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Do Reconstructed Wetlands Work?

Introduction:

Until recently it was thought the best thing to do with a marsh was to drain it and put it to use as dry land for farming or development. Now, wetlands are recognized for their value in flood reduction, water purification, and wildlife habitat. Since 1982 more than 400,000 hectares — almost one million acres — of fresh and saltwater wetlands have been restored in the U.S., and plans are to double that in the next ten years.

Professor Joy Zedler of the University of Wisconsin studied a reconstructed marsh near San Diego for more than ten years and found that while it does some good for wildlife, it does not fulfill its primary purpose, which was to provide habitat for the endangered light-footed clapper rail. We spoke with Professor Zedler about some of the finer points of rebuilding natural ecosystems.

ER: Professor Zedler, what is your background?

JZ: I got my Ph.D. at the University of Wisconsin in 1968. After one year teaching at the University of Missouri, I moved to San Diego State University, where I founded and directed the Pacific Estuarine Research Laboratory. Our lab became an internationally known research program in coastal wetland restoration. Work on estuaries and salt marshes continues, although I moved to Madison in January 1998. The University of Wisconsin offered me a terrific opportunity to broaden my interests and to create an interdisciplinary program in restoration ecology. Another major attraction was the university's Arboretum, a 1,200 acre reserve in the middle of the city, where we can conduct good science and ecosystem restoration.

ER: What is your niche in the academic landscape?

JZ: I'm a plant ecologist. My dissertation research was on habitat for the prairie chicken. In Wisconsin degraded, abandoned farmlands are managed for prairie chickens. In San Diego I studied salt marshes that were being restored for clapper rails. Despite their occurrence in very different ecosystems — terrestrial field versus tidal wetlands — these two birds are similar in that they have specific requirements for habitat structure and vegetation cover.

ER: When did the San Diego Bay restoration project start?

JZ: The Sweetwater Marsh project started just before 1984 with widening of a freeway, construction of a new freeway interchange and excavation of a new flood control channel. It was a combined project of the California Department of Transportation — Caltrans — and the U.S. Army Corps of Engineers, with review by the U.S. Fish and Wildlife Service.

There were legal requirements to make up for the construction damage to the existing marshes, compensatory mitigation. As they were building the freeway, Caltrans excavated about twelve acres of former fill, including sediments dredged from San Diego Bay's ship channel and refuse from an old urban dump. When they dug through this fill material, antique bottles were

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exposed, and broken glass, and lead contaminated soil had to be removed to a toxic waste dump. There were many surprises during the excavation, and the substrate that remained was quite unlike that of a natural salt marsh. The site was then contoured in 1984 and planted to cordgrass and other marsh plant species in 1985.

Sometime before 1988, it became clear that the mitigation requirements were not being met, so the League for Coastal Protection, Sierra Club, and others sued the three federal agencies involved for not carrying out the mitigation on time and in the proper sequence.

In 1988 that court case was settled; the plaintiffs won, and it opened up a new biological consultation under the Endangered Species Act. That led to new and stiffer standards for mitigation because new information had been developed about the endangered species in question. The US FWS determined that three species were jeopardized and that habitat would need to be created for the California least tern to forage, for the salt marsh bird's beak population to be reestablished, and for the light-footed clapper rail to establish seven home ranges, including nesting habitat.

That was when I was asked to become involved. I had been studying the cordgrass that supports rail nesting. In specifying how the created habitats should function, the U.S. Fish and Wildlife Service introduced the concept of a self-sustaining system. The mitigator would not be able to do something for two or three years and then walk away from the project. Instead, Caltrans and the Corps were required to provide a self-sustaining habitat for the light-footed clapper rail, a self-sustaining population of salt marsh bird's beak, which is a small endangered plant, and forage for the endangered California least tern. Criteria were established for each of these three species, but standards were strongest and strictest for the clapper rail. With the stricter standards, it became necessary to develop a monitoring and assessment program to see if the standards were being met.

California's wetlands have mostly been destroyed, the acreage is only 9 percent of what was there 200 years ago.

Caltrans asked me to begin assessing the restored site in 1989. At this time the marsh was five years old, but it still had only sparse, short cordgrass. That led me to solicit research funding to understand why the criteria were not being achieved. That was the point when the project became scientifically interesting because we could do more than just sample once or twice a year.

ER: Is this cordgrass the same Spartina that we're having so much trouble with here in Willapa Bay?

JZ: No, no. Our *Spartina foliosa* is a native plant that grows in tidal marshes from Bodega Bay and San Francisco Bay, south to the tip of Baja, California. It's a native, it belongs there.

ER: What were the shortcomings of the restored salt marsh?

JZ: We saw early on that the vegetation was shorter than the requirement of sixty centimeters. A comparison of areas that clapper rails used for nesting with those not used for nesting showed that the difference was in the number of tall stems. Clapper rails nest in areas with one hundred stems per square meter, of which at least thirty are taller than ninety centimeters. That explained why the clapper rails never used the habitats that were designed for them: the vegetation was too short. So the right plant species are there and if you look at it from a distance you'd expect it to support clapper rails, but it doesn't. Then we conducted field experiments to explain why the plants didn't grow tall enough.

A second 17-acre mitigation site was excavated in 1989 and 90, and opened to tidal flushing in 1990. Because we knew that the older site was not functioning well Caltrans

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allowed us to do experiments with the substrate amendments. We had a year to test fertilizers and organic matter additions before they planted the site in 1991.

ER: What did the experiments show?

JZ: We traced the cause of short cordgrass to the coarse sediment which would not hold nitrogen that plants need to grow. Of the three treatments alfalfa, which provides nitrogen-rich organic matter, nitrogen fertilizer, and straw, the best was the treatment with the most nitrogen. The plants grew taller for one year, but the next year the plants were short again. The one-time amendment did not produce self-sustaining cordgrass.

So we returned to the older marsh and experimentally added nitrogen for one month, two months, and all summer long. The more nitrogen we added, the taller the plants grew, but they remained tall only where we kept adding nitrogen year after year. After three years we thought that enough biomass would have built up below ground to sustain tall plants, but it didn't work. This gave us further evidence that our interpretation about the substrate texture was correct: coarse substrate simply can't hang onto enough nitrogen.

ER: How would you test that idea?

JZ: Two of my students did decomposition experiments with plants in bags that were allowed to decay. Within a couple of months most of the nitrogen from the decaying plants was gone; it had leeched out of the coarse sand. It's a leaky ecosystem. So although the highway department could fertilize year after year, that wouldn't satisfy the self-sustaining criterion.

We tried fertilizing the marsh on a larger scale — twenty by twenty meters — and we encountered two new surprises. A different plant out competed the cordgrass for the nitrogen. Kathy Boyer's experiment grew the two alone and together, with and without nitrogen. Nitrogen favored an annual prickleweed which grew two or three times taller than normal. That result was a total surprise. Normally an annual plant can't out compete a perennial grass.

ER: So intense fertilizing made it worse for the cordgrass?

JZ: It did. And sedimentation with various floods also changed the vegetation. In salt marshes, a ten-centimeter increase in topography can shift the marsh from cordgrass to prickle-weed species, and to the pickle weeds being the abundant dominants.
The pickle weeds — both the perennial and the annual species — are better competitors for nitrogen than cordgrass. So, where the sediment is too coarse and the topography too high the pickle weeds win.

ER: What other problems did you find?

JZ: Early on I noticed an outbreak of a little scale insect, a native species that had never been a pest in our natural marsh. We found over a thousand scales on a single cordgrass plant, and every plant was infected. It suggested a negative feedback mechanism: the scale seemed to be most prevalent where the plants were short, and because it was sucking so much food from the leaves, it kept the plants short. I suggested to Kathy Boyer that she do her masters thesis research on how that plant and its scale insect would respond to nitrogen addition.

There are two competing theories in the literature: first, if you add nitrogen, plants will be more susceptible to insect attack because some insects will attack nitrogen-rich plants. Second is that a nitrogen-fertilized plant is healthier and can ward off herbivores better. That's what she found for this plant. We needed to know that before making recommendations about fertilizing the restored marsh. Because nitrogen made the plants less susceptible to the insects, we were able to proceed with larger-scale experimentation.

ER: Why did the scale insect overrun the marsh plants?

JZ: The scale insect became a pest because its predator, a lady bird beetle, was missing. We didn't have many beetles in the constructed marsh because the cordgrass was not tall. The beetle is a terrestrial insect and it hangs out in tall cordgrass when the tide is high. So, if the water level rises and covers the whole plant, there's no refuge for the beetle, and if the beetles are rare, the scale insect populations expand.

ER: What could a non scientist make of all this?

JZ: I think the interesting thing for the lay public is how complicated the ecosystem is, and how these little interactions are all generated by the wrong substrate type, the coarse texture. So if you have coarse texture soils, the ecosystem is leaky with respect to nitrogen, organic matter decays rapidly, the nitrogen leaches out, the plants are nitrogen starved, they don't grow tall enough, the beetles can't be there, so the scale insects become too abundant; and because the plants are too short, the clapper rails can't use the area. If you add nitrogen it helps deter the scale insect pests, but it can also stimulate a competitor for the cordgrass, and the competitor is not as good habitat for clapper rail nesting. Because the system is so complex it took ten years of study and many graduate student theses to understand it.

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ER: Did you have good comparative areas nearby?

JZ: Yes, the best reference was Paradise Creek Marsh, which was partly damaged by highway construction. In addition we had sample sites at Sweetwater Marsh, which was just to the west of the constructed marshes, and we had years of data from Tijuana Estuary, which I've been studying since about 1973. That salt marsh is the second best habitat for clapper rails in the region. We also had data from Baja California, Mexico, which is a good reference site with lots of clapper rails.

ER: What was the substrate like in those places?

JZ: Marsh develops naturally in areas with slow moving water, where fine particles can settle out. The mud holds more water and nutrients and supports vegetation much better than sand.

ER: So Caltrans changed the flow of water through the reconstructed marsh, but not in the right way.

JZ: Caltrans did a good thing by excavating dry topography to make it wet, because a lot of native vegetation now occurs there, a lot of shorebirds use the marsh edges, and many fishes use the channels. There's a lot of good to be said about these constructed marshes, but they didn't comply with the requirement that they provide self-sustaining habitat for nesting by clapper rails, so it didn't meet the law's requirements.

ER: It sounds like it's not going to be self sustaining any time soon given the problems you've described.

JZ: Yes, this last year we convinced the responsible agencies, the Fish and Wildlife Service, and Caltrans, and the Corps of Engineers, that this site probably would never achieve the requirements established for it and that they should seek an alternative resolution to the mitigation program. Instead of having Caltrans continue to spend money on monitoring when we were convinced the site would not achieve its objectives, we recommended an alternative penalty: that Caltrans remove sediment from another area that had been filled, the nearby F/G Street Marsh; and that's the current requirement.

That will benefit many species. It probably won't help clapper rails very much, but it keeps the agencies from setting a precedent of accepting non compliance and allowing the mitigator off the hook. Instead, the Fish and Wildlife Service said, if you don't meet your mitigation criteria you'll have to pay a different penalty.

Caltrans should get credit for trying hard to meet the criteria. After all, they didn't have to let us do

research at the site, but they facilitated our work. They wanted to know what was wrong, and they looked to us for advice on how to fix it. We talked about many alternatives for replacing the coarse soil, but if they had tried to go back into the thirteen and nine-year old constructed marshes and make them appropriate for cordgrass and clapper rails, it would have destroyed system that's there. They would have had to cut tidal creeks with heavy machinery, making a mess of a site that's already troubled.

ER: So you're concerned about the value that is already there?

JZ: Yes, in part.

ER: Let's talk about that because I don't want people to get a totally negative view of reconstructed wetlands.

JZ: Yes. I appreciate that because we've had terrific support from the biologists at Caltrans. They've wanted to make this work, and they don't deserve negative publicity because the site didn't achieve its compliance criteria. Their efforts did not lead to completion because the site had the wrong substrate.

ER: But the reconstructed marsh has other values even it it doesn't provide rail habitat.

JZ: Criteria were met for the California least tern and for the salt marsh bird's-beak. For the tern, fish forage was provided. In fact, the channels support a higher density of fishes than the natural channels that we compared. Bigger, deeper channels do attract large numbers of fish.

We are however, concerned about the population of salt marsh bird's-beak. Caltrans was required to create a population of one hundred plants. We sowed seeds for several years in succession. Then in our first year of monitoring we found about 5,000 plants, then 14,000 plants the second year, and almost 14,000 plants the third year. The specific criteria for self sustainability were that the population meet the one hundred plant level and keep that level for three years, so they met the criteria. However, the subsequent year was dry and the population crashed to about 2,000 plants. Three years is not a long enough assessment period, as the population could still be wiped out. The fifth year, we found about 5,000 plants; now, in this year, the sixth year of monitoring, and the population numbers slightly higher.

We can't say that the population is out of jeopardy because if we had six dry years in a row, which has happened in the past, the habitat may not support it. But we've had a good-sized population for a number of years, and certainly more than were required.

In the salt marsh we had about twelve species of native plants that were present, as required. Also, the site is productive, with lots of nutrients coming in from urban runoff, occasional algal blooms, and a lot of food for animals. The invertebrate species list is about the same as in natural marshes. Early on there were only about one third as many individuals, but the species were there.

There are lots of native crabs, which are preferred by clapper rails if the bird could use the habitat. We're puzzled why they don't wander in to feed. Bird use was not a criterion, but casually you see lots of shorebirds, egrets, and herons all taking advantage of the fish there. So it's a diverse ecosystem. It's still adjusting and it's hard to say how it will look in fifty years.

ER: How can we generalize from this experience to mitigation or restoration of other wetlands?

JZ: It's tougher than we thought, and I think it's tougher than most people thought. And I like to explain that by referring to what my landscape architecture friends call the context of the restoration project. The regional context is important

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and so is the local context. If you construct or restore a wetland in a region where most of the natural habitat type is intact, there will be places from which the organisms can disperse, so it's more likely that the native species will be able to find, and establish in, your site.

For the local context, if the site is not fragmented, its natural hydrology is appropriate and it's not contaminated, then chances are much greater of being able to achieve restoration goals. Cordgrass is not a species that establishes very easily. In fact, we've had a very difficult time trying to grow seedlings, even pampering them. We have begun experiments here in Wisconsin to figure out what seedlings require. The only time that we've seen abundant seedlings in salt marshes is after major flooding. So in the greenhouse we're trying some cooler, moister conditions at lower salinities than in the salt marsh to see if we can propagate the plant for future restoration projects. We want to eliminate the need to disturb existing clapper rail habitat to remove plugs to create new marshes.

ER: That was the only way you could get cordgrass before?

JZ: Yes, so far that's the only technique. Some growers propagate the plugs vegetatively but genetic diversity is not ensured then. So we're trying to grow it from seed.

ER: Won't the cordgrass come back on its own?

JZ: California's wetlands have mostly been destroyed, the acreage is only 9 percent of what was there 200 years ago. So wetlands are isolated and small, and plants and animals are not likely to reestablish on their own. The San Diego Bay site had a low probability of success in retrospect because the regional context is missing and the local context was a tiny, highly modified, fragmented site with a freeway running through it, a railroad running through it, and a power line running over it. Lots of disturbance, urban runoff, former contaminants, feral animals, just about every problem that you could imagine, so no wonder it was difficult to comply with strict standards. But this was mitigation under the Endangered Species Act and the requirement was that habitat for endangered species had to be there.

ER: Just the habitat, not the animals?

JZ: Yes. The restoration just had to provide habitat for seven nesting pairs of clapper rails. There's no evidence that Caltrans actually caused the death of any clapper rails, but they eliminated some clapper rail habitat. That was one reason I was fairly comfortable with an alternative penalty. There was no evidence that Caltrans caused any pairs to stop nesting.

ER: What is the population status for the clapper rail?

JZ: It's better right now than ever recorded. Dick Zembal at the U.S. Fish and Wildlife Service is the expert who censuses the birds. The population at San Diego Bay has never been high, and the number has bounced around, by a few pairs. At Anaheim Bay near Los Angeles, there was a problem with predation by the introduced red fox. The Fish and Wildlife Service removed the red fox and that population is rebounding.

Newport Bay has the largest population, a couple hundred pairs. Tijuana Estuary is second or third. The San Diego Bay population is tiny because there's no habitat left. This Fish and Wildlife Service Refuge within which the restoration projects took place is only 317 acres; a lot of that is upland, so it's just a tiny wetland. Over 90 percent of the

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marsh area in San Diego Bay is gone, so that population is never going to be large.

ER: Speaking of context, what about the relation of the marshes to the upland areas?

JZ: That's important because mitigation projects tend to get constructed without buffers. Yet marshes are not independent of the upland. The light-footed clapper rail requires a high-tide refuge, it needs a place to come up out of the water when the tide is in and when we have storm tides. When you try to build a buffer with high-marsh vegetation, you find that the sediment develops a salt crust and the plants don't grow very well. Brian Fink, a consultant and former student of mine, added decomposed kelp as a soil amendment, which helped plants establish. Irrigation with fresh water was also required.

The criteria for a high-tide refuge were not very strong; just that certain species had to be present. We think in retrospect that this buffer cover should be required to have a certain height and canopy architecture to shield clapper rails who come up out of the marsh from feral dogs and from people. They really need someplace to hide.

The other upland link we saw was with the salt marsh bird's-beak, the little annual plant that needs to set seed to persist. Lorraine Parsons' thesis work on that species showed that pollinators were limiting. The pollinators are solitary bees that nest in the drier ground just above the high-tide line. Unless you have proper habitat above high tide line you won't have these bees, and if you don't have enough pollinators then this annual plant won't produce seed. There were several species that could pollinate it, but the ground nesting bees were specialized to pollinate this plant.

ER: Pretty soon you'll have to mitigate all the way up to the hills of San Diego.

JZ: [Laughing]. There are further links between habitats. Ecosystems that are isolated support fewer species than those in a natural landscape.

... we've lost 90 percent of the habitat and have only disturbed remnants. No wonder so many wetland dependent species are endangered with extinction.

ER: But the bird's-beak seems to be doing OK?

JZ: Well, I don't know that it's assured that it will persist. That population could be wiped out with a few successive dry years. We saw a sharp decline in 1996, when the population declined and the area occupied shrunk to the slightly lower, slightly wetter habitat. We know that most of the marsh is not suitable for it. So if there were several dry years in succession, the seed bank would be depleted. We don't know how long the seed bank remains viable. In the lab seeds that are as old as eleven years have germinated, but whether or not they can do so in the nature is hard to know. A student, Meghan Fellows, conducted an experiment in the spring of 1997 and 1998 on the establishment of this species. The only place she found seedlings was where she added seeds. So there's not much of a seed bank, even though there were 14,000 plants just a few years ago. One reason may be the high elevation due to a history of sedimentation. Back in the forties there was a big sediment plume that was deposited by a large flood, so the high marsh is a little higher than optimal. Perennial plants can grow up through the sediment but the annuals can't germinate when it's too dry.

I think that's what's happened here. Continued sedimentation can raise the topography by a few inches, enough to make a site marginal for seed germination and seedling establishment.

In a large region with lots of marshes, there would be alternative habitats to support rare annual plants. But we've lost 90 percent of the habitat and have only disturbed remnants. No wonder so many wetland-dependent species are endangered with extinction.

Making Sense of Taxes

Introduction:

In the book *Tax Shift, How to Help the Economy, Improve the Environment, and Get the Tax Man Off Our Backs*[1], Alan Durning and Yoram Bauman show how our tax laws encourage environmental damage and waste. The book discusses how taxes with perverse incentives can be replaced by a more rational and humane code which encourages conservation and thrift and does not punish responsible behavior.

Basic economic theory and practice tells us that if you tax something - income, or capital gains - less of it is produced. It makes sense to increase taxes on those things we want to discourage, such as resource extraction, non renewable energy, and to reduce taxes on things we want more of like income, renewable energy, and green technologies. Our society has evolved from a frontier, resource extraction-based economy to an economy based on services, information, and high tech. Our tax have not kept pace with the rapid, fundamental changes that have occurred in our society in the last half century.

The ideas put forth in *Tax Shift* are not new to the authors; they point out that tax reforms that more attuned to current social consensus have already been adopted in the U.K., Switzerland, Denmark, Germany, Finland, and Norway; and several states in the U.S. are considering some form of tax shifting as well.

We discussed the pros and cons of several of our current taxes and what should take their place with Alan Durning. Alan is director and founder of Northwest Environment Watch, a Seattle based research and education organization, and a former senior researcher with Worldwatch Research Institute in Washington, D.C.

ER: Alan, what is your background in conservation?

AD: I've been working on sustainability issues since 1986 when I started as a research assistant at Worldwatch in Washington, D.C. At Worldwatch my work had to do with the relationships between environmental degradation and social and economic inequalities. I wrote about poverty and affluence. The work on affluence is probably best received in the book I did in 1992,[2] that talked about the ways in which material success was bringing us up short in environmental terms and also in human terms. That book has since been translated into seven languages and run through several print runs.

In 1993 I moved back home to Seattle where I had grown up. It seemed like a global focus was unsustainable for me personally and I wanted to apply the skills that I had developed to one part of the planet that I felt most attached to, so I came back to Seattle and started Northwest Environment Watch.

Originally the group was conceived as a bioregional replica of Worldwatch. It has since evolved in several directions, but we continue to be above all else a research and publishing center that tries to inform people, especially in the Northwest, about the opportunities and dangers of the status quo. We do that mostly through books of about a one hundred pages that we publish two or three times a year on critical sustainability issues.

We have at our fingertips technology and resources that would have boggled the minds of even our grandparents, but at the same time it's not a sustainable lifestyle.

ER: What caused you as an environmentalist to study the tax code?

AD: The roots of tax shift are in what I see as perhaps the central sustainability challenge for North America. Our extraordinarily prolific economy is by material standards the most successful that's ever existed on the planet. We have at our fingertips technology and resources that would have boggled the minds of even our grandparents, but at the same time it's not a sustainable lifestyle. It certainly couldn't be practiced by all people on the planet and certainly can't be sustained indefinitely into the future, with each of us consuming our body weight each day in natural resources taken from farmlands and forests and

mines and grasslands. As you well know, our species appropriates about one quarter of the net photosynthetic productivity on the Earth, and also appropriates about one third of the fresh water flowing through inhabited regions of the globe. So the fundamental challenge is how to have more fun from less stuff, or more academically stated, how to create an economy that makes a quantum leap in how much value it generates from each pound of resource or pollution.

The market, which has been so extraordinarily effective in encouraging individual effort and in making production responsive to consumers is blind to the ecosystem we depend on. Many of our environmental ills can be described as a disparity between the prices we pay and the true cost of things.

We pay a little more than a dollar for a gallon of gasoline, but the true social and economic costs of producing that gasoline — defending the shipping lanes with the U.S. Navy; all the way through the cases of lung disease that result from breathing the exhaust from the cars — is several fold more, maybe six dollars, maybe ten dollars.

Specialists can argue over the methodologies of accurately ascertaining the true costs, but there's no doubt that costs of many things are far different than prices. That's the one humongous problem that we're up against: how to get prices to tell the truth, in order to get more value from each pound of stuff. For me, tax shifting emerged from a concern over the misalignment between our economy and our habitat.

The idea of a tax shift is pretty simple and certainly not original to NEW. It's roots go back at least a couple of decades, and probably a lot longer than that. The idea is to tax things we want less of, like pollution and resource depletion, sprawl, and traffic congestion and to use that revenue to offset existing taxes that fall mostly on things we want more of like income, payrolls, business, and buildings. If we shift the burden of taxation off of economic goods and onto environmental bads, we will benefit both the environment and the economy. This is something that both biologists and economists can agree upon.

So the fundamental challenge is to have more fun from less stuff, or more academically stated, how to create an economy that makes a quantum leap in how much value it generates from each pound of resource or pollution.

ER: How do you measure the economic cost of pollution?

AD: It's impossible to put precise values on many of the social and environmental costs of production, but they certainly aren't zero. A childhood cancer case that results from smokestack emissions or toxic byproduct in breast milk is worth something, and the market value is set at zero right now.

I don't think you can get the perfectly, unassailably right answer. My suggestion is to worry less about that argument and focus instead on the fact that the government needs revenue. Right now, we collect it by taxing paychecks and business and things that we want more of. We don't have to know the precise value of all externalities to know that, for starters, we should be taxing things we want less of rather than taxing things we want more of.

ER: How did you decide whether a tax is good or not?

AD: In our book, *Tax Shift*, coauthor Yoram Bauman and I evaluate taxes according to four tests. First, the economic effect of the tax. We all learn in Econ 101 that when you tax something you get less of it, and that's almost always true. If you tax profits then you'll generally have less profit; if you tax income you'll generally see less income; if you tax wages specifically, as we do with the payroll tax, you'll get less work. Those effects are measured, or at least estimated, in terms of what are called dead-weight losses; that is, how much economic output is reduced by the negative incentives that a tax creates in the economy.

The second test is equity: society cares not only how much is produced, but who gets it. In the book we look for progressive taxation where how much you pay reflects

your ability to pay. As income or wealth rises, it doesn't hurt as much to contribute through taxation.

The third test is the environment: does the tax encourage conservation and prevention of pollution? Does it help to correct failures of the market?

The fourth test is ease of administration. Some taxes may be a good idea but virtually impossible to do because of the amount of cheating that goes on. There would be costs in terms of record keeping and compliance, so that's always a limiting factor on how elaborate a tax system you can have. Some taxes, like the retail sales tax, exist largely because they're so easy to collect, despite bad economic impacts, awful equity impacts, and because of special provisions in most state codes. The code exempts high impact commodities like gasoline and other energy, and water consumption in most states. So you pay tax on your insulation, or walking shoes and bicycles, but not on gasoline or heating fuel.

ER: Personal income tax came out of the Populist movement and at that time it was considered a progressive idea.

AD: Yes. In our book we graded the personal income tax with a D, which is better than the grades we give for some other taxes. Personal income taxes are among the most progressive taxes currently in use, and from that perspective they're better than some, but they do put a heavy drag on the economy because of the disincentive implicit in taxing income.

It's conceivable that you could design a personal income tax that would be neutral towards the environment, but income taxes in North America are strongly anti-environmental because of two things: the first is they tend to tax wage income much more heavily than other forms of income; that tells employers to practice underemployment and makes natural resources relatively less expensive. The tax encourages them to substitute resources for labor.

Payroll taxes are so regressive that they push about a million children in the U.S. below the poverty line because they fall so heavily on working poor families.

And second, in the fine print of the tax code there are enormous numbers of tax breaks for everything from real estate developers to miners and loggers and major manufacturing industries with large smokestack emissions, with the result that clean businesses tend to pay disproportionately more under the income taxes. Those and other loopholes also erode the fairness, the progressivity of the tax.

Personal income tax is also a difficult tax to enforce. The amount of time it requires of people is inordinate, and because of that there is a large amount of cheating that goes on. About 20 percent of all income earned in the country is hidden from tax collectors.

When we run scenarios of how much revenue you could generate from pollution taxes and other environmental taxes, we usually left the residual to be covered by personal income taxes because they're the least bad of current options.

ER: You flunked payroll taxes.

AD: Congressional leaders are going around the country arguing for flat taxes now, and presidential candidates in both the last two elections called for flat taxes. Flat tax means the rate doesn't increase with income. The truth is, we already have a flat tax and it's called the payroll tax. The payroll tax collects about 15 percent of all wage and salary income earned in the U.S., half of that contributed by the employee and half contributed by the employer, unless you're self employed, in which case you pay the whole thing. It's actually worse than a flat tax in terms of equity because you only pay up to about $65,000. Above that, no tax is collected.

The result of that is that about 70 percent of American households pay more in payroll taxes than in personal income taxes, everyone at the median income and below, and some people higher up in the middle class as well. Payroll taxes are so regressive that they push about a million children in the U.S. below the poverty line because they fall so heavily on working poor families. It's a terrible tax. It's also antiwork. It discourages hiring and reduces after-tax wages substantially.

The environmental impact of the

payroll tax is that it makes labor more expensive relative to natural resources. There's no explicit environmental consequences. It's a pretty easy tax to administer, but the costs to the economy and equity are big. This tax is regarded as a special case by most of the public because they see it as retirement savings. Most of it goes to Social Security; there's also some for Medicare and for unemployment insurance.

ER: Politicians are unlikely to touch the social security tax.

AD: Yes. It's the most popular, or maybe I should say least hated, of the federal taxes in the U.S., and that's because people think of it as a retirement savings plan. The truth of the matter is that we collect more payroll tax than we pay out in benefits, and the surplus sloshes into Congress's hands. They, as you might expect, spend it on general fund activities and write IOU's to the Social Security trust fund. So when the baby boomers retire, then we're going to have to pay for that anyway, probably through income taxes. At least a substantial portion of the payroll tax actually is used as a general tax; it's not a dedicated fund. Many countries pay for retirement benefits out of income tax revenue or other taxes, not out of payroll taxes. I expect that the impending insolvency of the Social Security trust fund will bring about some changes, and I don't know what those are going to be. It sounds more like that there's going to be income tax money paid in to prop up the trust funds, but I'm hopeful that there will be a broader debate and discussion about how the system actually works and how much we rely on this extraordinarily regressive tax. About 36 percent of federal revenue comes from this flat tax, and that's the one we suggest at the federal level to reduce in a tax shift, offsetting it with a tax on greenhouse gases.

The idea is to tax things we want less of, like pollution and resource depletion, sprawl, and traffic congestion and to use that revenue to offset existing taxes that fall mostly on things we want more of like income, payrolls, business, and buildings.

ER: What about property taxes?

AD: Property taxes function as two different taxes: one is a tax on the value of buildings, and the second is a tax on the value of the land underneath the buildings. The two taxes have very different characteristics. The tax on buildings is a strong disincentive to build, maintain, and improve buildings; the tax on the value of the land underneath it encourages full use of sites, it encourages development — at least of premium sites in metropolitan areas.

Socially, the land value tax is progressive, the building tax is regressive. Environmentally this is an important tax because of its effects on sprawl. The current property tax tends to discourage compact, infill development in urban centers and suburban centers, so development goes somewhere else and that means it gets shunted to the suburban periphery. Property taxes are expensive to administer, but you can't cheat on them.

ER: What about sales tax?

AD: Sales taxes are favored by some environmentalists from the misperception that they tax consumption, but sales taxes are not taxes on the kind of consumption that matters to mother nature. They're a tax on retail sales, not on extraction, consumption, and expulsion of natural resources. Mother Nature doesn't care about dollars spent in acupuncture studios, only about tons of timber, soils, and water. So resource consumption taxes make good environmental sense, but retail sales taxes miss the mark.

The environmental impacts of sales taxes are worsened by the routine exemption of goods with large environmental impacts, including electricity, fuel, gasoline, minerals, natural gas, pesticides, logs, and water. All these things are exempt from sales taxes in most of the Northwest.

The economic impacts of the sales tax are fairly substantial, comparable to payroll taxes or the portion of the property tax that falls on buildings; not quite as large as the income tax's economic impact. But then, sales tax is very hard on low-income families. In the Northwest

states overall, the poorest fifth of families pay about three times as much of their income in sales taxes as do the richest fifth of families, while middle class families pay about twice as much of their income as do rich families. So sales tax fails the social equity test and the environmental test and the economic test, and it's one that we spotlight for reduction in any tax shift.

ER: What about corporate taxes?

AD: Corporate income taxes are the last major tax form that we propose to reduce. Many liberals favor corporate income taxes on the grounds that it puts a fair share of the tax burden on businesses. But corporate income taxes have very high economic costs, higher than any other tax because it doubles the tax bite on income: corporate income is taxed once as it's held by the corporation and a second time through individual income tax when it's paid out as dividends to shareholders.

In terms of the incentives, the better way to have a fair tax system is not to tax corporations at all, but to tax the wealth when it reaches the final owners of the wealth. You can tax that at a much more substantial rate and it helps the economy more than by taxing corporate income.

The equity impacts of the corporate tax are not as good as most people think because the tax is progressive in principle, but in fact a fair bit of the tax ends up falling on workers in the form of lower wages. It's not a good way to get an equitable tax system.

The environmental impacts of the corporate income tax are pretty high because of all the special rules written into the tax code that favor high-impact industries particularly in the resource extraction and heavy manufacturing sectors; that's an anachronism from the times when our economy was driven by heavy industries. Now in the information age we're left with these vestiges of frontier economy.

Washington state's business tax is almost in a class by itself for its perversity. We don't tax corporate profits, we tax all receipts, so it's like a sales tax paid by the seller rather than the buyer. The tax rates don't vary with profitability, so start-up companies and businesses that have small profit margins are hit hard under a corporate income tax.

We do vary the tax rates based on what you do, but the system seems to have been designed by someone possessed by the spirit of James Watt: resource extraction and heavy manufacturing industries pay at about three times the rate of service industries; non profit hospitals pay at five times the rate applied to nuclear fuel manufacturers; and agricultural enterprises are exempted entirely.

ER: That's no surprise, the state legislature is dominated by agricultural and industrial interests.

AD: Yes. There is definitely a lag between the current structure of the state's economy, and the power base in the legislature. The B&O tax's only good side is that it's relatively easy to collect, especially compared to an income tax where you have all these complex accounting rules.

ER: What do you propose to put in place of all these taxes?

AD: First I should say just a couple things generally about tax shifting. It's a novel idea this side of the Atlantic, but there are already six countries in Europe that have enacted tax shifts: Sweden, Finland, Denmark, the United Kingdom, Germany, and Switzerland; and there are three state legislatures in the U.S. that have begun to consider the possibility: Maine, Vermont, and Minnesota; and I expect there'll be bills introduced in other state legislatures before too long.

But I think that once the idea gets into the mainstream, we'll start to see a lot more tax shifting rather quickly. The history of tax reforms in North America shows that getting a tax enacted somewhere the first time takes more time and struggle

than getting it copied, if it gets good press. That's certainly the way federal taxes got enacted: they were copies of state taxes that received favorable attention. So in terms of strategy, state-level tax shifts may be where the action is.

That said, we propose a national tax shift that would reduce payroll taxes by about 25 percent in the Northwest states, saving typical Northwest families about $850 a year, saving their employers an equal amount of money, and replacing that revenue with a tax of $100 per ton of carbon dioxide emitted into the atmosphere. You actually collect the tax, not at the smokestack or the tailpipe, but as a levy on the fuel that is burned and releases the gases. There would be parallel rates on other greenhouse gases in proportion to their climate-altering impact.

ER: Raising the price of fuel in the process?

AD: It would raise the price of gasoline probably about twenty-six cents a gallon, the price of coal by about 180 percent, and natural gas by about 50 percent. People would pay out more for fuel and for other high-impact goods, but most families would come out ahead, particularly low income and middle income families that are hit so hard by the payroll tax.

But everyone seems to agree that the taxes aren't going to solve our environmental problems all by themselves. This would have to be one part of a climate change strategy that included other efforts to help people save energy, but prices are certainly an important piece of it. If you look at trend lines for energy consumption in North America, there are only two times when consumption declined in the last forty years, and those are when gasoline prices increased dramatically in 1973 and in 1979. Prices are an important motivator.

ER: It seems to me that people will pay whatever they need to to put gas in their cars.

AD The short-term elasticity of demand for gasoline is fairly low; that is, people tend to consume about the same, but over the longer term people can make quite substantial reductions in gas consumption as they get more efficient vehicles and rearrange their routine travel patterns. What's less well known about this is how good people would be at switching from one fuel to another. Different fuels have different greenhouse gas emissions. *[Inelastic demand is economist jargon meaning that demand doesn't go down when the price goes up. Ed.]*

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ER: What about pollution taxes?

AD: At the state level, pollution taxes might be the meat and potatoes of a tax shift because it's so obviously taxing something bad. There's overwhelming public sentiment that polluters should pay; and so a pollution tax is a straight forward, common sense response.

There are three ways you could do it: one is that major polluters — factories and sewage treatment facilities and so on — are almost all regulated and monitored already, and that existing regulatory mechanism could be the basis for pollution taxes that would be increased gradually over time until the tax rate is somewhere in the right order of magnitude in terms of their environmental impact.

Secondly, we would put taxes on agricultural chemicals, since pollution washing off of farms is a big source of water quality degradation in the Northwest, and for that matter, throughout the U.S. A major item of unfinished business in protecting water quality is working on farms; improving water quality with regulations is difficult, but by taxing the agrochemicals that eventually become pollution, you reduce the quantities of bad stuff washing off of farm fields.

Finally, motor vehicles, which are the source of about half of the smog in urban areas and one of the more rapidly growing sources of

pollution, are a little bit more tricky to tax. In metropolitan areas though, we could levy taxes at the emissions inspections that are already conducted every other year. By multiplying emissions rates times mileage driven based on the odometer, you can get a pretty good estimation of the quantity of pollution.

There are some smaller steps that we could take in that direction without going the full length too, like putting higher taxes on more-polluting fuels and lower taxes on less-polluting fuels. Gasoline blends make a big difference. Likewise, cleaner new cars could be taxed less than more-polluting cars.

Altogether, pollution taxes in the Northwest states would generate more than enough revenue to eliminate all corporate income taxes and business taxes. Businesses would be paying tax, but they would be paying in proportion to their pollution, not in proportion to their profit or gross receipts.

ER: You might win some fans on the right with that idea. If you're taxing pollution you're sending a market signal to make less of it. But if the government depends upon pollution for its revenue, it would be dependent upon a continuing stream of pollution.

AD: That's why you need to do it slowly enough so that you can discover how quickly people can green their lives and their businesses. If people turn out to be exceptionally good at it, then you need to have a revenue stream to fall back on. Presumably you'll end up with some taxes on economic good things left at the end of the day, but it's really an open question how quickly people will reduce pollution.

And while there are some examples of government agencies becoming complicit in environmental degradation because they're dependent on the revenue stream, like the U.S. Forest Service, there are more counter examples. Think of sin taxes, for example, on alcohol and tobacco where it hasn't stopped governments from being fairly strong proponents of public health.

Altogether, pollution taxes in the Northwest states would generate more than enough revenue to eliminate all corporate income taxes and business taxes.

So I think as long as we're dependent on a sufficiently diverse portfolio of environmental taxes, we don't have to worry too much about government becoming pro pollution in order to maintain its revenue stream. And then some green taxes will tend to grow over time, like land value taxes and traffic taxes. With pollution taxes we would hope the revenue, like the pollution, would tend to decline.

The big fact to remember is that there's so much pollution going on. It would take an awfully long time to completely run out of revenue, but that's a problem we should have: not enough pollution tax revenue.

ER: What other green taxes are there?

AD: There are three other categories of green taxes: there's traffic taxes, which are basically a system of electronic variable tolls on roads in metropolitan areas in order to reduce traffic congestion. Along the way they reduce pollution and traffic accidents because congested roads tend to produce more air pollution and more accidents as well.

The best kept secret among transportation experts is that these kind of variable tolls are really the only way to reduce gridlock in major metropolitan areas, places where there are more motor vehicles than licensed drivers. And while there's a fair bit of political opposition to it, we think that if we could get some pilot projects going, drivers would come to love it quickly.

Second is the land value tax. We would take the existing property tax and shift it off of buildings and on to land, encouraging more compact development of cities, discouraging land speculation in urban centers, and making the property tax much more progressive.

Finally, taxes on resource consumption: on diversions of water from rivers, on hydro power, timber, mining. Even if those resources were subject to taxes at a fairly low rate, the state could generate huge quantities of revenue at the same time as

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encouraging recycling and efficiency and conservation throughout the economy.

Adding it all up, carbon taxes, pollution taxes, land-value taxes, and resource taxes, plus fuel taxes, alcohol and cigarette taxes, we project that a tax shift could replace about 86 percent of state and local government revenue in the Northwest.

That said, I should hasten to add it's not an all-or-nothing decision. We came up with that calculation to show that green taxes could allow us to scrap many existing taxes, but we could also use them much more lightly. We could start very small and see how it goes. Politically that's probably the most logical progression.

ER: What would you like a reader to remember of this article?

AD: A tax shift gets taxes off our backs and on to our side. It gets taxes to work with us rather than against us. As long as we're going to have civilization, we're going to need government, and as long as we're going to have government, we're going to have to pay for it somehow. Right now we penalize things we want more of while letting pollution and habitat destruction go Scot free.

NEXT MONTH

A STEP BACKWARD FOR WOLF RECOVERY? ROBERT PLETCHER & ROBERT KEITER

SUSTAINABLE FORESTY IN THE TROPICS: RICHARD RICE

Literature Cited:

[1] *Tax Shift: How to Help the Economy, Improve the Environment, and Get the Tax Man Off Our Backs,* Alan Durning and Yoram Bauman, $9.95 from Northwest Environment Watch, 1402 Third Ave # 1127, Seattle, WA. 98101-2118 Phone 888-643-9820 or www.northwestwatch.org

[2] *How Much Is Enough?* Alan Durning WW Norton & Co. 1992 ISBN 039330891X

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