

Environmental Review

A Monthly Newsletter of Environmental Science and Politics

Volume Five Number Seven

July 1998

Urban Population Growth in Developing Countries

Since the 1970s mega-cities of the developing world have absorbed huge population increments, and other large cities have experienced on average, a doubling of population size. In their recent article *The Poverty of Cities in the Developing World*¹, Brockerhoff and Brennan used infant mortality and other indicators to compare people's wellbeing across cities of one million or more, smaller cities, and towns within developing regions. In Latin America and the Caribbean, the advantage of big city residents has declined since the 1970s, and was no longer apparent by the 1990s. In sub-Saharan Africa mega-villages have emerged, places in which basic human needs — adequate nutrition, early schooling, good child health — are less fulfilled than even in small towns. Unfavorable living conditions in mega-cities of Latin America and in the North Africa/Asia region, and in the medium-sized cities of sub-Saharan Africa, are strongly related to the pace of population growth of these cities since the 1960s and 1970s.

Martin Brockerhoff earned a Ph.D. in demography from Brown University in 1991 specializing in African studies, specifically studying child health problems in migrant communities in the areas around Dakar in Senegal and Bamako in Mali. He worked at the US Agency for International Development in Senegal and Washington D.C. from 1989 to

CONTENTS:

**MEGA-CITIES
AND THE
POPULATION
EXPLOSION:
MARTIN
BROCKERHOFF**

**THE MARINE
CONSERVATION
BIOLOGY
INSTITUTE:
ELLIOTT NORSE**

1993 as a health analyst and program officer, and since 1994 he has worked for the Population Council in New York conducting research on urban population, health, environment, and poverty issues. We spoke him about living conditions in developing countries.

ER: Dr. Brockerhoff, what is the Population Council?

MB: The Council was founded in 1952 by the Rockefeller family primarily with a concern about high fertility and global population growth, and that was its main focus until 1994. In that year there was an international

population conference in Cairo that focused more on gender-related issues, and high fertility since then has not been the exclusive, central concern in the population field; there has been increased research and programmatic attention to migration, the growth of big cities, child health problems in Africa, illegal immigration into the U.S., rising mortality in the former Soviet Union, a whole range of other issues that had been neglected for a long time.

One of the reasons I joined the Population Council was to study urban growth and its consequences. The U.N. and other organizations have projected that about 95 percent of population growth in the developing world in the first quarter of the 21st century is going to take place in urban areas. The Cairo agenda recognized that population growth rates in poor countries of the world have been slowing, and most of the population growth is happening in urban areas, largely because people migrate from rural to urban areas.

But those are just straight demographic projections. We may understand the demographic underpinnings of urban population growth but we don't know what the consequences of it are going to be. Some people have visions of what happened in the U.S. and Europe in the 1960s for instance, ghetto riots and social unrest. We see riots now in Jakarta, for instance, and some demographers relate such unrest to population pressures. This has not been studied much and the historical evidence that many of these social problems are related to urban growth

population growth or population density or high fertility but there haven't been any macro-level studies that look at the impact of city size on broader natural resource issues.

ER: What role have governments played in population growth?

MB: In Asia and Latin America since the 60s and 70s, there have been specific policies about the spatial distribution of populations. Most governments of the world have them, they are clearly articulated, but they are not very well implemented because they contradict governments' economic growth policies. Governments want to promote heavy industries in cities or export-oriented manufacturing, which in turn fuels internal migration and population pressure on cities, and exactly contradicts the objective of most migration policies, which is to retain people in rural areas, or to promote industrial growth poles a few hundred miles away from the capital city to re-channel migrants to those areas. There have been policies to try to move the capital, for instance in Brazil to create Brasilia, in Nigeria to move the capital to Abuja from Lagos, in order to relieve the pressure on the biggest cities.

But all of these have been pretty ineffective. They run counter to the basic economic strategies that governments have pursued, and people move where the jobs are. So unless governments can promote economic growth outside of the major cities, we are likely to have continued rapid population growth in urban areas. A demographic momentum is also built in for rapid urban population growth, just because of the size and youth of the urban population, even

World's Ten Largest Cities

though fertility is declining now in urban areas.

ER: Will urban population growth slow down if the economy slows down?

MB: The whole urban growth phenomenon has been generated in

most countries, except in parts of Africa, by rapid economic growth in cities. There was a long period of stagnation in Latin America which slowed the growth rate of São Paulo and Mexico City. At one time they projected Mexico City would have over 30 million people by now, and it

only has 16 or 17 million, and much of that is because of the economic problems the country went through over the last twenty years. Now for the first time, after years of rapid and continued economic progress, economies have collapsed throughout East Asia. If this continues over several years, the currency devaluation in relation to the dollar, the withdrawal of foreign investment and so forth, it will be interesting to see if there might be a process of de-urbanization in some of these countries. There won't be any new jobs in the cities, there may be massive layoffs and people may return to where their families are in the village. The environmental consequences of that for cities and the countryside are unpredictable and likely to vary across countries.

ER: What is a mega-city?

MB: The term mega-city was coined by the UN around 1980; it pulled the figure of 8 million or more people more or less out of the hat as a definition. The World Bank and Asian Development Bank use a figure of

10 million. But the fact is that the large majority of urbanites live in relatively small cities; there is quite a substantial concentration of people in places of 1 million to five million. Except in China and India, there are actually very few cities in developing countries with more than 5 million residents, perhaps twenty or twenty-five cities, and in the aggregate they don't encompass that much of the world's population. They get featured on the cover of Time magazine and on the 7

o'clock news but in terms of where most people live, mega-cities are not really that prominent. In Africa in particular, Lagos is the only mega-city.

Mega-city growth is not even an issue in Africa, yet Africa has some of the most horrendous urban conditions in the world. African cities are experiencing the highest rates of growth with no economic progress whatsoever and with terrible environmental and health consequences. For instance some of my research has shown that child mortality rates have increased in medium-sized African cities since the late 1970s, whereas they have slowly declined in towns and villages. This has happened

rural areas perceive that things are better in urban places, but because of declining economies there has been substantial deterioration in education opportunities, infrastructure, health services, and job opportunities; these medium-sized urban areas haven't really progressed much in the last twenty years. On the whole, there has been quite a bit of decline in most conditions.

ER: Things must be pretty grim in the rural areas.

MB: In sub-Saharan Africa mass violence has been predominantly a rural phenomenon, and one would need more than two hands to count the countries in Africa that have had

ongoing civil wars for the last decade or longer; obviously nothing has been happening with the economies of these countries.

Meanwhile there has been tremendous population growth in these medium-sized

cities in Africa but governments have not been committed or they haven't had sufficient economic growth to provide housing and jobs and public services to accommodate growing populations, so much of the poverty that used to characterize rural areas has been transferred to urban areas, encompassing larger concentrations of people, often several hundred thousand people living in village-like conditions where they don't have access to adequate sanitation and

**Except in China and India, there are very few cities in developing countries with more than 5 million residents, perhaps twenty or twenty-five cities, and in the aggregate they don't encompass that much of the world's population...
...in terms of where people live, mega-cities are not really that prominent. In Africa in particular, Lagos is the only mega-city.**

despite the so-called child survival revolution of expanded immunization coverage, oral rehydration therapy, improved access to potable water and sanitation and so forth by UNICEF, WHO, and other agencies. There are hundreds of these cities in Africa that range between one hundred thousand and less than a million, what I call mega-villages. Sub-Saharan Africa's economies have stagnated since the 1970s oil crisis, but population growth has continued unabated. People in

potable water. On the other hand, actual villages of a few hundred people or so have probably fared better from neglect over the years, at least they have not suffered the consequences of rapid growth, high densities and other population pressure. In countries of Latin America and the Caribbean, for instance, primary school enrollment levels are now higher and the incidence of diarrheal disease lower in villages and towns than in cities with more than a million people. In the 1970s, conditions were far superior in big cities.

ER: Would an African mega-village be comparable to the shanty towns of São Paulo and Rio?

MB: From a psychological perspective it is probably much dimmer in many of these African cities. In the favellas of Rio in the 1960s and 70s residents were very resourceful in improving their own lives. There were relatively wealthy residents in close proximity to them, they could tap in to electricity, squat on fairly good land and have close proximity to other services. Those conditions don't exist in Africa, but even in Latin America shanty towns have been pushed out, fifty miles or more from the core of Mexico City. Because of the sprawl of the largest cities, shanty town residents now live so far from the city core where services are located that they don't have much access to them. And in Africa those conditions apply at much shorter distances. The affluent population is extremely small in Bamako in Mali for instance, it is confined to a small, well protected neighborhood, and poor people can't even walk through it. This situation applies to many African cities, so more and more people are living under substandard conditions, in what

The *Environmental Review* is an independent newsletter of environmental science and politics published by Environmental Review Educational Services, a non profit corporation. It is not affiliated with any other organization, think tank, foundation, or political party. The *Environmental Review* provides an advertising-free forum for discussion of some of the most interesting and important issues of our time.

sociologists call the culture of deprivation.

This represents a growing proportion of the population in these regions, and the question is, What is going to happen? I have given several talks on this subject in the past year, and a concern voiced repeatedly is that big cities may explode because there are so many people living under the poverty line and inequality and frustration appear to be growing. Governments and researchers are concerned there will be more than just food riots and labor unrest, but real upheavals in some places. That is the apocalyptic view.

ER: People have worried about population growth and big cities since Karl Marx at least.

MB: Yes, exactly. This all happened in Europe and North America one hundred years ago. Think of the novels of Charles Dickens. Conditions in big cities one hundred years ago in North America and most of Europe were worse than they were in the countryside for a period of thirty to fifty years, but then things got better in the cities. The popular perception of the Southern Hemisphere in the last twenty to thirty years is that things were improving in cities as well as in rural areas. But many people point out, and a lot

of survey and census data show that basic living conditions have been becoming worse or at least scarcely improving in big cities since the late 1970s. One of the reasons may be rapid city population growth; there is a whole list of other factors one could enumerate, including that city-land carrying capacities have been overstretched in some cases. But people are wondering whether things will really deteriorate to horrific levels in some of these cities to the extent that they will have national revolutions, or whether this is just a transitory phase and twenty or thirty years from now things will balance out again between cities and countryside, as was the case in Europe and North America around 1900. And one can dichotomize those two viewpoints: many people see rapid urban growth as not a problem; many people including members of the U.S. government and the population community, see the world like Karl Marx did, and envision revolutions. That may be an alarmist view because upheavals generally didn't happen in late 19th century Europe; in London people didn't revolt even under the worst conditions of poverty.

ER: Santayana said those who forget the past are doomed to relive it, but there is nothing in our history to compare to today's population and environmental problems.

MB: Things have deteriorated in urban areas but I tend to think that this is a passing phase and would hope that there would be a more equitable distribution in the global terms of trade. International organizations are spending billions of dollars trying to improve health and slow population growth in Africa and Latin America and South Asia, in the poorest areas. I used to work for the Agency for International Development, whose office of the environment had virtually no budget whatsoever, whereas AID has an enormous population program: it is their biggest program, always has been. There is a lot of concern about the environment in government but there is little funding for international environmental programs, and part of the official rationale is that if we can control issues of population, poor health, and women's status, then the environmental problems will be alleviated somewhat.

ER: The assumption is that when economic conditions get better, people will have smaller families.

MB: Right. The paradox is that as fertility declines and as national populations get smaller and their economies prosper, families have an increased capacity to consume, to own two cars, refrigerators, and other modern durable items. National economic progress facilitates the construction of highways for those cars, of dams to generate electricity, and so on. So slow population growth,

achieved by rapid economic growth is not plainly beneficial to environmental conditions. As a case in point, China and India want to control city growth. Since the 1950s the Chinese have had strict policies regulating population movement based on work permits, household registration systems, food rationing, all kinds of policy levers. Meanwhile the economy in the south of China is growing tremendously, there is heavy demand for labor from the rural areas and surrounding countryside, and it is becoming very consumer oriented.

Population crowding and economic prosperity will actually worsen environmental conditions in the big

The main reason to control population is to improve people's standard of living, but an improved standard of living could create worse environmental conditions than any growth of population ever would

cities on the whole. It contradicts the government's rationale of urban population control. The main reason to control population is to improve peoples' standard of living, but an improved standard of living could create worse environmental conditions in the aggregate than any growth of population ever would. This is happening in China and will probably happen in India too.

ER: Most of Africa has been what we consider backward even before the population increased so dramatically.

MB: The argument any concerned African would make is the that problem is poverty, not population.

Tokyo, the world's largest city, certainly is not dismally poor, in fact it's had full employment until quite recently. Improving urban conditions is mainly a matter of redistributing the world's resources, changing the terms of trade, debt restructuring, and better city management. In the first population conference in 1974 there was a consensus that the problem was one of development, not rapid population growth. All the countries of the North underwent rapid population growth, and they prospered later on. It has become a global issue of resource distribution, and that applies as well to cities. Some people may be concerned about the carrying capacity of a certain

locale but ultimately if you have appropriate management, if you have a concerned government, a participatory process of government, sufficient job opportunities, then the problems of having

a large population are much less.

ER: Are the problems in sub-Saharan Africa because of a lack of societal or cultural infrastructure?

MB: It is not cultural. Rampant political corruption dates back to the colonial heritage of the countries. It is true there has been political instability in fifteen or twenty of the fifty countries in Africa for most of the last twenty years at least, and much of this instability is rooted in ethnic or religious or racial conflict. But I would stress that one cannot generalize about the problems of African cities, they are completely different from cities in Asia and elsewhere. You don't have

For previous issues of the *Environmental Review* and subscription information, visit our website on the Econet at <http://www.igc.apc.org/envreview>

giant cities in Africa, you have smaller cities, there has been no economic growth over the last twenty years, whereas in Asia there was tremendous economic growth, except for parts of south Asia, until this year when things changed. In Latin America there has been moderate growth, not very rapid economic growth over the last twenty years. And the demographic transition has been completely different in parts of the world as well. In Africa there is still a youthful population and high fertility, hence rapid population growth, that is being channeled towards urban areas largely. In most of Asia the fertility decline started twenty to thirty years ago. Seoul reached 10 million people in the 1980s and it hasn't grown much since then. Now they have below replacement fertility and they are worried about not having enough people in the future. I go to Seoul every year and it gets more and more congested. As the economy has prospered there are more and more cars, pollution gets worse every year, people are complaining more, and this is while the economy was growing at 7 percent a year until recently. But in Africa the demographic issues are different in each area. The issue is not one of urbanization or growth rates, the issue is just absorbing numbers of people in urban areas. When you talk about a growth rate of 10 percent someplace in Africa, that implies usually a fairly small increase in population in absolute numbers, but if you applied a 3 or 4 percent growth rate to Rio or Mexico City with their huge populations, that is a tremendous increase of people. In Africa the only comparable place is Lagos.

Over the next fifteen or twenty years, even in Africa, fertility will inevitably decline. There is going to be an increasingly rapid shift of population from rural to urban areas through migration. If more resources are

concentrated in urban areas, including smaller cities, then they may be able to handle population expansion. The guiding philosophy of the development field in the last fifty years has been small is beautiful, focused more on rural than urban community-based development projects. But what urban population trends clearly show is that whether it be in family planning or environmental health or social welfare programs, community-based development projects have to target urban communities, because poverty is being transferred from rural to urban areas.

From my perspective, population and economic problems in poor countries are real but they are essentially symptoms of more fundamental issues, the main issue being political equality and development both within countries and globally. Many countries are so marginalized in the world economy that their prospects seem quite dismal. They have no linkages to other economies; even for some countries that have very rich resource bases, and there are many in Africa, the prospects may be pretty dim. Ten years from now people will see that things still have not improved in Africa and they will point to population: the economy did not grow while the population surged, and we will say that this is why things haven't improved. But many current economic, population, and environmental problems stem from weak political commitment on the part of the international community and international leaders.

Literature Cited:

- ¹ The Poverty of Cities in Developing Regions. 1998 Population and Development Review 24(1): 75-114. Martin Brockerhoff and Ellen Brennan



Fishing Down Marine Ecosystems

Introduction:

In a research article in *Science* magazine Pauly et al. report that the kinds of fish harvested from the world's seas have changed from 1950 to 1994. In the process they call fishing down the food web, fishermen take the biggest, most profitable fish first, when they are gone, they go after the next most profitable fish. This has changed the ecosystems of the world's oceans by removing the top predators, destroying fish habitat, and changing the age structures of many populations of fish. The authors point out that this pattern of exploitation is not sustainable.

We discussed the Pauly paper with Elliott Norse, co-founder and director of the Marine Conservation Biology Institute in Redmond, Washington. While writing a report in 1980 for the President's Council on Environmental Quality, Dr. Norse coined the term biological diversity to describe the variety of life, from genes to species to whole ecosystems, that the world is losing due to human activities. Since then, the idea of biological diversity has played a prominent role in environmental protection legislation and has entered the lexicon of scientists, journalists, and activists.

ER: Dr. Norse, what is your training?

EN: My training was in tropical marine ecology. I got my Ph.D. from

the University of Southern California studying the ecology of swimming crabs. I wound up going to the Environmental Protection Agency for my first job in 1978 working on offshore oil and gas operations and their impact on the Flower Gardens coral reefs that are poised at the edge of the continental shelf in the Gulf of Mexico. In 1979 I became the staff ecologist of the President's Council on Environmental Quality, where I worked on marine sanctuaries. I also worked on MX missile system siting. One of CEQ's jobs was to analyze environmental impact statements and to safeguard the National Environmental Policy Act process. The MX missile basing system would have taken up every valley in southern Nevada and a large part of Utah and filled them with thousands of hardened concrete shelters and 200 MX missiles. We managed to hammer a stake into the heart of that program and it didn't happen, saving the United States many billions of dollars and saving the biological diversity in those valleys.

ER: How did you come up with the notion of biological diversity?

EN: CEQ puts out an annual report every year on the state of the environment, and for the 1980 issue I was asked to write a chapter on the status of life on Earth. I realized this is a pretty broad topic and what CEQ wanted was a look at what's happening to the diversity of life at different hierarchical levels of organization, and I called it biological diversity. Since that time the idea that diversity is important at the levels of genes, and species, and ecosystems, has become a driving force in conservation world-

wide. I was just in the right place at the right time to devise something useful.

I have spent my whole career on conserving biological diversity in different ecosystems. After I did my marine work I found myself working mostly on the terrestrial realm, particularly forests. I wrote two books: the first being *Conserving Biological Diversity in our National Forests*, which was published in 1986; *Ancient Forests of the Pacific Northwest* came out in 1990. But then I was hired by the Center for Marine Conservation in 1989 and went back to marine conservaton. In a sense I've recapitulated the evolutionary story of whales and seals.

ER: By returning to the ocean?

Trawling and related fishing techniques used to catch fishes, shrimps, clams, corals, and other bottom-dwelling species could well be the world's most important human-caused disturbance...

EN: Right. I was a marine thing that crawled out on land, then went back to the sea.

ER: When did you start the Marine Conservation Biology Institute?

EN: I founded MCBI in May 1996 to advance the new science of marine conservation biology, and to encourage the cooperation essential for saving the world's biological diversity. The institute works by bringing scientists together to focus on emerging issues. We organized the first

Symposium on Marine Conservation Biology in June 1997 at the annual meeting of the Society for Conservation Biology where more than a thousand scientists from over 30 countries came together in Victoria B.C. to examine the hottest questions in marine conservation.

ER: But why start a new organization?

EN: The need for marine conservation biology came about because the marine sciences were not focusing on conservation. There were some exceptions: fishery biology focused on maximizing the catch of fish, a rather narrow and utilitarian conservation goal; there were some sciences, particularly ones dealing with sea turtles and marine mammals, that

focus attention on conservation— sea turtle ones particularly — but they only looked at a very small portion of the biota, not at the full range of species and ecosystems.

On the other hand, the young science of conservation biology by and large, was not marine. I did a little study of *Conservation Biology*, the leading scientific journal in our field, to see how many marine papers it had and found thirteen times as many terrestrial studies as marine ones. Marine conservation has been just an asterisk to conservation, so I realized that to answer the big questions, to be proactive and provide the information needed for decision making that is so often lacking, we had to build a new science. That's why I founded MCBI.

ER: What is your role in the Institute?

EN: I think the most important thing I can do for marine conservation biology besides repeating its name enough times that people realize there is a new science developing, is to transfer concepts from non-marine conservation biology that fit and see which concepts have to be created anew.

ER: For example?

EN: If small populations are inherently more extinction-prone than larger ones in the terrestrial realm, then the same thing should apply in the marine realm. That won't be different in the sea. But other things will change profoundly because the marine realm is very different in its spatial and temporal scales, in its physical structure, in its taxonomic composition. It is a fascinatingly different challenge, and so we need to transfer what we can from the terrestrial realm so we don't have to reinvent the wheel, and fashion anew those concepts that are distinctly or even uniquely marine.

ER: What do you mean by emerging issues?

EN: One way MCBI tries to develop new approaches is by holding small workshops on emerging issues, crucial issues that few people — primarily scientists — have thought about and they have not yet gotten on decision makers' or the public's radar screens. There's often an enormous mismatch between public perception and what's actually important. For example, some years ago there was a big fuss because

used syringes and other medical waste washed up on beaches on the Atlantic coast of the United States, and people thought they could walk along the seashore and get AIDS. Well, that wasn't going to happen, and it was really a very minor symptom of a much larger problem, that we're trashing the sea. And so my focus is looking at ways that humans are affecting the marine realm and at ways that we can help protect, restore, and sustainably use the marine realm that have not gotten the attention they deserve. That's what I mean by

that explicitly or implicitly quite often, including from scientists at the National Marine Fisheries Service who are responsible for protecting marine species and believe that there's really nothing to worry about because they can't disappear. My answer to that since 1981 has been, Why is it that the fossil record is replete with the extinction of whole taxa of marine organisms? Many of these organisms had planktonic larvae, so how can it be that the world is safe for such species today when the human population is exploding and we're changing the

world rapidly, yet extinctions occurred in the past when there weren't any humans around?

This reasoning was confirmed empirically for the first time in 1991 when Jim Carlton of Williams College Maritime Studies Program and his colleagues published the first paper on the modern extinction of a marine

invertebrate, a little snail called the eelgrass limpet on the Atlantic coast of Canada and the United States. The story is particularly revealing. Until 1930 this limpet was described as abundant, but it only lived on the blades of eelgrasses. When a plague of unknown origin hit the eelgrass, the plant essentially disappeared, and this little limpet lost its habitat. The eelgrasses came back because estuaries were refugia where the salinity was too low for the disease to affect them, but the limpet never came back, it's gone. The amazing thing about the story is it took place on a coast with more marine laboratories per mile, including the renowned Woods Hole Oceanographic Institution, than anywhere on Earth. Leading marine scientists completely overlooked the extinction of an abundant marine

Whereas a tiger is a noble beast, an eagle is a symbol of fierceness and independence, a bear is the very notion of wilderness to us, a marlin, a swordfish, a tuna, or a shark are just meat; the statistics on their take is presented in tons.

emerging issues.

For example, we held a workshop called *Endangerment and Extinction in the Sea* for CMC just before I left. Now this may sound peculiar. You'd say, Oh, that should have been looked at a long time ago, and that kind of response is the hallmark, I hope, of everything we do. If you think it's so obvious it should have been done a long time ago but it hasn't, then we know we are looking at the right questions.

ER: What is an example of a new idea for marine ecology?

EN: There was a widespread notion that marine species that have planktonic dispersal are extinction-proof, that they can't disappear. I have heard

invertebrate for sixty years. I concluded there's a bigger story here, and so I held a scientific workshop called *Endangerment and Extinction in the Sea*.

Two months later, an infant MCBI held our first workshop: *Effects of Bottom Trawling on Marine Ecosystems*. It was the first scientific meeting addressing the effects of trawling worldwide, as strange as that is to believe. There certainly have been a few meetings in Europe on the effects of trawling, but the European experience is, in some ways anomalous as it turns out, and we couldn't have chosen a more appropriate emerging issue for our inaugural workshop.

A scattering of scientists had looked at trawling in Australia, Europe and New England; they all had pieces of the picture to contribute. Amazingly, there were virtually no studies from the southeastern or Pacific coast of the USA, Asia, Latin America or Africa, despite the tens of thousands of trawlers operating in their waters. So, at the University of Maine's Darling Marine Center we brought together seventeen scientists from Australia, New Zealand, the United Kingdom, Canada and the USA, including marine ecologists, fishery biologists, biogeochemists and geologists, to examine the effects of trawling on the world's seabed. We had observers from the federal and state governments, the fishing industry, environmental organizations, academia and the press. And what these scientists concluded was remarkable: That bottom trawling has effects on the seabed very much like clear-cutting's

effects on the land. It crushes, buries and exposes bottom-dwelling marine animals — sponges, corals, bryozoans, tubeworms, and crustaceans — to predators; it removes the structures that provide cover for myriad species, including the young of commercial fishes such as cod; it removes nutrients from the system and alters biogeochemistry. We suspect that trawling is a major reason why the once-abundant Atlantic cod populations crashed as trawling increased in the 1980s and '90s.

But there is one crucial difference between bottom trawling and clear-cutting: the area of seabed that is trawled each year is far, far greater than the area of forest that is lost each year. Trawling and related fishing

... bottom trawling has effects on the seabed very much like clear-cutting's effects on the land. It crushes, buries and exposes bottom-dwelling animals to predators...

techniques used to catch fishes, shrimps, clams, corals, and other bottom-dwelling species could well be the world's most important human-caused physical disturbance, and yet nobody had realized this until we brought the scattered experts together and got them to share their insights with one another. This kind of synergism is precisely why we hold such workshops.

Trawling is an emerging issue that begs for more attention. We will be publishing the results from this workshop in the December 1998 issue of *Conservation Biology*, and I hope that Congress will take notice of our findings when it is reauthorizing the federal law that governs fisheries in federal waters, the Sustainable Fisher-

ies Act, in 1999. Our findings argue strongly for strengthening of the essential fish habitat provisions in this law.

ER: Why hasn't the academic establishment been working on these emerging issues?

EN: [Laughing] Think about your own scientific training. When somebody has a new idea that starts a new scientific discipline, this person and his or her followers become the gods. Everybody else follows them and tries to mimic them, but the big ideas are mined out pretty quickly and most others in the discipline spend their time trying either to challenge or refine the ideas that were evolved

fairly early, when the paradigm was formed. Most people work at fine tuning within their disciplines and miss things that fall between the cracks between disciplines because at all levels, from

the training of the individual scientists to the funding institutions, almost everybody works with the disciplinary structure. And people who fit between, or worse yet among three or more disciplines fall between the cracks. So our job is to create a new discipline that fills the cracks among the different marine sciences such as marine ecology, fishery biology, oceanography and conservation biology, a new multidisciplinary paradigm that addresses problems that we had not envisioned when now-established scientific disciplines first took shape.

ER: As a Pacific Northwest-based organization, I assume that you're working on salmon.

EN: No. Wild salmon is not an emerging issue; it's front page news month after month, but the salmon issue has been building since I was writing *Ancient Forests* in the late 1980s, and especially since the early 1990s. It's very important to save our salmon, but because there are many good people doing good work on it, there's no need for MCBI. Our job is to go where there's something important happening that people are not noticing and then bring it to people's attention.

ER: I read that you are paying attention to the top predators in the seas.

EN: Yes. The next workshop we did was *Ecology and Conservation Biology of Large Pelagic Fishes*. The reason is that in the terrestrial realm during my lifetime our society came to a major decision. When I was young, predators were considered bad because they kill things we like, for instance deer, and so we would kill predators to have more deer. But now the U.S. is filled with deer and excessive deer populations damage forest ecosystems and people realize that predators might not be so bad after all, maybe they do have a role in their ecological system. Aldo Leopold, to me, is the father of that notion, but for quite a while after Leopold realized this in the 1940s, women were still wearing leopard coats, and states were still offering bounties on mountain lions. Then there was a change of consciousness. It's not everywhere yet, but it's to the point where, in the Sunderbands of Bangladesh, instead of shooting tigers, people are taking measures to deter them from attacking humans, even though such measures aren't always

successful and some people die every year. But I love their ethics. They're putting precious human lives at some small but non-zero risk to save a crucial part of their, and our, biological diversity.

In the sea we are not doing that. Whereas a tiger is a noble beast, an eagle is a symbol of fierceness and independence, a bear is the very notion of wilderness to us, a marlin, a swordfish, a tuna, or a shark are just

The extinction of the eelgrass limpet, an abundant marine invertebrate, took place on a coast with more marine laboratories per mile than anywhere on Earth, and was overlooked for sixty years.

meat; the statistics on their take is presented in tons. I want to see that apex predators in marine systems receive the same conservation priority that apex predators get in terrestrial systems, because as on land, they exert a disproportionate effect on their entire ecosystem. And so we held a workshop on ecology and conservation biology of the large tunas and billfishes in Islamorada, Florida, in October 1997.

ER: What is another emerging issue?

EN: Our most recent workshop was on another topic that has not previously been dealt with and it was called, *Controlling Established Populations of Alien Species*. Jim Carlton, one of MCBI's board members, is the father of marine invasion biology, besides being the first person to have discovered an extinction of a modern marine species with planktonic larvae. Everything I am learning about marine alien species says that the best way to deal with it is to

prevent more introductions. But hundreds or thousands of species have already become established, so Pandora's box is already open. What do you do with alien species that have become established? Some species are not perceived as problems, so nothing has to be done, but there are species that are definitely seen as problems. In Willapa Bay smooth cordgrass, *Spartina alterniflora*, has overgrown the estuary and threatens the oyster industry there; and now *Spartina* is in Puget Sound, and there has been bitter controversy over whether to control this weed with herbicides or by physical means.

But even that is a smaller question than the question of biocontrol. *Spartina* and at least three other alien species in the world are now subjects of research and development on biocontrol. One is *Mnemiopsis leidyi* which is a comb jellyfish, an animal native to the west Atlantic that appeared in the Black Sea in 1982. By 1989 its biomass was ten times as great as the entire world's fish catch. It eats the eggs and larvae of fishes and has been accused of devastating the Black Sea's fisheries. There are people who want to release a fish that eats *Mnemiopsis* into the Black Sea.

Another example is an alien alga spreading very rapidly in the Mediter-



1 mm-long marine copepods, a primary food for young fish.

anean. It's already spread from the Baleric Islands of Spain to the coast of Croatia. Apparently it escaped from the Oceanographic Museum in Monaco. It's called *Caulerpa taxifolia* and there are proposals to release Opisthobranch mollusks, shell-less snails, that eat *Caulerpa*, to prevent this seaweed from overwhelming the native seagrass beds.

Another example is on the west coast of North America and on the south coast of Australia where there are alien green crabs called *Carcinus maenas*. They were discovered in San Francisco Bay in 1989 or and then they spread to Humboldt Bay, California two years ago; in 1997 they were found in Coos Bay, Oregon; this year they reached Willapa Bay, Washington; next stop is Puget Sound, and they'll probably reach Alaska eventually. Green crabs are voracious predators of mollusks and crustaceans such as clams, mussels, and young Dungeness crabs, and could harm fisheries and aquaculture operations here.

In all four cases these species have been proposed for treatment with biological control agents, and that concerns me because in many cases biocontrol agents were released without careful evaluation and that caused serious problems.

ER: Are there any cases of biocontrol that have gone right?

EN: Yes. The *Cactoblastis cactorum* moth was released to kill prickly pear cactus that were introduced in Australia and had become a real problem. Apparently the moth was taxon specific and since there were no cacti native to Australia, it did what it was supposed to do. I like the idea: no pesticides, no scarring the land, just release it and it works. But the prob-

lem is that very often biocontrol agents don't eat just one thing and they can do a lot of damage to native organisms.

The worst example of that I know of involves a snail introduced from Africa called *Acatina fulica*, which promptly started eating everybody's gardens in Hawaii and a number of other Pacific and Indian ocean islands. So someone imported the rosy wolf snail, *Euglandina rosea*, from the United States. *Euglandina* proceeded to do fabulously well in Hawaii, Tahiti and everywhere else, eliminating at least dozens of species of native land and tree snails in the process.

ER: It's odd they didn't try a test first.

EN: Good point. There must be cautious, intelligently drawn protocols for testing and release of biocontrol agents before we do it, and currently there are no restrictions on doing it anywhere I know of. In theory a person could take a green crab from the Atlantic coast of the United States and fly it in a bucket and drop it in Puget Sound. Nobody can stop this legally; there are no protocols for taking a predator, parasite, or disease organism of green crabs and doing the same thing. I think there needs to be. That's why we held this emerging issues workshop.

ER: What issues do you see coming?

EN: The workshop we are planning next will be on emerging epidemics in the sea. We seem to be seeing more and more epidemics in the marine realm. I am concerned about the possibility that something is happening on a worldwide basis that could be affecting immune systems of marine organisms. We are seeing incidences of epidemics striking various marine

**The
Environmental Review
newsletter is a low cost, high
quality resource for
students, teachers, libraries,
or anyone interested in the
environment.**

**Try a six month subscription
to the newsletter for only ten
dollars and see if it suits you.**

**Call 206/523/2501 or write us
at 6920 Roosevelt Way NE,
STE 307, Seattle, WA. 98115
or email us at
dtaylor@igc.apc.org**

mammals around the world. Most recently, in 1997, endangered Mediterranean monk seals — which also live on the coast of West Africa — were devastated by something that killed at least half the population. It has also happened with seals in the North Sea, with dolphins on the Atlantic and Gulf Coasts of the United States, a different species of dolphin in the Mediterranean. Something bad is happening and it's not just with marine mammals. Corals are undergoing dramatically increased incidences of diseases that nobody has ever seen before, including in places where people have been studying corals well enough for long enough that these diseases would have been noticed. Green sea turtles around the world are suffering from what are called fibropapillomas. These growths apparently are caused by a virus; they grow to the point where the eyes and mouths of the turtles are covered and they die of starvation. There may be no mechanism in common for these

diseases, or there may be.

Organisms become susceptible to disease when they're stressed, when immune systems break down. The combination of weakened immune system and the introduction of new pathogenic organisms is a recipe for disease becoming an ever-larger problem in the marine realm.

ER: The Pauly paper in *Science* may convince some people this is not environmental hysteria.

EN: It is certainly not. Their paper is a beautiful example of the boy who tells us all that the emperor's not wearing any clothes. We have known for a long time that human beings are selective predators. When people came to North America, we did not go out of our way to catch beetles; we went for the mastodons, mammoths, horses, bison, ground sloths, the big meaty things, the high reward per unit effort things. We've done the same thing in the sea. We have systematically hunted great whales, and almost eliminated them until we underwent the socio-political system flip when people realized these are mammals, we can't do that.

There was a brilliant piece of work by Colin Clark some years ago. He's a mathematician, now retired, at the University of British Columbia, and he looked at the exploitation of whales in Antarctica. He plotted the tonnage of each species killed as a function of year, and he found that first people killed the blue whales and they went from low catch to peak and then trailed off; and as they trailed off, then we took fin whales, the next largest species; and then when the same thing happened to the fin whales,

we started doing it to the sei whales; and finally we were left with minkes, which are little guys. And that is a profound and very simple economic principal: Take the best first. And that's what we've been seeing all around the world.

In October I returned from the Black Sea. There used to be twenty-six Black Sea fisheries that together took 10,000 tons a year or more. Today there are only five, and all the big fish are gone. The sword fish, the tunas and bonita are gone, the turbot are almost gone, essentially extinct as a fishery. All of the large predatory fishes are commercially or biologically extinct there. The only fish that remain in the Black Sea to keep the fisheries

We seem to be seeing more epidemics in the marine realm. ... in 1997 endangered Mediterranean monk seals were devastated by a disease that killed at least half the population. It has also happened with seals in the North Sea, with dolphins on the Atlantic and Gulf Coasts, a different species of dolphin in the Mediterranean.

afloat are planktivorous pelagic schooling fishes like anchovies and sprats, little guys.

So we've eaten the marine equivalents of lions and the zebra into commercial extinction and now we're eating the equivalents of dandelions, rats, and cockroaches. And that's what Pauly is saying: we have systematically eliminated the large predators, replacing them with ourselves. Now we're eating their prey and eliminating them, and we will reach a point where we can't do that any longer and we're going to have to back off because the

next trophic level available to us is zooplankton, and very few people I know are willing to pay for fillet of copepod.

ER: Or green slime.

EN: Yes, science fiction writers have talked about that for a long time, but there are thermodynamic reasons why that's not going to work: you have to go through a lot of water to get the phytoplankton. It's much smarter to let a herring eat those for you, or better yet to let a tuna catch the herring, or a marlin catch the tuna and you just catch the big fish. But we have overexploited them, and as a result we're finding that the high-value, high-profit fishes are gone or going fast. As Pauly said, we've fished down the food web.

I think that along with Jim Carlton's paper on extinction of the eelgrass limpet, this is the most consequential paper in marine conservation in this decade. I'm heartened that Pauly

and his colleagues had the vision and courage to stand back and look at the big picture instead of doing what most scientists do, which is look at a small question over a short period of time. There is a word I learned recently from an ad for a brand of wine, the word is tessera. A tessera is one tile in a mosaic. Most scientists make the individual tiles; Pauly showed us the mosaic, the big picture, and I hope their work will be stimulating to people to think for a long, long time because it tells us we are doing a disastrous job of managing marine

ecosystems.

ER: We're not eliminating all species in food webs.

EN: No, nature is robust, and when you remove the large predators, something replaces them. When we caught all the haddock and cod and yellow tail flounder that dominated George's Bank, dogfish sharks and small skates replaced them.

The best example of how an ecosystem can be completely altered and yet have the same net productivity came from a freshwater paper by a brilliant Canadian named David Schindler. He was the head of the Freshwater Institute in Winnipeg. First of all for years he got baseline data on a number of little lakes, and then he poured lots of

sulfuric acid into one of the lakes and studied what happened. The primary production didn't change; the main phytoplankton, the diatoms which need waters of fairly moderate pH, were replaced by acid-loving desmids. So in primary production — a gross ecological measure — there was no change; but there were enormous changes in the food web. A mysid shrimp which eats diatoms, a crucial part of the food web, went extinct in that lake ecosystem, and the lake trout that fed on it went from being fat, sleek fish to heads with skeletons and fins. There were profound changes in the ecosystem if you looked at species composition and population characteristics.

ER: Why hasn't the academic establishment gotten excited about overfishing?

EN: One of the reasons why fishery biologists are not as alarmed as they should be is that the world's aggregate fish catch has not changed much. The reason is that every time we find a fish population worth fishing, we mine it out and we take the money and we move on to the next one, the next, and the next, and so far we haven't completely run out of things to mine out.

Now we're catching the last Patagonian tooth fish on seamounts in the Southern Ocean. The seafood industry calls them Chilean sea bass, but these are old-growth fish just like orange roughy are old-growth fish. And when you cut the last old growth tree or catch the last orange roughy or Patagonian toothfish, then there will be no more to catch for a century or

Now we're catching the last Patagonian tooth fish ... The seafood industry calls them Chilean sea bass, but these are old-growth fish just like the orange roughy...

more. I think we should stop fishing for them.

We still keep going into seas farther from the consumers, going deeper, spending more energy because people are willing to pay, but we are devastating those organisms and their ecosystems.

And once we run out of desirable things to catch, we will still have *cyclothone*, the most abundant fish in the world - it's a deepwater pelagic fish. Its population densities are low, but the oceans are very big, so multiplying their population density times the size of the ocean makes them the most abundant fishes in the world. But they have the texture of mucus, and if we don't mind eating gray mucus or

green slime, we will not run out of food any time soon.

ER: That's encouraging.

EN: Myself, I prefer swordfish steaks, but I can't eat them any more. There aren't enough of them left. We should give them a break. But I don't know if we have the intelligence and decency to do so.

ER: What's it going to take to get people's attention on overfishing?

EN: Human beings are the most intelligent species in the world; we typically apply our intelligence first to acting and only later to noticing the consequences of our actions and compensating for them. Our technologies for taking fish and for altering the marine ecosystem have changed so rapidly that we have profoundly altered these systems, yet almost nobody noticed.

That recalls the eelgrass limpet, an abundant animal on a coast studded with marine labs, whose disappearance was not noticed for sixty years. As marine conservation biology grows, more people will be looking, more people will be thinking, and it's less likely that bad things will happen and not be noticed. That's one of my objectives.

Awareness is changing. People don't think the sea is invulnerable any more; we don't think that only whales, sea turtles, and sea birds count. We are even extending this to fishes and will slowly reach the point where even phytoplankton and invertebrates will merit enough concern to have friends.

Table of Contents: *Environmental Review* Volume Four

January - December (1997)

January

Range Collapse in Endangered Mammals - Mark Lomolino
Ice Shelf Breakup in Antarctica - Mark Fahnestock
What is Sustainability? - Fraser Shilling

February

Human Effects on the Landscape of Ancient Greece - Curtis Runnels
Natural Gas Development in Northern Michigan - Keith Schneider

March

Scientists Sue the Forest Service - Donald Waller
National Wetland Inventory - Kenneth Klemow

April

Lead Poisoning at the Bunker Hill Superfund Site - Jerry Cobb
Biodiversity Losses in Prairie Remnants - Mark Leach
Studying Forest Conditions from Space - David Wallin

May

Jobs versus the Environment? - Thomas Power
Managing the Columbian White-tailed Deer - Alan Clark
Lead Poisoning of Wildlife - Dan Audet

June

Recovery of the California Condor - Noel Snyder
The Chemical Weapon Disposal Program - Richard Magee

July

Why the North Atlantic Cod Fishery Collapsed - Ransom Myers
A Pesticide Spill and Feminized Alligators - J. Perran Ross
Is Development Sustainable? - Robert Goodland

August

Grizzly Bear Recovery in the Northern Rockies - Christopher Serveen
Science, Nonscience, and Nonsense - Michael Zimmerman
Are Sperm Counts Declining? - C. Alvin Paulsen

September

Aquatic Habitat Conditions in the Sierras - Peter Moyle
When Will the Oil Run Out? - Robert Kaufman
Measuring Human Exposure to Pesticides - Robert Hill Jr.

October

Degradation of the Nile Delta - Daniel Stanley
Ecosystem Services Provided by Insects - Carol Kearns
Grassland Bird Declines in the Midwest - James Herkert

November

Air Pollution in the Sierra Nevada - Thomas Cahill
Science and Politics of the Sierra Nevada Ecosystem Project - Donald Erman

December

Commercial Use of Alligators as a Conservation Tool - Ruth Elsey
An Epidemic of Arsenic Poisoning in West Bengal - K.C. Saha
Beyond Ecophobia - David Sobel

To order back issues, or to subscribe to a full year of *Environmental Review* for \$25.50, a fifteen percent discount, mail this card to us at:

Environmental Review
6920 Roosevelt Way NE STE 307
Seattle, WA. 98115

Students, seniors, libraries and teachers may subscribe for \$15.00 per year, a fifty percent discount.

Visit our Website on EcoNet at <http://www.igc.apc.org/envreview> for back issues.

One Year Subscription (\$25.50) _____	Student (\$15.00) _____	Visa _____ Mastercard _____ # _____ exp date _____ amount _____
Six month trial subscription (\$10.00) _____	Back issues at \$2.50 each _____	Signature: _____ or payment enclosed _____
Name _____		
Address _____		
City _____ State _____ Zip _____		

This is an encouraging sign because once we know the adverse consequences of what we're doing, we can make reasoned choices. In many cases I think we will choose to do the right thing once we have enough information. I've staked my professional life on building the science of marine conservation biology because I think our knowledge will make it impossible for us to keep wrecking our planet the way we have thus far.

ER: That reminds me of Churchill's saying that the Americans always do the right thing, after they've tried everything else.

EN: [Laughing] Yes. Well, we have tried just about everything else and look what's happened. When I was writing *Ancient Forests of the Pacific Northwest*, I was astounded that nobody was sounding the alarm bell about the salmon. If people throw dams across their rivers, log their forests and pollute their habitat, sooner or later something's got to happen. And it happened, and now everybody is in a panic. It's tragic that we behave in ways that require us to feel fear

NEXT MONTH
MECHANISMS AND CONSEQUENCES OF NITROGEN DEPOSITION:
ROBERT HOWERTH
&
PAMELA MATSON

HOW TO THINK ABOUT NATURE, THE WISDOM OF ALDO LEOPOLD: AN ADDRESS BY ESTELLA LEOPOLD

before we put our brains into gear and say, Hey, maybe we need to do something. That's why MCBI is here.

If we can show people enough things whose knowledge would alarm them or encourage them, we can engage their emotions before it's too late.

Literature Cited:

D. Pauly, V. Christensen, J. Dalsgaard, R. Froese, F. Torres Jr. Fishing Down Marine Ecosystems. 1998 Science 279:860-863

The Marine Conservation Biology Institute's phone number is 206-883-8914. Their website address is <http://www.mcbi.org>



Printed on recycled paper with soy based inks.

To subscribe to the *Environmental Review* call 1/206/523/2501 any time and follow the recorded instructions. We accept Mastercard and Visa, or we can bill you. Libraries, students and teachers are eligible for a half-price rate of \$15.00 for a one year subscription.