
Sir David Attenborough introduces
LOPHELIA .ORG
View Sir David Attenborough's full length introduction

Getting to the heart of the matter:

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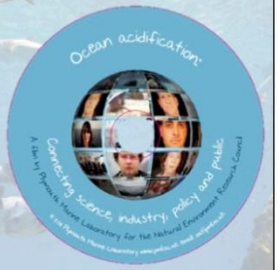

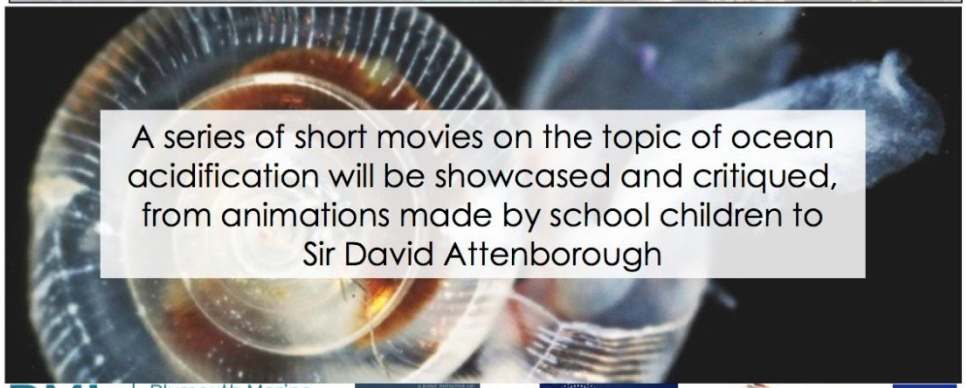

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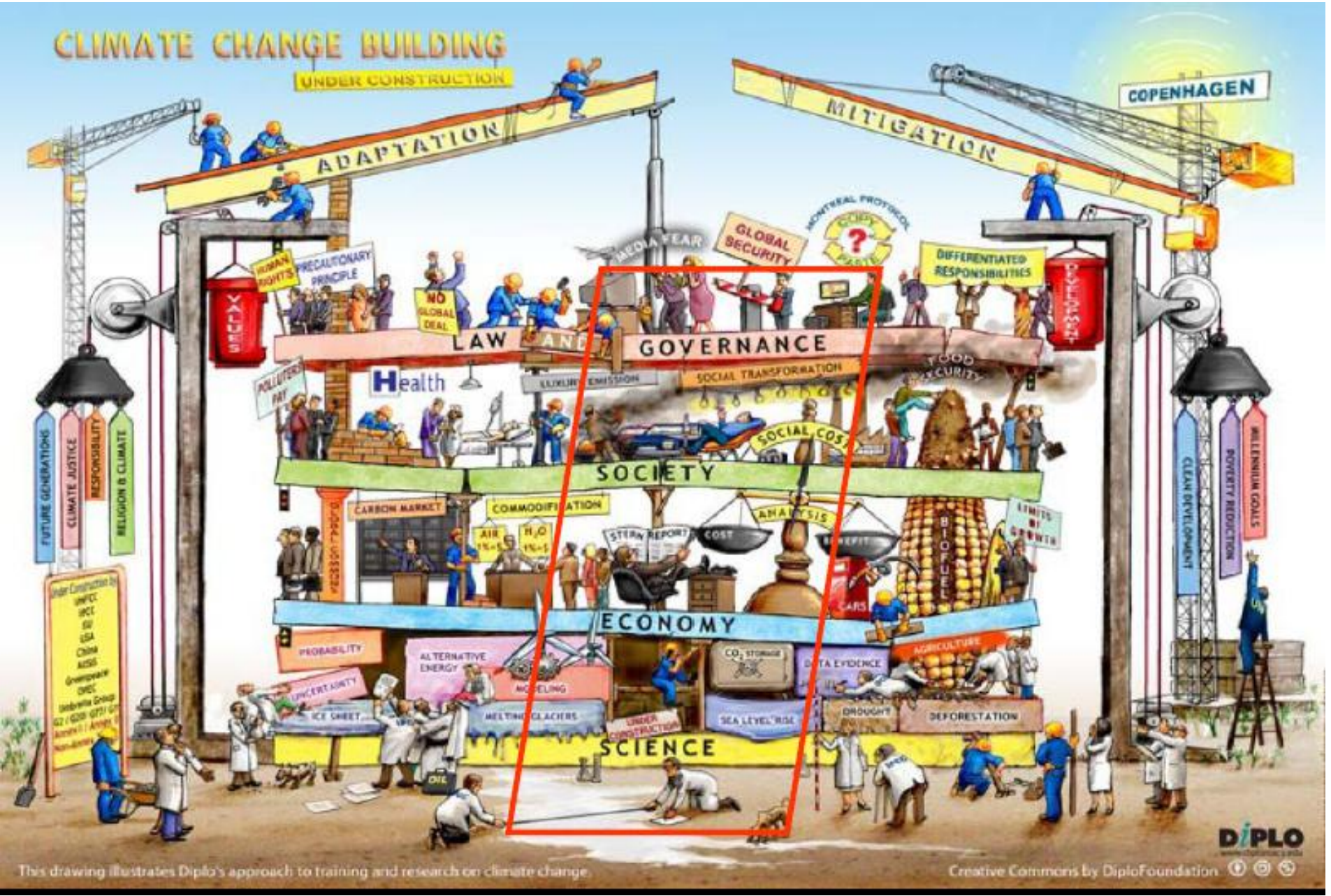
PML Plymouth Marine Laboratory

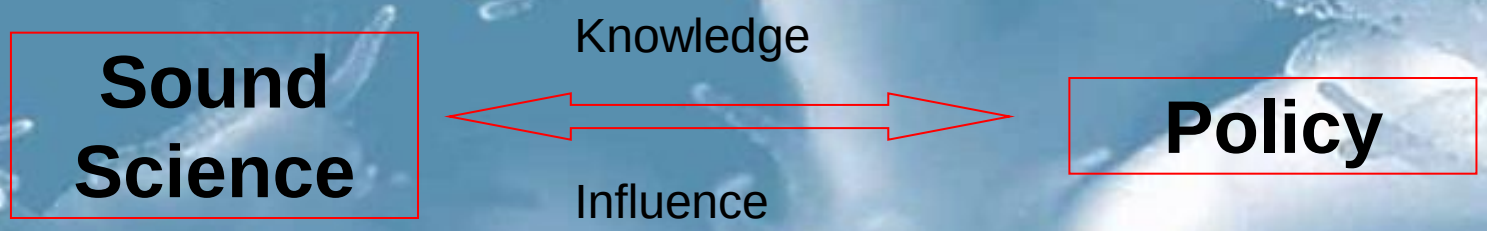
Connecting Science, Policy, Industry and the Public



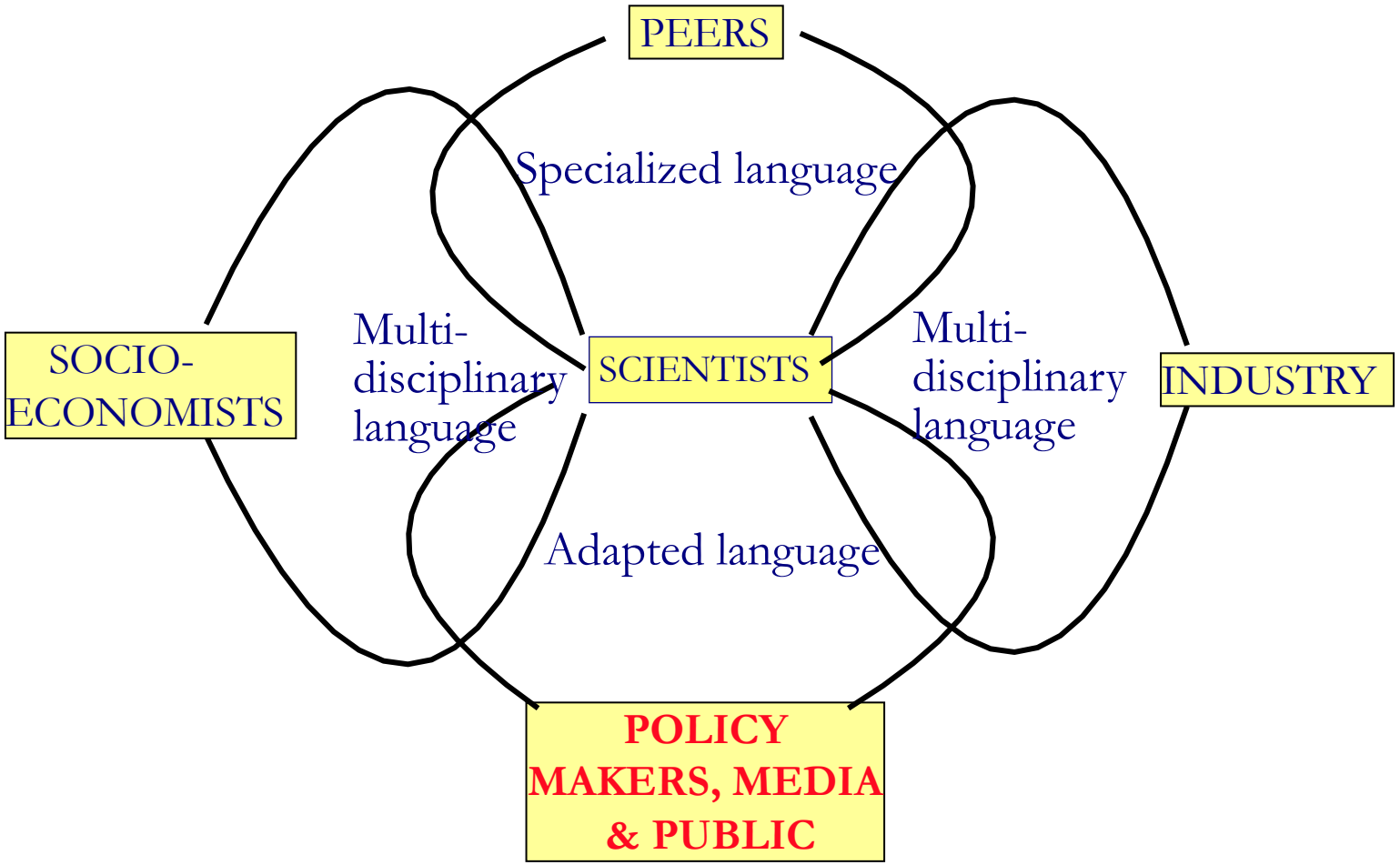
Dissemination, Exploitation and Management of Knowledge

We have a globally important message to get across to key stakeholders and that needs to be based on sound science

The Science and Policy Link



Taking the Science to Stakeholders: Getting the Language Right

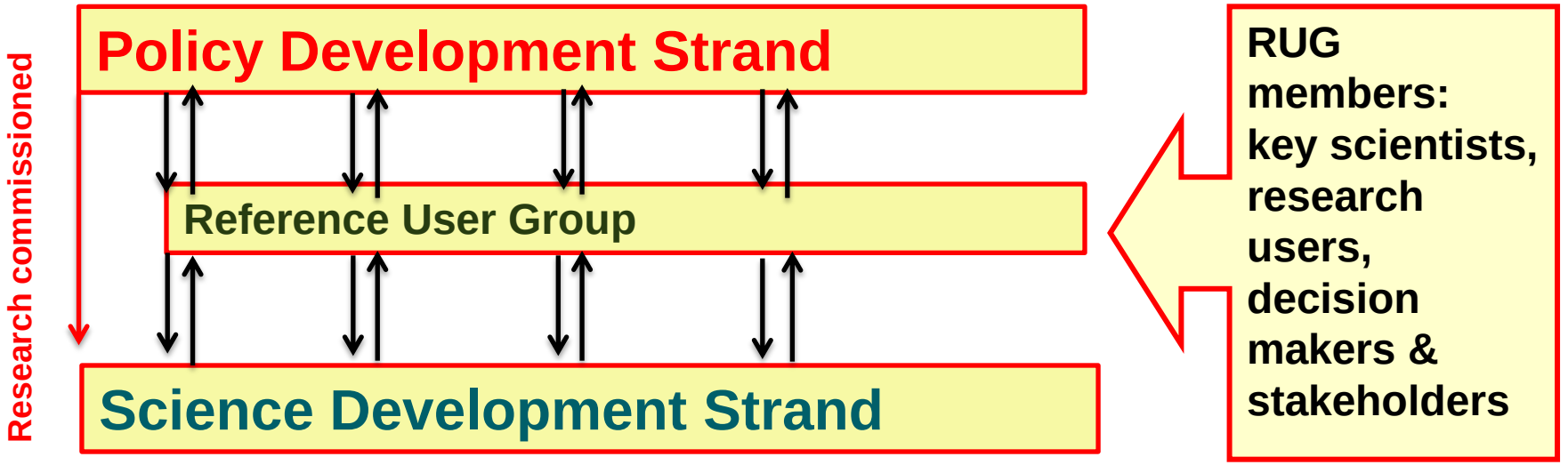


Scientists need to know their audience and adapt their language appropriately

Connecting Science to Policy at the Very Start of Research

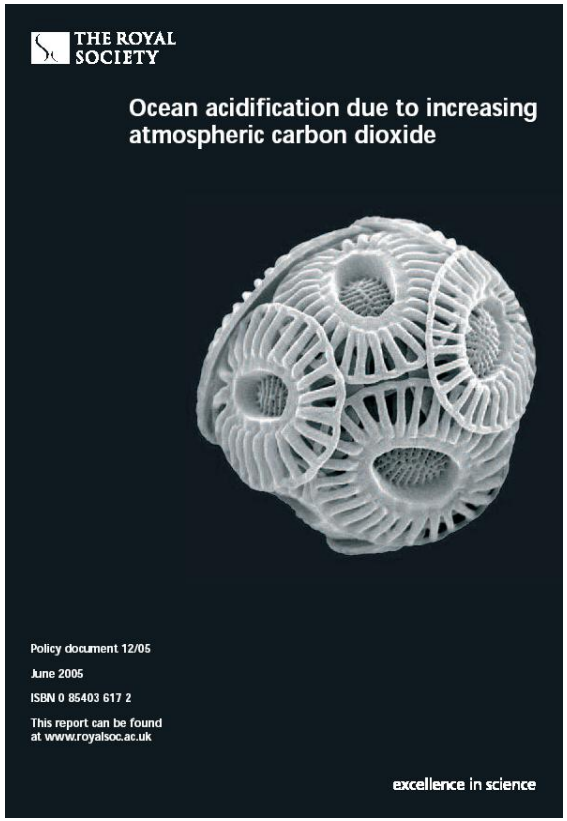
The Ocean Acidification Reference User Group (RUG)

Policy-science links – better practice



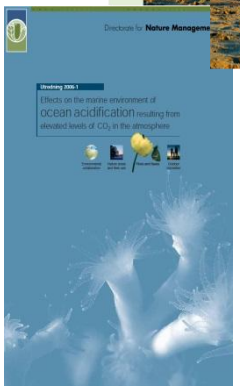
RUG publications for policy makers ….

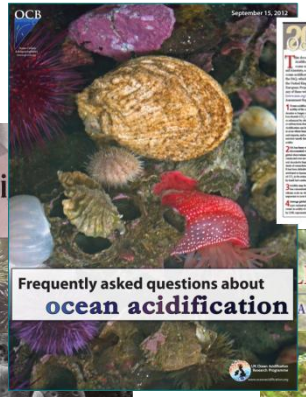
The Power of Reports: The Royal Society Working Group Report on Ocean Acidification - 2005

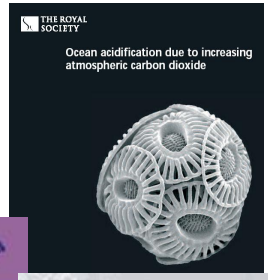


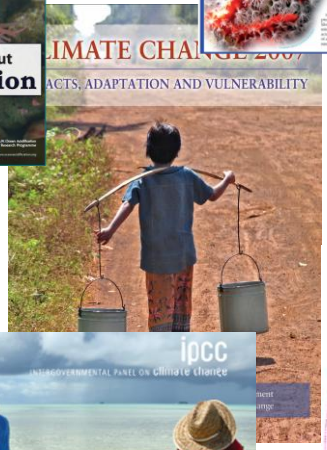
http://www.royalsoc.ac.uk/document.asp?id=3249

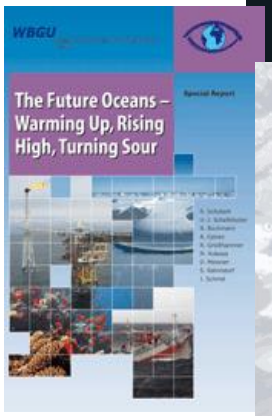
Scientists Getting the Message to Stakeholders – a concerted international effort

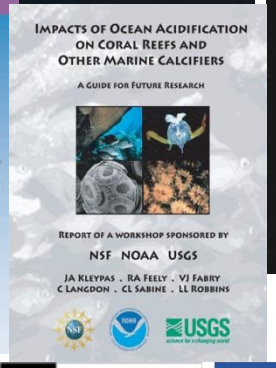






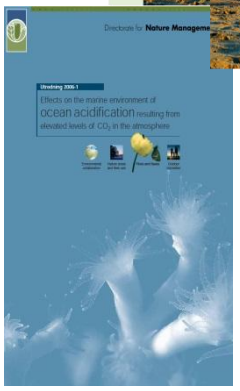


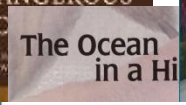


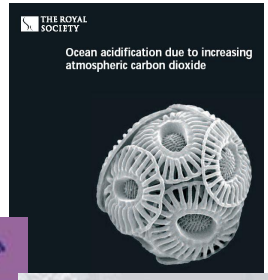


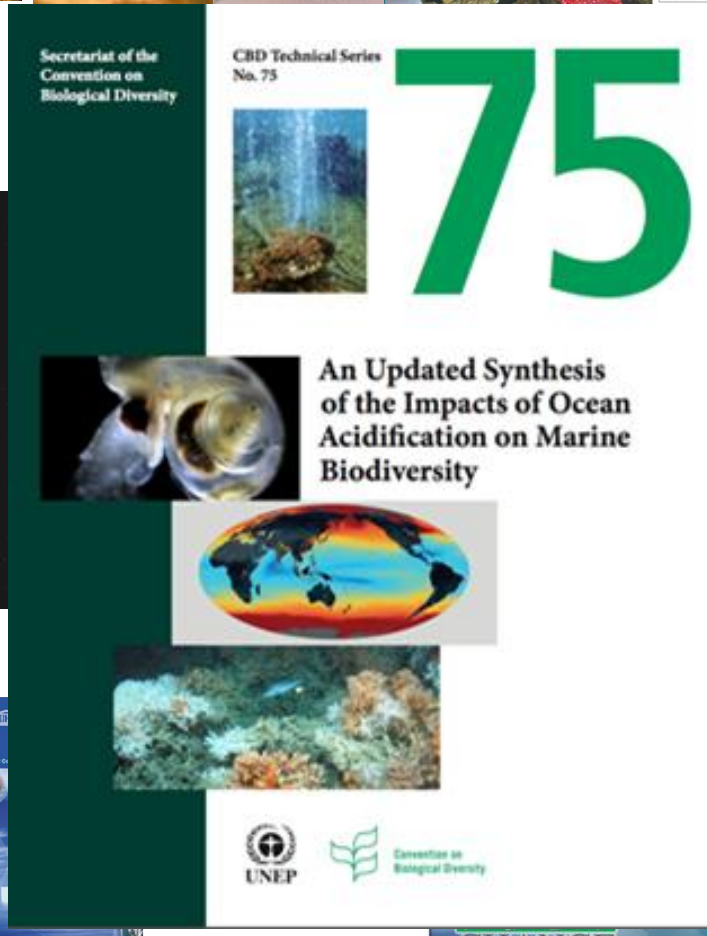
IGBP-SCOR Fast Track Initiative "Ocean Acidification"

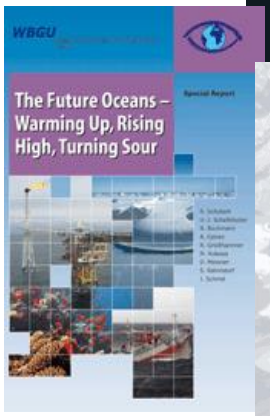
Scientists Getting the Message to Stakeholders – a concerted international effort

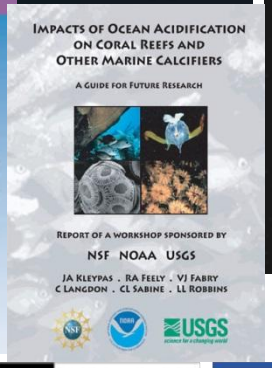


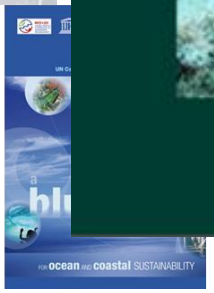












Track Initiative "Ocean Acidification"

Ocean Acidification and the UN-

Growing Interest at UNFCCC COP Climate Discussions but still a long way to go

COP15
COPENHAGEN
UN CLIMATE CHANGE CONFERENCE 2009

RIO+20
United Nations Conference on Sustainable Development

Major opportunity for ocean

Convention on Biological Diversity

Biodiversity for Sustainable Development
PYEONGCHANG, KOREA 2014

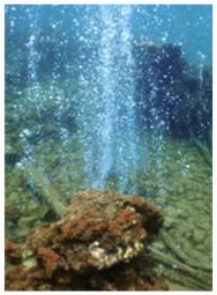

Hot, Sour & Breathless
International Collaboration
Ocean Under Stress
Vulnerable Marine Biodiversity
스트레스 받는 바다
Ocean Under Stress
Partners
Shellfish Aquaculture
Coral Reefs
Sea Butterflies
www.OceanUnderStress.com
Home and visit our exhibition stand in the Exhibition Tent!
Convention on Biological Diversity
Biodiversity for Sustainable Development
YEOSU, KOREA 2014

Civil Society Adds its Voice…… Fishermen and Mariners from Alaska …..

Lou Dematteis (2009) Associated Press.

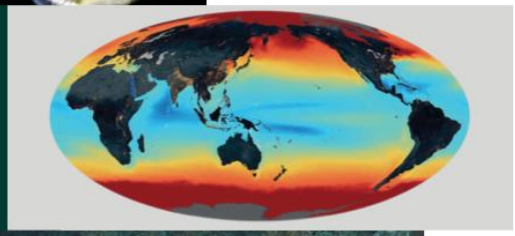
Secretariat of the Convention on Biological Diversity

CBD Technical Series No. 75



75

An Updated Synthesis of the Impacts of Ocean Acidification on Marine Biodiversity



UNEP

Convention on Biological Diversity

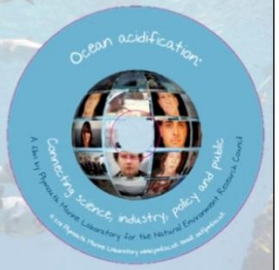
Why it matters: the ocean provides food and livelihoods for billions

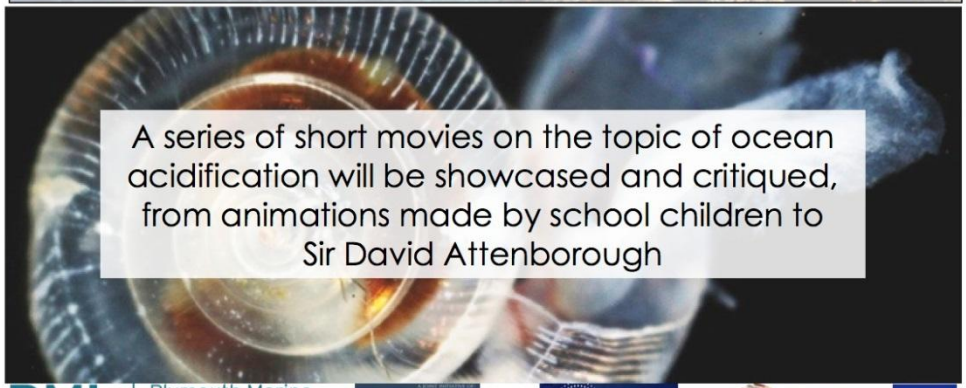
Getting to the heart of the matter:

Communicating Ocean Acidification

Carol Turley, Plymouth Marine Laboratory: ct@pml.co.uk
Sebastian Hennige, Heriot-Watt University: s.hennige@hw.ac.uk
Nina Bednaršek, NOAA: nina.bednarsek@noaa.gov

CEPA Fair
Music tent
09.10.2014
@ 10:00





A series of short movies on the topic of ocean acidification will be showcased and critiqued, from animations made by school children to Sir David Attenborough

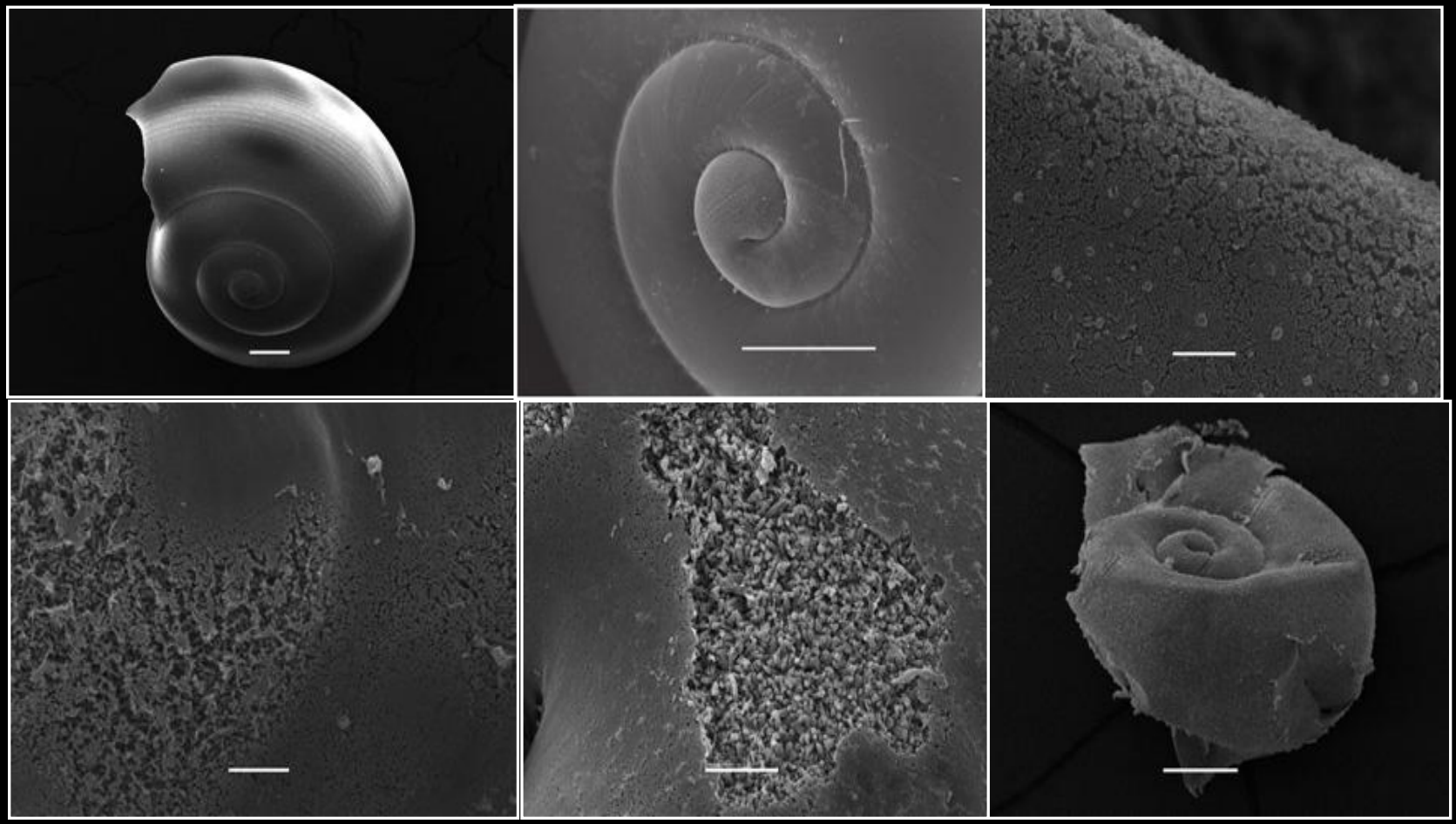
PML Plymouth Marine Laboratory

Getting to the heart of the matter: Communicating Ocean Acidification

Dr. Nina Bednarsek

NOAA, Pacific Marine Environmental Laboratory

Pteropod shell dissolution under scanning electron microscope (SEM)



How can scientific material be used not just for scientific purposes?
One venue: ART

Dissolution video

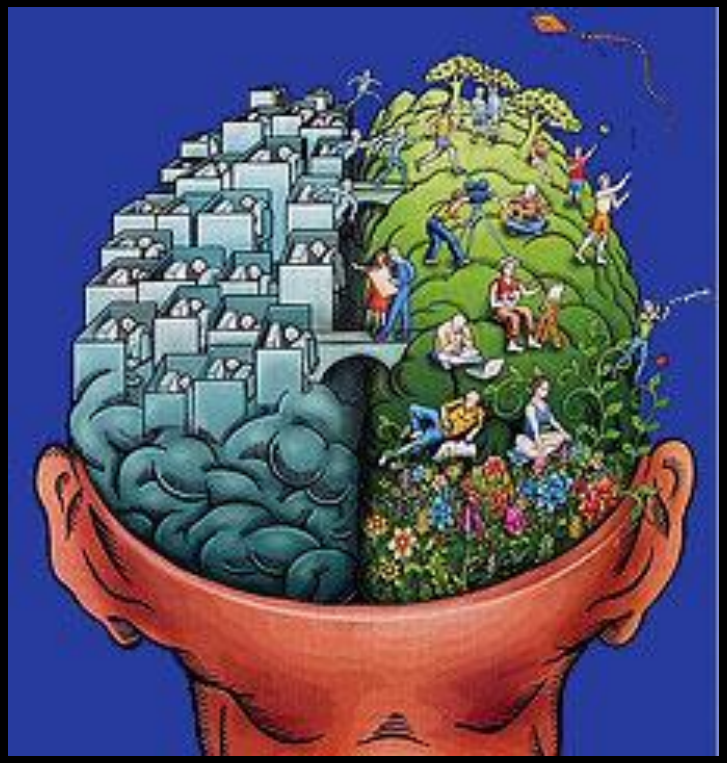
How can different scientific material be used not just for scientific purposes?

Scientist and artist work on the same topic…

Using scientific material → transformed into art → art to convey scientific message

Brainstorming ideas, scientist provides scientific material to the artist, iterative process, sound science

Science and art: formidable combination for "challenging" environmental questions



→ Making audience more susceptible to environmental questions through opening their right brain side (emotional side)
→ Art triggers emphatic response from audience

→ Easy information dissemination
→ 3D experience
→ Outreach for different sciences

→ Only scratching the surface of possibilities!

→ *media support, use of social media for broad audience*

Outcome: Art-science Exhibition:
Art supporting science. Science fueling art.

Interactive discussion with audience: art and science talk, Q&A session

Connection with art: artistic expression of scientific idea

Bronze sculptures.
Based on the SEM images
Depiction of pteropod shell dissolution.
Iconic spiral form.
Faces.
Forces audience to think.

Shell Game sculpture by David Eisenhour (eisenhousculpture.com)

Connection with art: artistic expression of scientific idea

- Coal imbedded in concrete castings, dissolution revealed by acid wash (coal as a building element but also destroyer)
- Imagery that raises questions, enters the subconscious, requires response
- ***"Dancing around the questions to solicit the subconscious for answers"***

2014 SCOPE Galleries Art Award - MELISSA SMITH, Australia

Graphic artist

Awarded artistic work: Art Concerning Environment

Artist Statement

The sea butterfly (pteropod - *Limacina helicina antarctica*), a vital link in the marine food web, is an icon of environmental fragility. The formation of its delicate shell is being affected by the rising acidity of our oceans due to the absorption of increasing levels of carbon dioxide, which is threatening its very existence.This sculptural work contributes an empathic response to otherwise purely scientific descriptions of this situation...

DLVE II
SA SMITH

CT scan of a shelled
acina helicina
butterfly) is animated
nd inspires creative
n original music score.

l falls into view and
al its beautiful,
Just as we feel we
fragile surface, it
the illusion dispelled.

esents the threat
teropod due to ocean
s the seas absorb
oxide, their chemistry
nate ion levels decline
nt is an important
for the pteropod's shell.
n the marine food chain
he pteropod will have a
ffect on the web of life.

other works in this
d on the *Dissolve*
dvances earlier
to the tilt in our
mental balance. The
production of this
ling the paper, *Krill*
rs: a dialogue on
eptions of climate
oberts & Nicol, 2011),
ed me to the potential
opod, commonly
ea butterfly, a species
indicative of the ecosystem health of the Southern Ocean. Inspired to learn more about this creature I established contacts with scientists in Hobart and Canberra, Australia and Seattle, USA. These relationships have enabled an exchange of information and data allowing me to better understand the consequences of ocean acidification. Through these collaborations I have gleaned a greater insight to the work of the scientists, who in turn have embraced the opportunity for their research findings to be visually interpreted and communicated to a broader audience. Through our different research and expressive methods we contribute to making sense of climate change.

I have combined new technologies with traditional print methods, to visualise an empathic response to otherwise purely scientific observations. New technologies increasingly expand methods used in art and science to help decipher our changing environment.

Midden 2013
polylactide and acrylonitrile butadiene styrene
20cm x 26cm x 26cm

Listen 2013
laser cut acrylic, ink

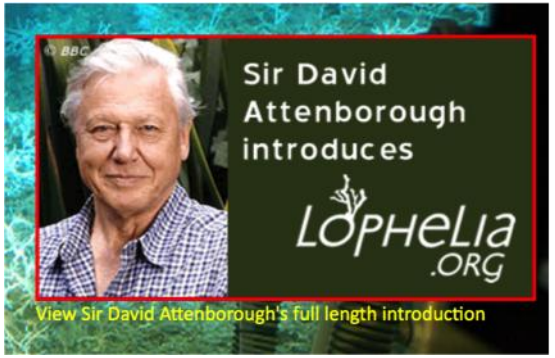
Loss III 2013
embossed relief print

Science behind art

Getting Very Important People Involved!

OUR OCEAN
US Department of State

conference website (www.state.gov/ourocean)



Search hits on “ocean acidification”:

October 2003 = 17 (total)
June 2006 = 267,000 (total)
February 2007 = 326,000 (total)
August 2007 = 356,000 (total)
October 2014 = 1,660,000 results (in 0.28 seconds)

Getting to the heart of the matter:

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Nina Bednaršek, NOAA: nina.bednarsek@noaa.gov

CEPA Fair
Music tent
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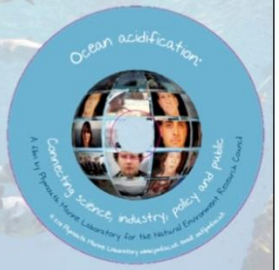

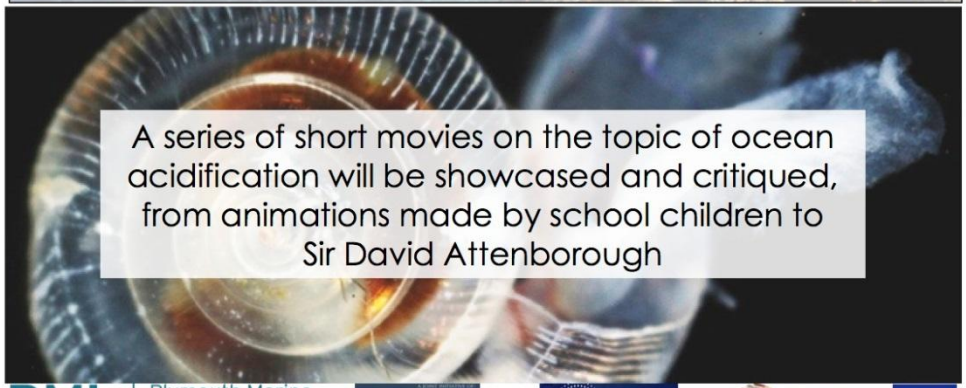

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