THE ENDLESS VOYAGE

"Dirty Water" Episode 125

Surprisingly, to most people, the vast amount of oil enters the ocean from runoff from rivers and so forth, which is essentially accumulated materials like dumping your engine oil in the wrong place.

We have dispersed pollutants into estuaries as a result of industrial operations like oil refineries and port and harbor facilities. We've disturbed the natural habitat of plants and animals and migrating or resident birds within estuaries.

The real fear with global warming is not that this average is gonna cause a problem. It's really that there are uncertainties in this system. It's not a linear system. It's not a simple system and the interaction of all the parts of the climate system can give us surprises. And these surprise—we have some hints at what they might be, could be the things that are devastating.

NARRATOR:
A PRISTINE AND SECLUDED BEACH, WARM SAND, GENTLE WAVES, A COASTAL OASIS UNSOILED BY THE IMPRINT OF HUMAN ACTIVITY. BUT NOT EVERY PLACE IN THE MARINE ENVIRONMENT IS SO FORTUNATE. THE IMPACT OF POLLUTION IS LOCALIZED IN SOME CASES, GLOBAL IN OTHERS—AT RISK, EVERYTHING FROM EARTH'S NATURAL BEAUTY TO THE HEALTH AND SURVIVAL OF ALL WHO LIVE HERE.

MICHAEL FOSTER:
In terms of pollutants in the marine environment, traditionally one of the ones that people worried about the most were sewage pollution.

JAMES ALLEN, Ph.D., So. California Coastal Water Research Project:
When you have a storm, the water runs off from the lawns, from the parking lots, from the streets and it carries all those contaminants that are in there. And this includes oil that people discharge there and all of this comes down through the storm drains and it comes out into the ocean.

NARRATOR:
THE AMOUNT OF OIL THAT REACHES THE OCEAN FROM TERRESTRIAL SOURCES GREATLY EXCEEDS THE OIL THAT COMES FROM TANKER SPILLS.

ERIC TERRILL:
Urban runoff and the oil drips out of cars are, in fact, probably in order of magnitude higher in level in terms of the amount of gallons that reach the ocean. So, in fact, it's not

the great catastrophic events we see but it's the general overall urbanization that brings oil to the coastline.

NARRATOR:
WHILE MOST OF THE OIL THAT'S INTRODUCED INTO THE MARINE ENVIRONMENT COMES FROM ROUTINE, EVERYDAY DISCHARGE, TANKER SPILLS DO REPRESENT ANOTHER SOURCE OF OIL POLLUTION. THE IMPACT OF THESE EVENTS VARIES, DEPENDING ON A NUMBER OF FACTORS, INCLUDING LOCATION.

MICHAEL FOSTER:
For example, if it's spilled well offshore, say a tanker lost power and blew up or something and spilled its oil where it has many, many days of, maybe even months to ever get to shore, the impacts are pretty minimal because a lot of the material either evaporates or mixes and gets sunk. So the main concern is when tankers get stranded or blowouts occur near shore. And in those cases, the two main impacts are on any organism that passes through the sea surface. So diving birds, sea otters, seals, those sorts of things that have an opportunity to oil themselves since the oil is floating on the surface.

ERIC TERRILL:
Birds, they swallow it or get it on their heads, they're going to be harmed by that. As it enters in the surf zone and gets whipped up into a froth, you will have animals interacting with that and becoming, you know, ill and die from that.

JUDITH McDOWELL:
During the early stages after a spill, many of the organisms can be narcotized. Compounds like benzene, zylene, napthalene, they're very high in concentration. They degrade very quickly so they don't persist for very long but many of the acute effects of oil, are the effects that these compounds can have on feeding mechanisms. Organisms cannot feed, they can't sense the food around them. They really have a narcotizing effect on these organisms and the organisms essentially starve to death because they can't detect their food.

MICHAEL FOSTER:
For invertebrates, the problem is primarily smothering their breathing apparatus. And then while they're feeding, if they ingest the oil itself, it can either clog their guts, or if there's enough volatile, toxic compounds left in it, can actually damage their cells and, you know, be acutely toxic.

The longer term consequences of these compounds are the more subtle effects that they'll have on metabolic pathways, on respiratory systems, on growth, on reproduction. And their persistence in the environment can be linked to the lower growth potential and lower reproductive potential of organisms that are exposed to these compounds for long periods of time.

NARRATOR:
IN STARK CONTRAST, THE IMPACT OF OIL SPILLS ON SOME OF THE LARGER PLANTS, INCLUDING MANY OF THE SEAWEEDS, CAN BE SURPRISINGLY SMALL WHEN THE OIL DOESN'T STICK TO THE PLANT'S NATURALLY SLIMY SURFACE.

MICHAEL FOSTER:
However, if it gets into areas, for instance, like sea grass beds which are seed bearing plants that don't have this slimy covering and whose cuticles—the covering of them—actually will absorb the oil, it can get very sticky and damage them quite severely, actually break down the cell membranes and kill them.

NARRATOR:
IF AN OIL SPILL DOES OCCUR, FIGURING OUT THE MOST EFFECTIVE RESPONSE CAN BE QUITE A CHALLENGE.

JUDITH McDOWELL:
In the very early days after a spill has occurred, physically containing the oil so that the slick does not move into sensitive areas, is one technique. It's probably effective for the surface slick, but as some of the oil begins to be dispersed, it does not control that portion of the oil which will go sub-surface and move with the currents.

Chemical dispersions are used in many instances, again to avoid a slick moving into a sensitive shoreline habitat. Those can be very effective in some circumstances but not effective in other circumstances. In the Exxon Valdez spill there was a lot of effort spent on steam cleaning the rocks in the intertidal zone. Many people wanted to do something to help the environment and they spent many hours out, steam cleaning the rocks and trying to rid the oil from the habitat. And these habitats were some that had really not much interaction with society. They'd never been walked on or very little human interference with the habitats in the past. How much the walking on the habitat and the steam cleaning itself—that in itself could have had a major impact on the habitat. So whether it helped get rid of the oil or it made it worse is questionable.

MICHAEL FOSTER:
We did some work in Alaska and other people have repeated some of it in other areas since then that actually shows if there's a reasonable amount of wave action, that you probably actually do more damage by cleaning the oil off which is generally done with very high pressure hot steam which essentially sterilizes the shore. You're probably better off actually to leave the oil alone, and let it naturally degrade if your concern is for the best recovery of the plants and animals. If your concern is with more of an image of the area and how it looks, then perhaps you should steam clean the shore. And this suggestion created quite a controversy but the various reviews since have sort of verified that in many cases, it's probably better just to leave it even if it's on shore.

JAMES HARVEY:
I think the best thing to do would be to try to get in and take the major oil that you can get your hands on right away, and do as best job you can with the immediate clean up and then get yourself out of there and let nature take its course after that.

JIM HARVEY, Ph.D., Moss Landing Marine Laboratories, CSU:
I think spending a lot of effort and time trying to get the last little drop of oil out of there actually does more harm than good.

NARRATOR:
BECAUSE CLEAN UP FOLLOWING AN OIL SPILL IS GENERALLY A DIFFICULT PROPOSITION AT BEST, MORE AND MORE EFFORT IS GOING INTO AVOIDING SPILLS IN THE FIRST PLACE.

MICHAEL FOSTER:
One way is by constructing ships with double hulls or even triple hulls, so that if they do run aground, there's a good chance that at least the inner hulls will retain their integrity and the ship can be dealt with, pulled offshore, pumped out before leakage occurs.

Another thing that's been done a lot is to move the shipping lanes further offshore or away from areas that might be particularly sensitive so that if an accident does occur, at least it occurs in a place that's further away.

NARRATOR:
AMONG THE AREAS HARDEST HIT BY MARINE POLLUTION ARE BAYS AND ESTUARIES, WHICH UNDER NORMAL CIRCUMSTANCES, ARE EXTRAORDINARLY PRODUCTIVE.

The greatest habitat destruction has occurred in bays and estuaries mostly because they were ideal places to develop. They were close to shipping and they were calm.

ANTONY ORME, Ph.D., University of California, Los Angeles:
Estuaries have a long history of human involvement, in part because they represent shallow water, in part because they represent sheltered water, where ports and harbors can be developed and where people can live protected from perhaps the ravages of storm-wave activity or high tidal ranges on the open coast. And therefore we find many of our estuaries throughout the world have been used for ports and harbors through time. And in that way, they've been severely manipulated.

NARRATOR:
IN FACT, IT IS THE VERY QUALITIES THAT MAKE ESTUARIES SO DESIRABLE—THEIR SHELTERED LOCATION, THEIR RELATIVELY CALM WATERS, THAT MAKE THEM ESPECIALLY VULNERABLE TO THE RAVAGES OF OIL SPILLS.

MICHAEL FOSTER:
Oil spills that have happened in estuaries where there's not a lot of water motion, not a lot of agitation to encourage bacterial action, and the material gets sedimented on. It'll stay varied as a layer for very, very long periods of time. There's a couple of classic spills when they were still detecting oil and oil products ten to twenty years after the event, but especially in estuarine bay type environments.

NARRATOR:
ESTUARIES ARE VULNERABLE TO MORE THAN JUST OIL SPILLS AND HARBOR DEVELOPMENT. THEY CAN ALSO BE HARMED BY THE CHEMICALS THAT POLLUTE THE FRESH WATER THAT FLOWS INTO THEM.

ERIC TERRILL:
One of the things that estuaries depend on are the freshwater input. And with the urbanization of the environment and with runoff now from an urban environment that comes with it, not only freshwater and sediment but say—oil runoff, pesticides that people use for their lawns, all these various suite of chemicals are also reaching the estuaries right now. So, urbanization, the paving of the environment inland of these estuaries is in fact, affecting the watersheds that bring the water to the actual estuary.

NARRATOR:
AMONG THE GREATEST THREATS TO ESTUARIES AND OTHER CLOSED BODIES OF WATER IS EUTROPHICATION.

ERIC TERRILL:
Eutrophication is the process by which high levels of nutrients are provided to the environment. So while these nutrients may not be toxic, it creates an imbalance in the ecosystem—the local ecosystem, where a certain species of animals may become more dominant because of the nutrients, the accelerated levels of nutrients present in the water.

JUDITH McDOWELL:
Nutrients are good in themselves in that they allow plants to grow. They allow the phytoplankton to grow and that's the basis of marine food chains. But in excess, you might get undesirable species to grow.

DENNIS J. McGULLICUDDY JR., Ph.D., Woods Hold Oceanographic Institution:
There are examples all over the world, where man has added nutrients into the ocean and you see massive profusions of phytoplankton, these sort of—what are known as harmful algal blooms can occur. And these take a variety of forms. But essentially when too many nutrients are added, that creates a tremendous mass of plankton and surface waters. When that becomes a problem is actually after that material dies and then sinks into the deeper layers of the coastal ocean. As that material then decomposes, it uses up all of the oxygen that is in the deeper part of the coastal ocean, causing what's known as anoxia or lack of oxygen, which kills the animals that need oxygen to breathe. For example fish and shellfish and what have you.

NARRATOR:
ALONG WITH OIL AND EXCESS NUTRIENTS, TOXIC METALLIC COMPOUNDS CAN ALSO MAKE THEIR WAY TO THE MARINE ENVIRONMENT AND CAUSE DAMAGE.

MICHAEL LATZ, Ph.D., Scripps Institution of Oceanography, UCSD:
In San Diego Bay, there's a problem because of many ships being present—of metals leaching off from the hulls. Metals are used in ship paints to reduce the growth of fouling organisms on the ships and also metals enter the marine environment from runoff. So, metals come into the marine environment in bays. The metals accumulate in the sediment, and there they can contaminate and accumulate in the marine organisms living on the bottom. So one example of this are brittle stars. Brittle stars are organisms related to seas tars that are found all over the world. And they crawl around in the sediment and eat the sediment. They accumulate metals. And so the concern is what effect do the metals have on the brittle stars and other organisms found in the coastal communities? Metals are accumulated and they are passed along through the food web. And so there is an accumulation of metals, which is of great concern.

NARRATOR:
WHILE THE TASK OF COMBATTING POLLUTION IN THE MARINE ENVIRONMENT CONTINUES TO PRESENT CHALLENGES, PROGRESS IS BEING MADE. PROBLEMS RELATED TO SOLID WASTE DISCHARGE FOR EXAMPLE, ARE HAPPENING MUCH LESS FREQUENTLY THAN THEY ONCE DID. AND TOXIC OUTBREAKS CAUSED BY CHEMICALS LIKE DDT AND MERCURY, WHICH AT VARIOUS TIMES HAVE CAUSED SERIOUS INJURY AND EVEN DEATH AMONG HUMANS AS WELL AS MARINE ANIMALS, ARE MUCH LESS COMMON THAN IN THE PAST. BUT THERE IS ONE POLLUTION-RELATED ISSUE LINKED TO THE MARINE ENVIRONMENT THAT SOME BELIEVE MAY BE GETTING WORSE. IT IS THE CONDITION KNOWN AS GLOBAL WARMING AND IT HAS SPARKED CONTROVERSY AND DEBATE ON A GLOBAL SCALE.

ANTHONY MICHAELS, Ph.D., Wrigley Institute of Environmental Studies, University of Southern California:
One of the big buzzwords and drivers really in the science that we do is this issue of global warming, whether or not by adding these greenhouse gases to the atmosphere we're warming up the temperature of the earth.

DAVID PIERCE, Ph.D., Scripps Institution of Oceanography, UCSD:
Human activity tends to release gases into the atmosphere. The one that scientists think about most is carbon dioxide which acts as a greenhouse gas. And what that means is the carbon dioxide traps the heat lower down to the surface. So if you're in a greenhouse, the sun shines through the windowpane—and you get warmed from that, then you warm up, you start emitting infrared radiation but the glass panes block that infrared radiation. They won't let it back out. So you get both the sunlight and the infrared coming at you

from the glass. Carbon dioxide has the same effect. It lets through the sunlight but it traps the infrared radiation. So it tends to make the surface of the earth warmer.

NARRATOR:
ONE OF THE REASONS MANY SCIENTISTS ARE SO INTERESTED IN CARBON DIOXIDE OR CO_2, IS THAT IT'S CURRENTLY BEING RELEASED INTO EARTH'S ATMOSPHERE IN GREATER AMOUNTS THAN AT ANY TIME IN THE RECENT PAST.

DONAL MANAHAN, Ph.D., University of Southern California:
The big debate now is not whether CO_2 is increasing. We know it is. Not if the temperature's increasing because we know it is. But is one driving the other? And it will require quite a deal of study to dissect this out, to be able to make convincing cases that one is driving the other. In my personal opinion, from reading the literature, and I believe that the evidence is very strongly leaning towards our production of CO_2 as a society is causing climate change.

With respect to current issues of global warming, this is a hot potato. It's a hot potato politically, it's a hot potato scientifically. And like with many other aspects of scientific inquiry, it's undergone periods of great heat and relative coolness. At the present time, we're in a period wherein there's a general belief that global warming is having a significant impact on sea level, on other aspects of coastal ecology and probably on life, generally.

NARRATOR:
THOSE WHO BELIEVE THAT GLOBAL WARMING IS A REAL AND SERIOUS PROBLEM OFTEN CITE SEA LEVEL RISE—A CHANGE IN THE LEVEL OF THE OCEANS, AS ONE REASON FOR THEIR CONCERN.

ANTHONY MICHAELS:
It can change for two reasons, either big chunks of ice that are now on land, ice sheets in Antarctica that break off and come into the oceans or raising it like an ice cube plopped into a glass, or because as the ocean warms, it expands. And a warmer ocean then is expanded essentially and that then raises the height of the column of water.

CHIP FLETCHER, Ph.D., University of Hawaii at Manoa:
Today we do know that sea level is rising, it's rising on the order of… 1.8 to 2 millimeters per year. That is a higher rate of rise than has been experienced over the last century or two. There are projections based on computer models of global warming in the future, that sea level will not only continue to rise, but that it will accelerate its rate of rise—and that we have actually put enough heat into the oceans and into the atmosphere that we're currently committed to a sea level rise on the order of several centuries.

MICHAEL FOSTER, Ph.D., Moss Landing Marine Laboratories, CSU:
It's going to have huge consequences for some nations in which most of their country is just slightly above sea level. Large parts of Indonesia, for instance. And when you hear

about typhoons wiping out parts of India—those are low-lying places that are affected by hurricanes over the ocean. They're going to be greatly affected by rises in sea level. So there'll be a lot of consequences for human beings.

NARRATOR:
WHILE GLOBAL WARMING MAY INDEED PLAY A PART IN SEA LEVEL RISE, SOME SCIENTISTS CAUTION AGAINST PUTTING TOO MUCH EMPHASIS ON THE LINK BETWEEN CLIMATE CHANGE AND SEA LEVEL FLUCTUATION.

ANTONY ORME, Ph.D., University of California, Los Angeles:
There's enough circumstantial evidence to suggest from tide gauges and other information that sea level is rising gently towards the land at the present time. Not enough to make us run out and abandon our coastal properties but certainly rising. But sea level is a very complex matter and sea level change is the response to a whole series of forces at work within the coastal zone and within the ocean basins and the earth's crust as a whole.

NARRATOR:
THOSE WHO BELIEVE THE GLOBAL WARMING THREAT IS REAL, ARE ALSO CONCERNED ABOUT ITS POTENTIAL IMPACT ON OCEAN CIRCULATION.

PETER RHINES, Ph.D., University of Washington:
If sufficient warming occurs at high latitudes to melt ice, and if more precipitation lands on the oceans at high latitude, you'll create a super layer of very buoyant fresh water will float out. And it's been known to happen—at the terminus of the last Ice Age. This super layer of buoyant water can insulate the ocean from the atmosphere and basically shut down the overturning and sinking circulations for a time probably not forever but possibly for a hundred years. And the changes in circulation would be more dramatic than one can imagine really. Whether or not it would freeze Europe because it would prevent the oceanic heat from being carried northward by the circulation—that is one prediction. I think that's overly dramatic. However, major changes in the lives of people living in the north would be inevitable.

NARRATOR:
IN ADDITION TO POSSIBLE CONNECTIONS BETWEEN CLIMATE CHANGE AND CIRCULATION, THE WORLD OCEAN MAY BE LINKED TO THE GLOBAL WARMING STORY, IN A NUMBER OF OTHER WAYS.

ROSS HEATH, Ph.D., University of Washington:
We can determine something about land temperatures, or in fact temperatures for the whole world, from looking at ocean temperatures, because it's all very much connected. In fact, the atmosphere has a very short memory. It forgets everything that's happened to it in about two weeks whereas the ocean remembers for decades. So if the ocean warms up a little, then we know that the world climate is going to warm up a little and will continue for quite a while.

NARRATOR:
MANY SCIENTISTS BELIEVE THEY CAN BETTER UNDERSTAND TODAY'S CLIMATE PATTERNS BY COMPARING THEM TO THOSE FROM THE PAST. ONE WAY THIS IS DONE IS BY EXAMINING ANCIENT SEDIMENT SAMPLES.

JAY YETT, Ph.D., Orange Coast College:
When you look at the sediments and the animals that are found within the sediments, if you have representatives still living today, the same kinds of animals, you can make some inferences about what those environmental conditions were in the past that would allow that organism to live in that particular area. And the interesting thing about looking at sediments is that you can have a very long record—you know, it could be millions of years. So we can get an idea of what past climates might have been—give us a much longer time interval to look at climatic changes, which is important when you start to look at issues about global warming, etc. The longer period or longer record that you have, the better your interpretations will be.

NARRATOR:
BUT THE ROLE OF THE OCEAN IN GLOBAL WARMING, GOES WELL BEYOND THE CLUES IT HOLDS ABOUT PAST CLIMATE.

PETER BREWER, Ph.D., Monterey Bay Aquarium Research Institute:
It was realized by the late 1950's, that the ocean is so powerful, that perhaps 30 to 40 percent of all of the carbon dioxide emitted from our factory chimneys and our automobiles and so on—after a short residence time in the air, it would be taken up by the ocean. And the reason we do not have a far worse greenhouse gas problem today than we do, is because the ocean is taking up our waste material—our energy waste.

WILLIAM JENKINS, Ph.D., Woods Hole Oceanographic Institution:
The oceans represent such a substantial carbon reservoir that it will, in some sense, be the primary recipient of the anthropogenic carbon dioxide insult that we're providing for the environment. How rapidly it takes up the CO_2 is crucial because it will play a role in regulating the atmospheric CO_2 concentration over time.

NARRATOR:
ACCORDING TO SOME, ONE WAY TO INCREASE THE AMOUNT OF CARBON TAKEN UP BY THE OCEAN IS TO INCREASE MARINE PHOTOSYNTHESIS, POSSBILY BY ADDING IRON TO THE OCEAN. A NUMBER OF EXPERIMENTS HAVE BEEN CONDUCTED TO TEST THIS THEORY.

KENNETH COALE, Ph.D., Moss Landing Marine Laboratories, CSU:
Small amounts of iron were added to sea water, parts per trillion level of iron were added to seawater and massive blooms result. This supports the notion that iron—is kind of a key that controls ocean productivity and as a result, may affect the exchange of CO_2 between the atmosphere and the oceans.

NARRATOR:
BUT SOME SCIENTISTS BELIEVE THAT SIMPLY DRAWING DOWN MORE CO_2 INTO THE OCEAN IS NOT ENOUGH.

LIHINI ALUWIHARE, Ph.D., Scripps Institution of Oceanography, UCSD:
What you really want to do is try to get that CO_2 out of the surface ocean somehow into the deep ocean or into the sediments. The deep ocean doesn't come back into contact with the atmosphere for timescales 1000 or just over 1000 years.

KATHERINE BARBEAU, Ph.D., Scripps Institution of Oceanography, UCSD:
You can generate a large bloom of phytoplankton in some areas if you add iron. But whether that carbon actually gets effectively taken out of the surface ocean and goes into the deep ocean, or whether there's respiration high enough in the water column, that a lot of that CO_2 is re-released, is not clear.

LIHINI ALUWIHARE:
Much of the carbon that's produced by photosynthesis—the organic carbon—is taken up and degraded very quickly, and this happens in the surface ocean. And so what you have is CO_2 going to organic carbon, going back to CO_2 in the surface ocean, and there's a cycle. And only about 1% of the carbon as we know it, actually escapes that cycle into the deeper ocean. So most of it's recycled. So, not only do we have to increase photosynthesis, we have to find a way of getting that carbon out of the surface ocean into the deep ocean.

NARRATOR:
APART FROM THE PURELY SCIENTIFIC CHALLENGES OF TRYING TO COME TO GRIPS WITH CLIMATE CHANGE, THE GLOBAL NATURE OF THE PROBLEM MAKES IT EVEN MORE DIFFICULT TO ADDRESS. AND IN FACT, THIS IS TRUE WITH MANY OF TODAY'S MOST VEXING POLLUTION PROBLEMS.

Although the United States is the main contributor, it's not something that just we need to deal with. And so it requires a level of cooperation beyond local or national governments. And so achieving sort of worldwide clean water acts or clean air acts is much more difficult. And I'm actually not very optimistic about the success of reducing CO_2 levels.

It's great to talk about renewable energy and so forth, it's hard for me to imagine that occurring at a scale soon enough to change what's happened. And the ramifications of that are enormous. The earth is going to change. So, I don't know, I guess I'm happy that the sewers are doing better. I'm happy that discharges are regulated better. But I'm sort of a bit frightened about what's going to happen in the future. It's going to be a different world.

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