Docket EF-131590

Tesoro Savage CBR
Scoping Comment
#199

How can we explain to future generations that we selfishly destroyed a marine ecosystem that took 30 million years to evolve?

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Our state is at a crossroads. We can continue using fossil fuels, "business as usual" and build a crude oil terminal here in Vancouver. But at what cost? Ocean acidification will increase and our oceans will be dead in less than 100 years. Even worse, climate change will get worse and the human race will become extinct. Long before humans finally die off, they will be fighting over land, food and water.

I believe your choice is clear. You must study the impact this oil terminal will have on our oceans and climate change. Future generations are counting on you to do the right thing.

Date: October, 29, 2013
To: The Energy Facility Site Evaluation Council (EFSEC)
Public Comment on the proposed: Port of Vancouver Tesoro Savage Crude Oil Terminal
From: Virginia Nugent 5111 NE 125th St Vancouver WA

To back up my public comments I am submitting the following information for your thoughtful consideration:

1. A copy of my oral public testimony October 29th Scoping Hearing for the Port of Vancouver oil terminal proposal.
2. April 16, 2013 article, Panel: Ocean Acidification Threatening Sea Life Here, published in the Peninsula Daily News.
3. Christine O. Gregoire's November 27, 2012, Executive Order 12-07 Washington's Response to Ocean Acidification.
4. An Article titled, Threat To Oceans Isn't Fiction, by **Representative Jay Inslee.**
5. A fact sheet from the video, Acid Test: The Global challenge of Ocean Acidification." Produced by the Natural Resources Defense Council.
7. An article titled, Ocean Acidification Threatens Marine Life. The Seattle Times, 10-2013
6. Fast Facts: Coral Reefs are being Lost Twice as Fast as Rainforests.

Date: October, 29, 2013
To: The Energy Facility Site Evaluation Council (EFSEC)
Public Comment on the proposed: Port of Vancouver Tesoro Savage Crude Oil Terminal
From Virginia Nugent 5111 NE 125th St Vancouver WA

As a mother and grandmother I'd like to speak on behalf of future generations and urge you to study the impact that a crude oil terminal in Vancouver will have on climate change, ocean acidification, and our state's shellfish industry. I have always been awestruck by the vastness of the ocean and the beauty of the life it contains. I thought this treasure on earth, would last forever. Sadly, I was wrong.

Three hundred million years ago, the ocean became too acidic, and sea life worldwide, was wiped out. This became known as the Great Mass Extinction. It could happen again. Burning fossil fuels, releases CO2, causing our oceans to become more acidic. Ocean acidity is increasing at the fastest rate in at least 300 million years. In 100 years our oceans could be dead. How can we possibly explain to future generations that we destroyed a marine ecosystem that took 30 million years to evolve?

Increased ocean acidity prevents oyster larvae from forming their shells. In 2005, oyster larvae started dying by the billions along the Pacific Northwest Coast. Are we willing to sacrifice our state's $270,000,000 shellfish industry that provides 3,200 good jobs, for a crude oil terminal?

Our state should set an example to the nation and the world by saying "NO", to increased use of fossil fuels, and instead lead the way toward a green energy future.

Thank you.

Virginia Nugent

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Article published Apr 16, 2013

Panel: Ocean acidification threatening sea life here

By Rob Ollikainen
Peninsula Daily News

PORT ANGELES — Acidification of the world's oceans could have a profound effect on the North Olympic Peninsula, a panel of experts told Clallam County commissioners Monday.

Caused by carbon dioxide from the burning of fossil fuels, ocean acidification can destroy shells of crabs, clams, oysters and scores of creatures at the bottom of the food chain.

The Strait of Juan de Fuca, Puget Sound and outer coast of Washington are particularly vulnerable because acidic water is upwelled off the coast every spring and summer.

The state supports 42,000 jobs in the seafood industry.

"There is no silver bullet," said panelist Eric Swenson, Seattle-based communications and outreach director for the Global Ocean Health Program.

"'It's a whole number of lead bullets that are going to make this happen."

Swenson was joined by members of the Washington State Blue Ribbon Panel on Ocean Acidification, which recently reported that 80 percent of the oyster larvae in some hatcheries were killed by acidification.

The Clallam Marine Resources Committee invited the governor-appointed panel to speak at the commissioners' work session.

The same panel was scheduled to make a presentation at the Port Angeles Senior Center Monday night.

After the work session, Swenson said that raw sewage from Victoria is not contributing to acidification in the Strait.

"There is no real effect on the quality of ocean water that comes out of Victoria," he said.

"If there were 10 Victorias, maybe there would be a problem. But the power of the currents and what comes through, they've got a good cause for the fact that they're not causing any harm to the ocean."

Ed Bowlby, a marine resource committee member and research coordinator for the Olympic Coast National Marine Sanctuary, said that "it may be a different story" on the north side of the Strait, adding: "We haven't seen any effects here."

Brad Warren, director of the Global Ocean Health Program, used his time to summarize the panel's work and present its recommendations.

Swenson said there is little doubt that ocean acidification is being caused by humans.

"Just like DNA evidence, there are fingerprints left on the isotopes, and the ratio between carbon 12 and carbon 13 is definitive," he said.

"It shows that this came from burning fuel, and therefore our fingerprints are all over the carbon."

The water being upwelled off the coast came from the surface of the South China Sea about 40 years ago.

"We've got 40 years or so of bad water ahead of us, or increasingly bad water, because of our increasing emissions of CO^2," Swenson said.

"We can't do anything about that except strive to protect the resources we have, and try and adapt to what we know is coming our way. What we must do, on the big problem, is reduce our CO^2 significantly."

Acidification is measured on a pH scale of 0 to 14, with neutral water being a 7 and battery acid rating 0.

"We're are [at] about 8.1 right now," Swenson said.

"Before they started out with the industrial revolution, they were about 8.2. That seems like a minuscule drop, but this is a logarithmic scale. So that drop of 0.1 percent equals a 30 percent increase in acidity."

A University of Washington professor began studying the effects of acidification at Tatoosh Island about 30 years ago.

In 2000, the work was passed onto researchers from the University of Chicago, who became "alarmed at what they're finding," Swenson said.

The panel found that more than 30 percent of the marine species in the Strait of Juan de Fuca and Puget Sound are vulnerable to acidification.

"The calcifiers are the first to be hit," Swenson said.

"In addition to the disruption of the food chain, there is a direct effect on fin fish."

Among the vulnerable species is the pteropod, a shelled snail whose demise would cause "important ripple effects on the wider food chain," said Nina Bednarsek, a National Oceanic and Atmospheric Administration scientist.

"This would be one of the first species to be severely affected by the ocean acidification,"

Bednarsek said, while showing slides of rapidly deteriorating pteropod shells.

Other speakers included Betsy Peabody, founder of the Puget Sound Restoration Fund, and John Forster, a Port Angeles consultant who is exploring seaweed aquaculture as a means to "make a meaningful contribution to the food supply" while reducing local carbon levels.

Former Gov. Christine Gregoire appointed the 28-member panel on ocean acidification in February 2012.

To see its findings and 42 recommendations, which were presented in November in Seattle, visit http://tinyurl.com/oceanacidificationreport.

Reporter Rob Ollikainen can be reached at 360-452-2345, ext. 5072, or at rollikainen@peninsuladailynews.com.

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CHRISTINE O. GREGOIRE
Governor

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EXECUTIVE ORDER 12-07

WASHINGTON'S RESPONSE TO OCEAN ACIDIFICATION

WHEREAS, acidification of the world's oceans, measured by the lowering pH numbers and caused primarily by increasing levels of carbon dioxide in the atmosphere, has arrived on the West Coast sooner than predicted and is already reaching levels that are corrosive for shellfish and other marine organisms; and

WHEREAS, Washington's marine waters are particularly vulnerable to ocean acidification because they experience the effects of global carbon dioxide absorbed by the oceans in addition to regional and local factors. One of the most important regional factors is coastal upwelling, which occurs when strong northerly winds blow across the Pacific Ocean, bringing deeper water up to the surface, along the Washington coast, into coastal estuaries like Willapa Bay and Grays Harbor, and the Puget Sound basin. Today's upwelled water is rich in carbon dioxide and low in pH and oxygen, and was in contact with the atmospheric concentration of carbon dioxide from 30 to 50 years ago, meaning we will continue to see acidification for several decades after global carbon dioxide emissions begin to fall; and

WHEREAS, acidification near the coasts, and particularly in highly populated and developed areas, is often exacerbated by local sources of pollutants, such as nutrients and organic material, that generate additional carbon dioxide in marine waters; and

WHEREAS, between 2005 and 2009, the Pacific Northwest oyster hatcheries experienced disastrous production failures when billions of their youngest oysters, the larvae, died due to acidified seawater that dissolved shells or prevented their formation; and

WHEREAS, Washington is the country's top provider of farmed oysters, clams, and mussels. Our shellfish growers employ directly and indirectly more than 3,200 people around the state and provide an annual total economic contribution of $270 million statewide. The increasing levels of acidification in Washington's marine waters pose serious and immediate threats to our shellfish resources, and the revenue and jobs supported by the shellfish industry; and

WHEREAS, ocean acidification has important implications to Washington's tribal communities and fishermen who increasingly depend on shellfish species to support their families; and

WHEREAS, increasing levels of acidity also have implications for the broader marine ecosystem because many organisms that are important food sources for species such as salmon, whales, and seabirds, are dependent on their ability to form and maintain shells, skeletons, or other hard parts; and

WHEREAS, Washington is a national leader in addressing the problem of ocean acidification. World-class scientists are already working on ocean acidification; state agencies, businesses, tribes, and others are implementing innovative approaches to reduce carbon dioxide and nutrient runoff; federal partners are engaged on solutions to ocean acidification; the shellfish industry is committed to protecting ecosystems and cultivated resources; and diverse nonprofit organizations are ready to give voice to the problem; and

WHEREAS, to chart a course for addressing the effects of ocean acidification on Washington's shellfish resources and other marine organisms, I convened the Washington State Ocean Acidification Blue Ribbon Panel comprised of scientific experts, industry representatives, public opinion leaders, and state, local, federal, and tribal policy makers; and

WHEREAS, the Panel produced a *Scientific Summary of Ocean Acidification in Washington State Marine Waters* and a set of recommended actions in a document titled *Ocean Acidification: From Knowledge to Action – Washington's Strategic Response to Changing Ocean Chemistry*, documenting the understanding of ocean acidification in Washington, and recommending actions to reduce contributions to the problem, help the shellfish industry adapt to changes, advance our knowledge about acidification in Washington's marine waters, and educate and engage stakeholders, the public and decision makers in addressing the problem; and

WHEREAS, it is critical to our economic and environmental future that effective and immediate actions be implemented in a well-coordinated way and that we work collaboratively with federal, tribal, state, and local governments, universities, the shellfish industry, businesses, the agricultural sector, and the conservation/environmental community to address this emerging threat.

NOW, THEREFORE, I, Christine O. Gregoire, Governor of the state of Washington by virtue of the power invested in me by the Constitution and statutes of the state of Washington do, effective immediately, hereby order and direct:

1. The Office of the Governor and the cabinet agencies that report to the Governor to advocate for reductions in emissions of carbon dioxide at a global, national, and regional level. The Office of the Governor and cabinet agencies shall work on this effort with federal and regional partners (including at a minimum Oregon, California, and the Province of British Columbia) and shall consult with affected public and private entities.

2. The Director of the Department of Ecology to:

   a) Coordinate effective implementation of the Blue Ribbon Panel's recommendations. In doing so, the Department shall work with other state agencies, the Commissioner of Public Lands, the University of Washington, the National Oceanic and Atmospheric Agency (NOAA), the Environmental Protection Agency (EPA), Tribes, non-governmental organizations, and the shellfish industry. This effort will require coordination of numerous activities at the national and regional level aimed at protecting and restoring the health of our marine waters.

b) Work with the University of Washington (UW), the Commissioner of Public Lands, NOAA and other state agencies to establish a coordinating mechanism to: continue the focused and productive interaction between scientists and decision makers to enhance Washington's ability to respond to the problem of acidification; promote sharing of scientific information; and secure efficiencies in implementing the Panel's recommendations. In doing so the Department shall build on existing efforts such as the Puget Sound Strategic Science Plan, the UW coastal and marine research programs, NOAA Ocean Acidification Program, California Current Acidification Network, Pacific Shellfish Institute, and other related efforts.

c) Craft and execute a memorandum of understanding or other mechanisms among key state and federal agencies, including Departments of Natural Resources and Fish and Wildlife, NOAA, EPA, and U.S. Department of Interior, to support data sharing, collaboration, and leveraging and prioritizing of funds.

d) Work with the University of Washington to deliver the technical analysis recommended by the panel on the relative importance to ocean acidification of local land-based sources of nutrients and organic carbon and local air emissions.

e) Reduce nutrients and organic carbon in locations where these pollutants alone, or in combination with other pollutants, are causing or contributing to multiple water quality problems in our marine waters. This effort shall be coordinated with the Directors of the Department of Agriculture and Department of Health, and the Executive Director of the Conservation Commission. In implementing this directive, Ecology with its partners shall prioritize watersheds with the most significant water quality problems, regardless of the source(s) – urban storm water, septic tanks, large and small sewage treatment facilities, or rural runoff from agricultural lands. This effort shall be carried out in consultation with other agencies, affected local and tribal governments, federal agencies, landowners, and the environmental community. These efforts shall:

   i. build on existing programs;
   ii. utilize, where appropriate, the voluntary stewardship program established by RCW 36.70A.710; and
   iii. utilize other approaches, including technical assistance, funding, permitting and enforcement, where most appropriate and effective.

f) Formally request that EPA begin the assessment of water quality criteria relevant to ocean acidification and encourage EPA to work with scientists from NOAA, Ecology, and other agencies in carrying out this effort.

g) In consultation with the Department of Commerce and Department of Transportation, review unimplemented actions recommended by the Climate Action Team and identified in the State Energy Strategy and, where appropriate, propose a path forward to implement additional actions to reduce atmospheric

carbon dioxide. In developing the proposed actions, the Department of Ecology shall consult with affected stakeholders.

h) Work with other agencies, NOAA, universities, the Puget Sound Partnership, WA Sea Grant, shellfish growers, Tribes, non-governmental organizations, and various education and outreach networks to increase understanding of ocean acidification and its consequences among policymakers, interested organizations, and the public.

i) Work with other state agencies, the Commissioner of Public Lands, and appropriate federal agencies to engage agricultural, business, and other stakeholders; coastal communities; shellfish and fishery interests; and other affected or interested groups, in developing and implementing local solutions.

3. The Executive Director of the Puget Sound Partnership to work with its partners to advance the implementation of the Panel's recommendations by incorporating the scientific findings, and strategies and actions into the Puget Sound Action Agenda, the Biennial Science Work Plan, and ecosystem monitoring programs, by December 1, 2014.

4. In implementing this Executive Order, the state and its agencies shall invite consultation, on a government-to-government basis, with affected and interested Indian Tribes and Nations in Washington State.

5. The Director of the Department of Ecology, in cooperation with affected agencies, shall provide a progress report to the Governor by December 31, 2013.

Signed and sealed with the official seal of the state of Washington on this 27th day of November, 2012, at Olympia, Washington.

By:

/s/

Christine O. Gregoire
Governor

BY THE GOVERNOR:

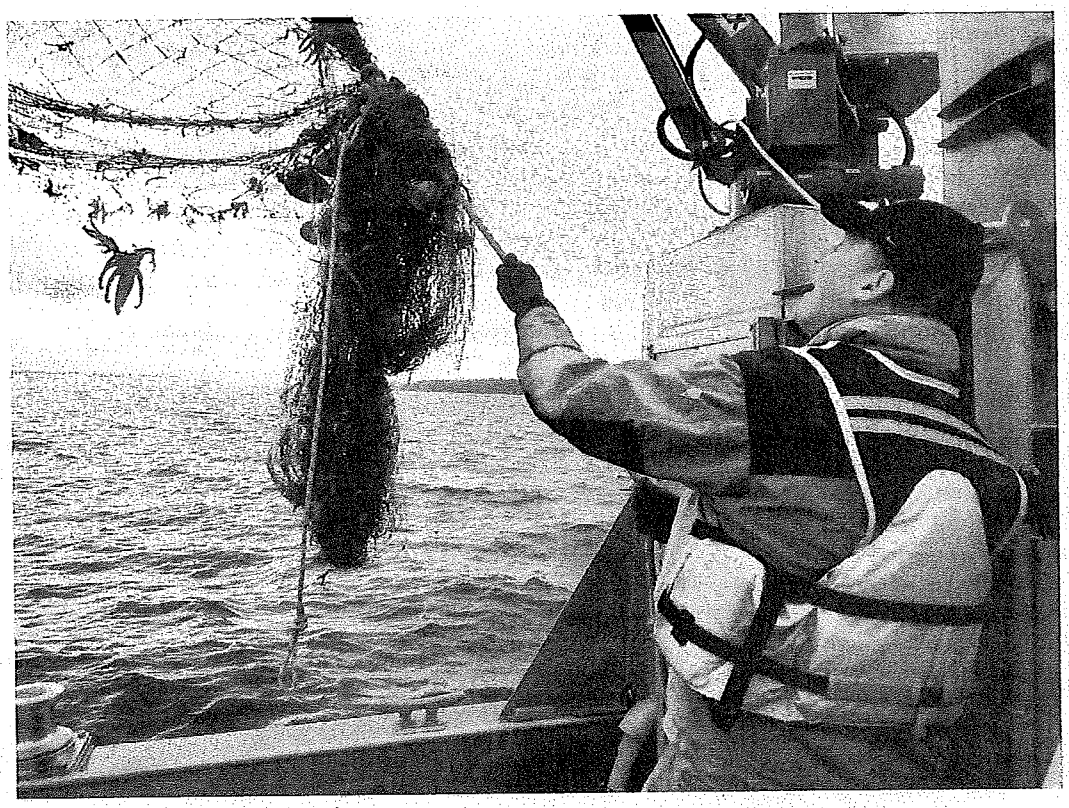
/s/

Secretary of State

Threat to Oceans Isn't Fiction

by Representative Jay Inslee

Mark Twain famously noted that truth can be stranger than fiction. A corollary to that notion would be those who work in fiction are often the best truth tellers. Recently, a brilliant physicist and a famous movie star offered their views on threats to our planet Earth. Amazingly, it turns out the movie star was more accurate than the physicist.



Representative Jay Inslee removes derelict gear on a recent NW Straits Initiative outing

Renowned physicist Steven Hawking talked about the risk aliens might someday pose to earth. In contrast, Sigourney Weaver stood before Congress and warned of rising ocean acidification. In this case, we best heed the warning of the movie star rather than the science star, because the actress and her documentary, *Acid Test,* show the immediate threat to our planet if we do not act on carbon pollution – the oceans will die.

Ms. Weaver eloquently narrates *Acid Test,* a tale much more terrifying than her movie *Aliens.* This new documentary explains what is now happening in our oceans: the unrelenting and accelerating acidification of the seas, a disturbing 30% increase in acidity that is already on a path to make the seas so acidic in this century that healthy coral may no longer be able to live anywhere on the planet. This acidity is created as carbon dioxide is spewed from our smoke stacks and tail pipes, carbon dioxide which is then absorbed into our oceans and creates acid by the gigatons.

Thousands of species form their very body structures by precipitating calcium carbonate out of the seas to form their shells, their spines, and their bodies. As the oceans become more acidic, more acidic than they have been for 400,000 years, these citizens of the deep can no longer take up that calcium and form their bodies.

This bright but acidic sea water is more dangerous to humans than the creepy creations in James Cameron's *Aliens* because the sea is a significant source of protein.

That vast food supply is threatened because it is built upon a food chain that could collapse as the bottom links of the chain disappear. The most basic link of that chain are the pteropods, little plankton that swim about by the gazillion, that have begun to show signs of melting in the most acidic waters of the Arctic already.

No bill in Congress can shield us from aliens from a distant galaxy, but there is a bill ready to go that can build a clean energy economy, reduce carbon pollution, and thus save us from ocean acidification. When that bill passes, we will ignite a revolution in clean energy technology that will help wean us from our oil addiction so that we do not destroy the oceans with the carbon pollution we now so needlessly inject into the air, and thus, the waters.

If you'd like to help reduce ocean acidification and climate change, please contact Sarah Rasmussen, Coal-Free Washington Campaign, 206-378-0114 x 316.

Acid Test

The Global Challenge Of Ocean Acidification

Produced by Natural Resources Defense Council

"One hundred years ago our ocean was inexhaustible. You couldn't touch it. You couldn't harm it. Now, in 100 years it might be dead"

- **Our oceans are rapidly becoming more acidic due to CO_2 emissions caused by burning fossil fuels.**
- **"Since the Industrial Revolution, the oceans acidity has increased by 30%. If we continue to emit CO_2 at these rates, we will double the oceans acidity by the end of the century."**
- **"Science models show that in just a few decades we will profoundly change the ocean's chemistry. Such conditions haven't existed since the age of the dinosaurs. This is happening so quickly that many ocean species will be unable to adapt and become extinct."**
- **The bottom of the food chain, plankton and other species are having difficulty making their shells due to the increase in ocean acidity. Their shells are becoming thinner and dissolving away.**
- **"If the food chain is disrupted at the smallest level it will have a ripple effect and hurt the largest creatures in our ocean".**
- **"Once the food chain is broken, the ability for all species to survive is threatened. Our oceans could be dead, "a Sea of weeds" in 100 years."**
- **Warmer ocean temperatures and increasing acidity threaten coral reefs. Coral reefs are home to millions of species. We have ten years to reduce emissions or our coral reefs will be gone in 20-30 years.**
- **We caused this problem and we need to solve it. The solution is to reduce our CO_2 emissions. We need to stop burning fossil fuels, and make a transition to green energy.**

Ocean acidification threatens marine life

Sea chemistry changing at record pace due to CO2

By CRAIG WELCH
The Seattle Times

NORMANBY ISLAND, Papua New Guinea — Katharina Fabricius plunged from a dive boat into the Pacific Ocean of tomorrow.

A bleak portrait emerged: Instead of tiered jungles of branching, leafy corals, Fabricius saw mud, stubby spires and squat boulder corals. Snails and clams were mostly gone, as were worms, colorful sea squirts and ornate feather stars.

Instead of a brilliant coral reef like the one living a few hundred yards away, what the Australian Institute of Marine Sciences ecologist found resembled a slimy lake bottom. The cause: carbon dioxide.

OCEAN HEALTH

A three-part Seattle Times series on the effects of ocean acidification

PART ONE

In this volcanic region, pure CO2 escapes naturally through cracks in the ocean floor, altering the water's chemistry the same way rising CO2 from cars and power plants is changing the marine world.

As a result, this isolated bay offers a chilling view of the future of the seas under attack what fish eat.

Those changes pose risks for food supplies, from the fillets used in McDonald's fish sandwiches to the crab legs sold at seafood markets. Both are brought to the world by a Northwest fishing industry that nets half the nation's catch.

Sea-chemistry changes are coming as the oceans also warm, and that's comes at a price.

Reefs are just one way shifting ocean chemistry can harm fish.

In 2007, American biologist Danielle Dixson, then a graduate student at Australia's James Cook University, was studying the important ways clownfish use their noses to navigate the ocean. Then she bumped into James Cook professor Philip Munday.

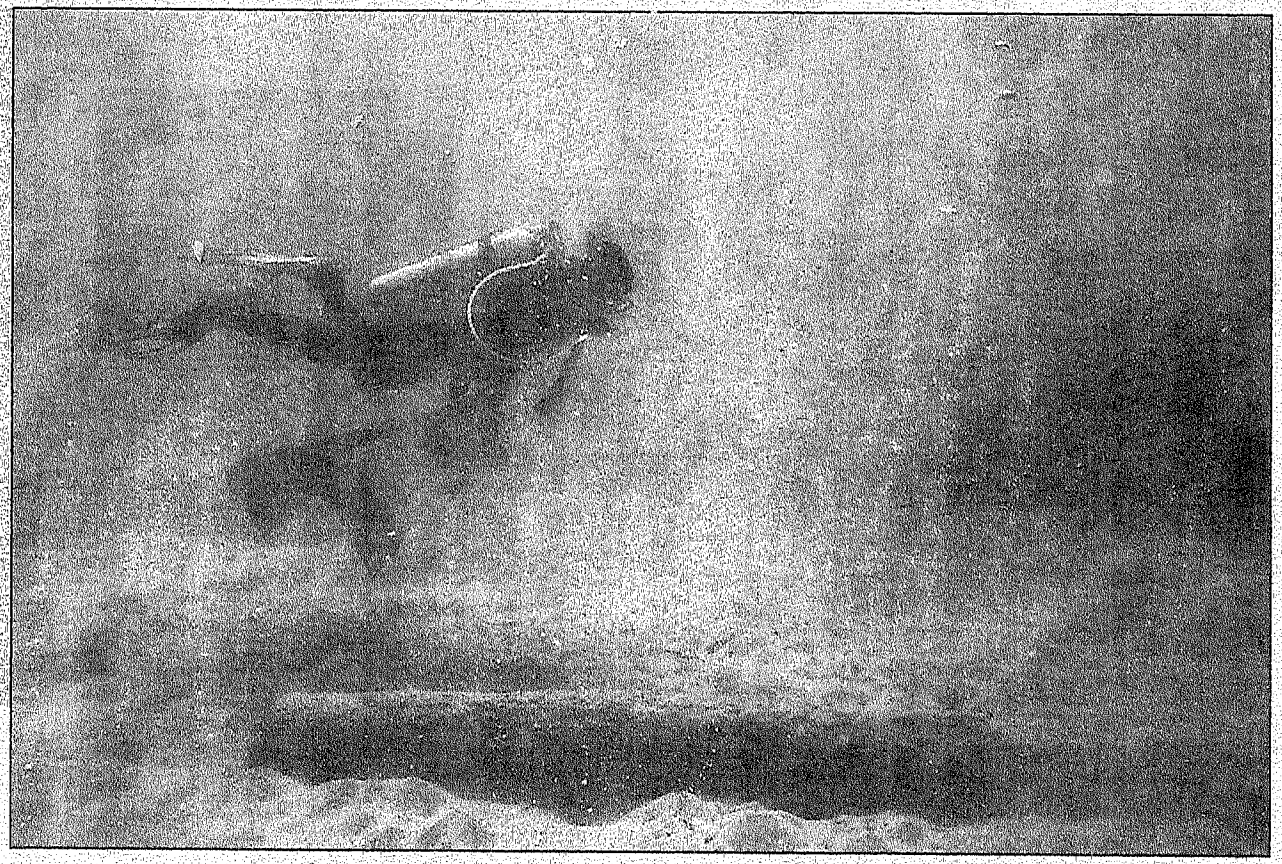
Munday had been trying to see if carbon dioxide hurt fish. The pair decided, on a whim, to see if CO2 altered how fish use their noses. Their findings were a shock.

Exposed to high CO2, the fish lost their ability to distinguish among odors. Since clownfish use smell to stay safe, the scientists then exposed baby fish in high-CO2 water to bigger fish that eat young clownfish.

Normal clownfish always avoided the danger. The exposed fish lost all fear. They swam straight at predators.

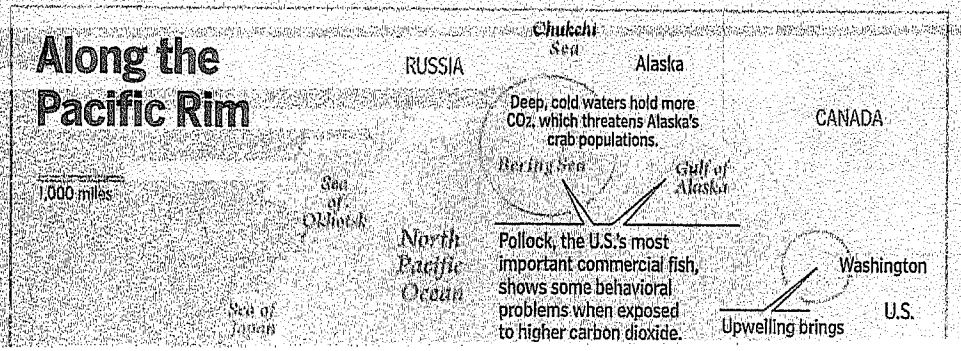
Over the next few years, scientists learned CO2 changed many reef fishes' senses and behaviors: their sight, hearing, the propensity to turn left or right. Most important, that caused them to die two to five times more often.

Last year, researchers figured out why. Elevated CO2 disrupts brain signaling in a manner common



Photos by STEVE RINGMAN/Seattle Times

Katharina Fabricius swims through carbon-dioxide bubbles off Papua New Guinea in January. The waters here offer a glimpse of how acidification is likely to transform the seas.



ocean acidification.

As the b[illegible]ing of coal, oil and nat[illegible] gas belches carbon dioxide into the air, a quarter of it gets absorbed by the seas, changing ocean chemistry faster than at any time in human history.

To understand how that will alter the seas, The Seattle Times crisscrossed the Pacific Ocean from Papua New Guinea to Alaska, interviewed nearly 150 experts and people most likely to be affected, and reviewed most of the peer-reviewed studies.

The Times found that ocean acidification is helping push the seas toward a great unraveling that threatens to scramble marine life on a scale almost too big to fathom — and far faster than first expected.

Already, it has killed billions of oysters along the Washington coast and at nearby hatcheries. It's helped destroy mussels on some Northwest shores. It is a suspect in the softening of clam shells and in the death of some baby scallops. It already is dissolving tiny plankton, called pteropods, in Antarctica that are eaten by many ocean creatures — and that wasn't expected for 25 years.

The problem: When carbon dioxide mixes with water, it takes on a corrosive power that erodes some animals' shells or skeletons. It also robs the water of ingredients animals use to grow shells in the first place.

New science shows ocean acidification also can bedevil fish and the animals that eat them, from sharks to whales and seabirds. Shifting sea chemistry can cripple the reefs where fish live, rewire fish brains and

expected to frequently amplify the impacts.

This transformation — once not expected until the end of the century — will be well under way, particularly along the West Coast, before today's preschoolers reach middle age.

"I used to think it was kind of hard to make things in the ocean go extinct," said James Barry, of the Monterey Bay Aquarium Research Institute in California. "But this change we're seeing is happening so fast it's almost instantaneous. I think it might be so important that we see large levels, high rates of extinction."

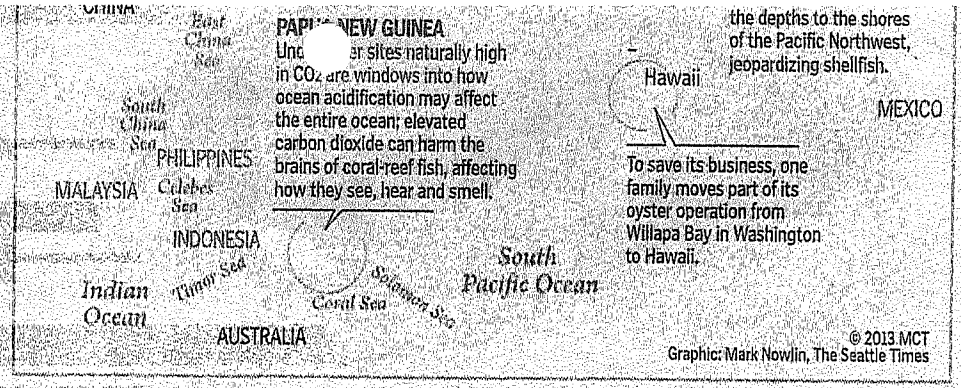
Globally, the world can arrest much of the damage by bringing down CO2 emissions soon. But the longer it takes, the more permanent these changes become.

"There's a train wreck coming, and we are in a position to slow that down and make it not so bad," said Stephen Palumbi, a professor of evolutionary and marine biology at Stanford University. "But if we don't start now, the wreck will be enormous."

The country isn't doing much about it. Combined nationwide spending on acidification research for eight federal agencies, including grants to university scientists by the National Science Foundation, totals about $30 million a year — less than the annual budget for the coastal Washington city of Hoquiam, population 10,000.

The federal government has spent more some years just studying sea lions in Alaska.

Species' reaction to high CO2 can vary dramatically. Acidification can kill baby



abalone and some crabs, deform squid and weaken brittle stars while making it tough for corals to grow. It tends to increase sea grasses, which can be good, and boost the toxicity of red tides, which is not. It makes many creatures less resilient to heavy metal pollution.

Roughly a quarter of organisms studied by researchers in laboratories do better in high CO2. Another quarter seem unaffected. But entire marine systems are built around the remaining half of susceptible plants and animals.

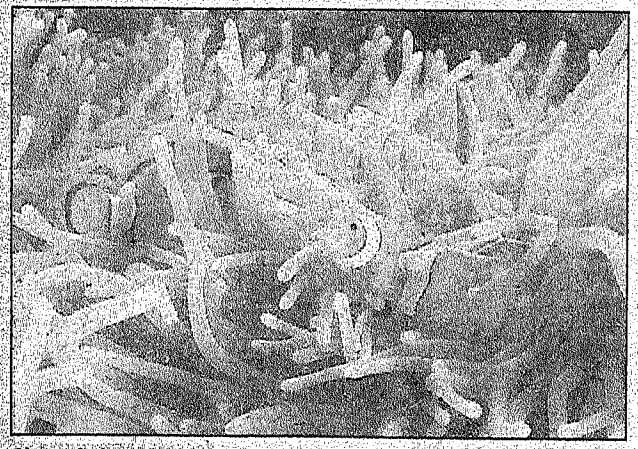
"Yes, there will be winners and losers, but the winners will mostly be the weeds," said Ken Caldeira, a climate expert at Stanford's Carnegie Institution for Science, who helped popularize the term ocean acidification.

Many species, from sea urchins to abalone, do show some capacity to adapt to high CO2. But they may not have time.

"It's almost like an arms race," said Gretchen Hofmann, a marine biologist at the University of California, Santa Barbara.

"We can see that the potential for rapid evolution is there. The question is, will the changes be so rapid and extreme that it will outstrip what they're capable of?"

Already, the oceans have



Clownfish swim through an anemone near Dobu Island, Papua New Guinea. Carbon dioxide can alter how clownfish see, hear and smell, which increases the chance of death

grown 30 percent more acidic since the dawn of the industrial revolution — 15 percent since the 1990s. By the end of this century, scientists predict, seas may be 150 percent more acidic than they were in the 18th century.

In fact, the current shift has come so quickly that scientists five years ago saw chemical changes off the U.S. West Coast that hadn't been expected for half a century.

Meanwhile, the Arctic and Antarctic are shifting even more rapidly because deep, cold seas absorb more CO2. The West Coast has seen consequences sooner because strong winds draw its CO2-rich water to the surface where vulnerable shellfish live.

Sea chemistry in the Northwest already is so bad during some windy periods that it kills young oysters in Washington's Willapa Bay. In less than 40 years, scientists predict, half the West Coast's surface waters will be that corrosive every day.

These chemical changes threaten to reduce the variety of life in the sea.

Study after study shows the same thing — the more reefs collapse and fleshy algae spreads, the more fish

clownfish story in other words, was n[illegible]ger just about clownfisn.

So scientists have been testing the most important fish in America: pollock.

Fishermen in Alaska catch roughly 3 billion pounds of pollock a year in the North Pacific. It gets carved into fish sticks, sold overseas as imitation crab or packed in blocks. Seafood companies reel in $1 billion a year from that catch.

After tracking clownfish research, government scientists in Oregon exposed young pollock to high CO2 and introduced the scent of what they eat. The fish struggled to recognize their food.

"In some of the very early work, it looks like pollock may show some of the same kinds of deficits that are seen in coral-reef fishes," said NOAA biologist Thomas Hurst.

To understand the future of the marine food web, government computer modelers have been studying how sea-chemistry changes could reverberate through the ocean.

Their initial results, looking at just the U.S. West Coast, are disturbing.

"Right now, for acidification in particular," said Isaac Kaplan, a NOAA researcher in Seattle, "the risks look pretty substantial."

Kaplan's early work projects potentially significant declines in sharks, skates and rays, some types of flounder, rockfish and sole, and Pacific whiting, also known as hake, the most frequently caught commercial fish off the coasts of Washington, Oregon and

Fast Facts

Coral Reefs are being lost twice as fast as Rainforests

- One third of all **carbon dioxide emitted by humanity** has been **absorbed by the world's oceans**. This is making them more acidic than they have been for tens of millions of years.
- One of the greatest impacts that Ocean Acidification is having is on **reef building corals**, which are known as a 'framework species'. Without corals, reefs cannot exist. Ocean Acidification is already **slowing their growth rates**. Left unchecked they will soon stop growing and erode away.
- Direct effects on some important species of plankton and the sensitive larval stages of many marine organisms are now being reported in **globally respected scientific literature**.
- Ocean plankton **provide 50% of the oxygen that we breathe**. Due to Global Warming, that capacity to provide oxygen and support the fundamental food chains of the ocean has **decreased by 6%** over the last three decades.
- As oceans have warmed, oceanic nutrient deserts have **expanded by 6.6 million square km's** over the past two decades.
- There are approximately 10,000 Coral Reefs and **we are destroying one every other day**.
- Coral Reefs are being lost **more than twice as fast as the rainforests**. Current estimates reveal that we will lose the other 50% over the next 40 years.
- The Great Barrier Reef generates **over 6.5 billion dollars in tourism** revenue and 63,000 jobs.
- Left unchecked Ocean Acidification **could trigger a Great Mass Extinction Event**. Growing evidence suggests that four of the five Great Mass Extinctions have been associated with rapidly acidifying oceans – due to spikes in the concentration of atmospheric CO_2.

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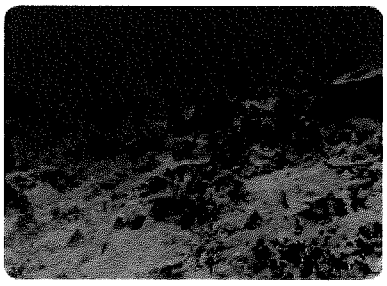
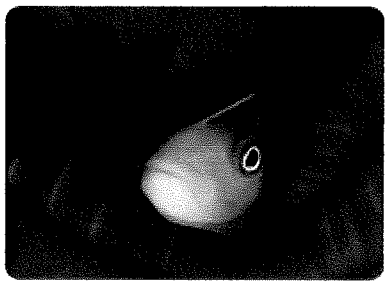
- 
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