Testimony of Dr. Roger Payne
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I am Roger Payne, co-discoverer that humpback whales sing. I am founder and President of Ocean Alliance, in Lincoln, Massachusetts, an organization dedicated to ocean conservation through research and public education. I direct a 32 year, ongoing study of the biology of 1500 known Patagonian right whales—the world's longest continuous study of a whale species based on known individuals.

But I am here today to speak about another Ocean Alliance program called "The Voyage of the Odyssey." It is aimed at quantifying a serious threat to ocean life from synthetic compounds known collectively as POPs (Persistent Organic Pollutants). They include such compounds as DDT, DDE, PCBs, aldrin, endrin, dieldrin, dioxins, furans, etc. Their other name, Endocrine Disrupting Compounds, describes their greatest threat to humans—that some of these compounds are hormone mimics which even at concentrations as low as a few parts per billion can upset fetal development, cause reproductive disorders and malformation of sex organs, compromise immune systems, do neural damage, and, in young children, diminish their ability to concentrate and learn.

Most EDCs are nearly immortal molecules that most animals store in their fats because they cannot remove them from their bodies (or can do so only very slowly). Because they accumulate throughout an animal's lifetime, every time an animal eats anything, it adds the EDCs in that food to its body. EDCs thus pass intact up food pyramids, their concentrations getting multiplied by about ten at each step of the pyramid. Whales, and most all ocean fish that humans prefer to eat, feed at the tops of food pyramids where the EDC concentrations they get are as much as 10^7—i.e. ten million times higher than they are in the water they swim through.

As a result, one of the best ways to study EDC concentrations in the seas is to analyze the fats of whales—especially predators like sperm whales. The anecdotal evidence about whales is alarming. Bearing in mind that the U. S. government forbids the sale of fish containing more than two parts per million of PCBs, and that anything with more than 50 parts per million is classified as a toxic waste:

- Killer whales have been found with 400 parts per million of PCBs. These were mid ocean animals, not individuals living by the outfall of some upstream factory. So if you pushed a stranded orca back into the sea you could be fined thousands of dollars for polluting the ocean.

- Beluga whales—white whales—from the Gulf of St Lawrence have been found with PCB concentrations as high as 3200 parts per million.

- Off the Northeast coast of the United States, bottlenosed dolphins (that's "Flipper") have been found with PCB concentrations as high as 6800 parts per million. Such animals are swimming, toxic, dump sites, and would be eligible for cleanup under the Superfund Site laws if they could be cleaned up. They cannot.

The studies I have quoted are alarming, isolated examples. We a systematic look at the concentrations of these contaminants before it is too late for remedial action. That's just what we are doing at Ocean Alliance.

The voyage of the Odyssey, a 5-year research program currently in its second year, is designed to quantify pollutant concentrations in the world's oceans. It will demonstrate in a scientifically defensible but dramatic way just how serious the problem of synthetic pollutants is. If the results are as bad as we fear, we will be describing a major threat to the very existence of the fishing industry, as well as to human health and to ocean ecosystems.

The Odyssey is now in the middle of the Indian Ocean. Using biopsy darts the crew has blubber samples from over 600 Pacific and Indian Ocean sperm whales. Scientists at the Woods Hole Oceanographic Institute, and from Japan will analyze these samples for EDCs. We also collect data aimed at determining the boundaries, if any, of sperm whale stocks. For these data, scientists at Cambridge and Cornell Universities will do the analysis.

And, we run a website from the Odyssey that gets 100,000 hits a month. (PBS has made it part of their website: pbs.org)

At the end of the voyage we will be able to make direct comparisons of pollutant loads in different oceans. We will use these results to draw the attention of the world to the threat posed by EDCs and to push for an international protocol to prevent their further entry into the seas. Thus what Ocean Alliance has devised is an experiment that will look at synthetic contaminants in the ocean by using sperm whale as the integrating factor—an approach, we believe, worth far more than simple water quality measurements. We feel that just doing science is not enough. Scientists must translate their results for the public and policy makers—

That has not been happening.

However, the Ocean Alliance is committed to making it happen. We work with educational institutions all around the country, and are dedicated to the principle that it is wrong to keep scientific research separate from education. They must be integrated. If we fail to do so we will make a terrible mistake.

In conclusion, we need a national ocean policy that supports work of the kind being done aboard the Odyssey and which also supports the kinds of programs Ocean Alliance is doing in partnership with educational institutions across the country. After all, it may be that the principal gift whales offer humanity is that they are the only animals that can impress us enough to persuade us to change our minds about the importance of the wild world.

Background and Details of the Odyssey Experiment

The species in the above examples were all toothed whales and toothed whales eat fish, not krill. How about baleen whales? Aren't they feeding far lower on the food chain where their food contains lower concentrations of EDCs?

It turns out that many baleen whale species **do** eat fish. For example, in some parts of Norway fin whales are called herring whales because they eat so much herring. And anyone who has gone whalewatching off Boston or in the inside passage of Alaska has probably seen humpback whales cutting swaths through whole schools of fish as they feed on them.

Minke whales, the current mainstay of the whaling industry, and the smallest of the baleen whales also eat fish…lots of fish… making it less surprising that the highest concentration of EDCs ever found in ***any*** animal, terrestrial or marine, came (recently) from a Minke whale.

Initially, it was believed that the most serious threat EDCs represent to human beings and other mammals was their carcinogenic properties. But that has proven to be of far less concern than the tendency of several EDCs to mimic hormones

So what can we do about all this? On land, EDCs can be confined in carefully prepared and covered dump sites or transported to special facilities to be oxidized or reduced down to their harmless molecular components. But when allowed to enter the atmosphere or the sea (either deliberately or accidentally), they soon become distributed worldwide by air and ocean currents. The atmosphere and the ocean work together thereby acting like giant conveyor belts, spreading EDCs throughout the world. Since the net movement of both air and ocea currents is the same (polewards), the highest EDC accumulations are found in polar animals and peoples.

However, even at the much lower latitudes where most of us live, alarmingly high concentrations of EDCs have already been found in some of the fish we eat. Unless steps are taken to prevent further contamination of the seas by EDCs, humanity may soon lose access to one food fish species after another as they become too contaminated to be eaten safely. Older specimens of very fatty species like salmon have already become so—because mature individuals have had more years to accumulate EDCs. Although fish and all other vertebrates are at risk from EDCs, mammals (including whales) face a special problem:

A mammalian fetus receives EDCs from its mother while still in her uterus. It is at this time that EDCs appear to do their worst work seriously disrupting the early development of the fetus.

But after birth when the infant mammal starts to nurse, it receives vastly more EDCs, dissolved in the fats of its mother's milk. This means that in such an infant, although we would expect it to begin life as a pristine creature, starts instead at a contaminant level almost equal to that of its mother. Humans are mammals so this affects us too: in fact, that most gentle of all human interactions—a mother breastfeeding her babe, has become a process during which what is actually going on is that the mother is unintentionally dumping her lifetime's accumulation of EDCs into her beloved infant. If the infant is a female, she will later pass these contaminants to her own offspring plus whatever EDCs she has accumulated in the food she has eaten up until that time. Because many EDCs have such long lives, every new mammalian generation contains more EDCs than did the previous generation. Unless we take steps to reduce the amounts of EDCs reaching the ocean, it seems all too possible that marine mammal species that feed feed high on food chains (most of them) will start to show increasingly serious effects from these chemicals, with the end result being extinction. Humans can defend themselves from this problem of polluting their babies to some extent—they can raise them on formula instead of breast milk.

That is not an option for a marine mammal, however.

For such species it is hard to see how such a threat could avoid leading to the eventual extinction of several marine mammal species, unless we can summon the will to prevent the further pollution of the oceans by EDCs. Like the proverbial canary in the coal mine the whales have something important to teach us—their message is urgent—that we are allowing deadly compounds to accumulate in the fish that whales and we get from the sea.

Normally, as the old saw says: "the solution to pollution is dilution" but when EDCs enter the sea they are so soluble in fat and so sparingly soluble in water that they attach to the first droplet of fat they encounter—for example the fat droplets in diatoms—the most numerous plants, and the plants with the greatest biomass, on earth. From here the EDCs climb food pyramids until they are concentrated back to dangerous levels in the food we take from the sea. That means that when we let EDCs reach the sea we guarantee that we will get much of them back in our food, and since we cannot get rid of them from our bodies we guarantee that they will accumulate there.

So why hasn't humanity done something about this?

One of the things preventing action is that in spite of their multiple and very serious effects, neither the concentrations of EDCs in the oceans nor their global rates of increase have been measured comprehensively. Although individual studies exist, it is impossible to draw direct comparisons between most of them owing to differences in the protocols that were used to obtain, preserve and analyze the specimens on which the existing studies were based. This lack of a uniform baseline of data about concentrations of EDCs in the seas makes it all but impossible to persuade governments to take the steps necessary to pass sufficiently strong legislation backed by sufficiently large budgets to stop ocean disposal of EDCs (most EDCs are no longer intentionally manufactured, but many are unintentionally created as byproducts of the synthesis of other compounds).

I believe that pollution of the ocean with synthetic compounds will someday become one of the greatest threats to whales and people. Because of that I have dedicated the major resource of my institute, our research vessel, *Odyssey* to what I feel is the most important scientific research program of my life—the five-year oceanographic research effort designed to gather the first-ever coherent set of baseline data on levels of EDCs throughout the world's oceans.

The reason we take our samples from whales is that with their thick blubber, long lives, and positions at the tops of food pyramids, cetaceans often show high, chronic, contaminant burdens. Because large whales usually feed over relatively enormous areas of ocean, the oils in their blubber carry a thoroughly integrated sample of the contaminants found in relatively enormous ocean areas. By sampling from sperm whales in equatorial waters we will take advantage of the fact that adult males and females of this species are unusual in that they feed in different ocean regions: the females in tropical waters, the males in polar waters. In both the northern and southern hemispheres, females do not make it to latitudes higher than 40 degrees, whereas adult males are usually only found at much higher latitudes. When mature males are encountered in equatorial waters it is because they have come there to seek mating opportunities. However, most of the food that powers their migrations from polar to tropical seas was obtained at polar latitudes. By collecting samples in equatorial waters from both mature male and mature female sperm whales we sample EDC concentrations both from tropical waters (the adult females) and polar waters (the adult males). The males thus save us the expense, difficulty, and danger of having to go to higher latitudes to collect our samples.

Stock identity. The identity of whale stocks has been the subject of intense debate for many years. Of primary interest is the answer to the question: what is a stock and how should it be managed? The variability of the different answers to this question has provided whalers with the opportunity to put many irresponsible practices into effect. Chief among these has been the tendency to divide whale species up into distinct stocks and then to award themselves killing quotas for each of the resulting units. When such ‘stocks’ are simply discontinuous populations of the same stock this practice can have, and has had, disastrous consequences.

Many whale species are distributed globally and most individual whales are presumed to make routine trips covering thousands of miles. Consequently, the relationship between the different whale populations and stocks (if indeed there are different whale stocks) remains for the most part obscure. Photo-identification studies can help to reconstruct general patterns of movement, but cannot elucidate functional relationships between populations: in other words, gene flow. Our work will rectify that situation.

The program will result in a unique reference database of genetic type-specimens. Such a resource will provide an invaluable tool for the regulation of possible future commercial whaling operations, as well as for the identification of samples from stranded whales indicating the region in which they have spent most of their lives.

Low genetic variability may be interpreted either as the natural characteristic of a species, or as the consequence of severe population depletion.

The Voyage of the Odyssey will provide an opportunity to assemble an invaluable reference data set for future studies, describing both the distribution and levels of genetic variability among the target species.

To construct a realistic population model for any given species, data must be collected from as many sub-populations and geographic regions as possible. The Voyage of the Odyssey will give us a unique opportunity to do just that.

WCI personnel will also use acoustic arrays to record and monitor the sounds (and, when possible the associated behaviors) of cetaceans, listening on fixed hydrophone arrays to whales that are vocally active in the vicinity of the *Odyssey*. These data will be used to develop methods for doing acoustic censusing of whales.