

Elizabeth Le Geyt is a good writer who uses a light, breezy style to bring the reader into her passion. Her tales are told with warmth and humour. I really enjoyed learning of her childhood and comparing it to my own. The wonder she shows at seeing her first Canadian birds is something else I can share. When she describes the exploits of Jacko, Joey and Rattles her writing reflects her own warm and kindly nature. Her journeys to other countries again reminds me of my own travels.

I think all those readers who followed Le Geyt's column will delight in this book. Any one who loves nature will enjoy this light-hearted book. The reader will feel relaxed and uplifted with every chapter, so perhaps even non-naturalists should buy a copy – it will improve their environmental awareness. This delightful book is a remarkable achievement for a woman who is over 100 years old.

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The Dismal State of the Great Lakes

By James P. Ludwig. 2013. Xlibris. Orders@Xlibris.com. Telephone 1-888-795-4274. 273 pages. Paperback 19.99 USD; hardcover 29.99 USD; e-book 3.99 USD. Printed on demand.

The Laurentian Great Lakes of North America contain 18 percent of the planet's fresh surface water and 90 percent of the United States' supply. The Great Lakes region has been the major manufacturing hub of North America, and has supplied vast quantities of timber and minerals, particularly iron ore, to the world's markets. Today, agriculture, recreation and tourism, fishing, and shipping are the important industries. The Boundary Waters Treaty of 1909 between the governments of Canada and the United States established an International Joint Commission and mechanisms for resolving any disputes over waters bordering the two countries, as they pertained to their use for domestic and sanitary purposes, navigation, power, and irrigation. The Great Lakes Water Quality Agreement of 1972/78 committed the Parties to cooperation in the restoration and maintenance of the chemical, physical, and biological integrity of the waters of the Great Lakes Ecosystem. These legislative tools attest to the tremendous importance of the Great Lakes to Canada and the United States and to planet Earth. Unfortunately, the scientific findings documenting the demise of the Great Lakes, and the political failure to address their implications are not well-known outside the Great Lakes community. *The Dismal State of the Great Lakes* is James P. Ludwig's attempt to remedy that by detailing his personal and professional journey in studying the extensive damage that has been done to the Great Lakes over his lifetime, the once-promising but eventual political failure to restore them, and his analysis of why they happened and how we might fix the mess.

This is a book written by an ageing, angry man with a fire in his belly for justice and a deep love for these great "sweetwater seas." It is "a call to debate the possible paths to effective change and to reignite the fires of public involvement." This is a book with an important message.

The Ludwig family have documented the biological changes in the Great Lakes for over 70 years. Jim Ludwig's father and uncle, both physicians, were the first of two generations of admittedly "compulsive bird

banders," who each year visited the colonies of cormorants, gulls and terns to place aluminum bands on the young birds. On these occasions they recorded the catastrophic effects of a succession of chemicals and invasive species. Trained in science, they kept good records, understood the implications of what they were seeing, and raised the appropriate "red flags." Jim Ludwig was awarded a PhD from the University of Michigan in 1968 for his thesis entitled "Dynamics of Ring-billed Gull and Caspian Tern populations of the Great Lakes." He founded Ecological Research Services, a small consulting firm, in 1969. Glenn Fox (GAF), who also devoted his career to the study of fish-eating birds in the Great Lakes, has collaborated with Jim Ludwig directly and indirectly, in research projects. Stuart Houston (CSH), a physician and compulsive bird bander, has corresponded occasionally with the Ludwigs, father and son, since the 1950s.

Ludwig's story consists of several threads. One deals with the biological information; alien species, eutrophication, algal toxicity, botulism, changes in the nature, size, and nutritional quality of the food base, and the effects of toxic chemicals on the health, reproduction, and survival of fish-eating birds and mammals, including humans. Another deals with the complex and on-going contamination by toxic chemicals; their detection, identification, sources and environmental behaviour, and our efforts to control their release. A third is the history of the Great Lakes fishery, its management, and the conflicted culture of fisheries managers. The final thread is the socio-political history surrounding the Great Lakes Water Quality Agreement and the International Joint Commission, the successes and failures of numerous collective actions and Ludwig's interpretation of what went wrong. He suggests how to get it right in the future.

Alien species. The Great Lakes have been invaded by numerous alien species. The sea lamprey, which infested Lake Ontario via the St. Lawrence River, and the upper Great Lakes with the completion of the Welland Ship Canal in 1932, greatly impacted Lake Trout

(and later introduced salmon) stocks. The Alewife, a small herring, invaded the Great Lakes by a similar route and became superabundant. It suffered periodic die-offs in response to sudden changes in water temperature; extraordinary numbers of their dead and dying bodies were cast up on beaches. Alewives became a major food item for Ring-billed Gulls, whose populations increased tenfold to a million birds. Zebra and Quagga Mussels, Round Gobies, and the Spiny Water Flea were among many alien species introduced in ballast water of ships from the Baltic Sea. Today, the vast populations of these mussels filter out much of the phytoplankton, altering energy transfer in the food web; moribund gobies are eaten by loons and cormorants who then die from ingesting botulism toxin concentrated within the gobies.

Eggshell thinning, the first of many health effects observed in fish-eating birds. Bald Eagle productivity dropped drastically due to eggshell thinning caused by DDE which was widely used by the mid-1940s. The effects persisted from 1955 until a decade after widespread use of DDT was banned in 1972. In 1972, a high percentage of cormorant eggs failed to hatch. None of the eggs in the second clutch hatched that year. This was attributed to severe DDE-induced eggshell thinning [cormorants incubate by standing on their eggs]. Cormorants and bald eagles were the most affected by DDT, gulls the least.

Crossed bills in cormorant chicks warn of developmental toxins in Great Lakes fish. In June 1983, on Little Gull Island in northern Green Bay, Ludwig found 5 of 460 cormorant chicks had crossed bills, the first he had seen, an unusually high incidence of a developmental defect. By June 1988, he had collected 41 more cross-billed cormorant chicks, but only 1 from Canadian colonies. He also saw numerous chicks with eye, leg and hip deformities. These findings suggested that biologically significant amounts of developmental toxins were present in Great Lakes food webs. Intensive collaborative studies involving teams of analytical chemists and toxicologists from Michigan State University, Ehime University in Japan, a teratologist and biologists from the U.S. Fish and Wildlife Service and the Canadian Wildlife Service suggested that nearly 90% of the variability in egg viability among colonies was explained by TCDD-EQs (tetrachloro-dibenzo-p-dioxin equivalents) in the eggs alone. The Michigan Department of Natural Resources initially encouraged these studies and provided the funding for the work in 1986-88. However, the arrival of a new director and strong criticism from MDNR biologists who were furious over findings released to the public which could reduce fishing license sales resulted in withdrawal of MDNR support. Fortunately, Dow Chemical and Upjohn Pharmaceuticals (two companies who used, made, and discharged a wide variety of chemicals), the McGregor Foundation of Detroit, and Consumers Power Corp stepped up to provide finances to

complete the studies, which provided very strong cause-effect linkages between these biological effects and dioxin-like synthetic chemicals.

Cosmos the Cormorant, poster child for toxic chemical regulation. Much public interest and political support was generated by Cosmos, a cormorant chick with a severely crossed bill that Ludwig rescued from an island in northern Lake Michigan in June 1988. Ludwig made himself a promise that he "would do everything possible to keep Cosmos alive, and he would handle the public relations for the movement to ban toxic chemicals and clean-up Great Lakes' Areas of Concern with high contamination." Cosmos made 16 TV appearances in the United States and Japan and testified by her presence in numerous state and federal legislative committees, and accompanied Ludwig on 27 evening presentations to environmental and teachers groups in five of the Great Lakes states. Ludwig writes "I think it safe to claim Cosmos in her single short year of life did more to propel the issue of toxic chemicals to the forefront of political agendas in Michigan and Wisconsin than all the other environmental activists and scientists were able to achieve through lobbying or explaining their findings." Cosmos's legacy lives on in Japan where she has become the symbol of the dangers of unregulated toxic chemical use. She was the cover image on the fifth grade textbook on pollution and climate change that is used in all Japanese public schools.

Bird Banding reveals population level impacts of chemical contaminants. Ludwig's family began banding Caspian Terns and other colonial waterbirds in 1922 and continued to do so until 1995. Jim periodically trapped nesting adults in some of these same colonies 1966-1992. By 2008, he had amassed 7000 encounter records of Caspian Terns banded as chicks in Great Lakes colonies. This immense and unique data set has proven very useful. As early as 1971, he found that nearly half of adults in Lake Michigan colonies were hatched in Canadian colonies which was not the case in 1966 and 1967. When Ludwig analyzed the 7000 encounters, he found, that relative to birds raised in Canadian colonies, survival to adult age in the most contaminated colonies in Saginaw Bay and Green Bay was 20% and 30%, respectively, while that of colonies with intermediate contamination in northern Lake Michigan was 59%. This pattern in relative survival to breeding age was almost identical to that of relative immunocompetence in chicks of this species that Keith Grasman, a Ph D student from Virginia Tech measured in these same colonies 1989-1992. In Saginaw and Green Bay colonies the immunocompetence of chicks was less than 50% of that in the cleaner Canadian colonies in Lakes Huron and Superior and was inversely correlated with TCDD-EQs in the eggs from these colonies. Caspian Terns banded as nesting adults in Canadian colonies survived twice as long as adults banded in Saginaw Bay colonies, 5 years longer than

those from Green Bay colonies, and 4.2 years longer than those from northern Lake Michigan colonies. Previous investigations had found a significant negative correlation between recruitment of terns in these colonies and circulating blood concentrations of total PCBs. PCB concentrations in the blood of adults from the Canadian colonies were half those in blood of terns nesting in Saginaw and Green Bay colonies. It is not surprising that Ludwig makes a strong pitch for long-term studies and adequate funding for investigators.

Toxic chemical contamination. Ludwig does a good job of describing and explaining the universal role of energy transfer and bioaccumulation in natural systems and how trace amounts of synthetic chemicals are similarly transferred and bio-accumulated to toxic concentrations. A great many persistent toxic chemicals pollute the waters of the Great Lakes. Mercury, polycyclic aromatic hydrocarbons, the insecticide DDT, hexachlorobenzene, and the polychlorinated biphenyls (PCBs) and dioxins have probably been the most important. Like important amino acids and hormones in animal bodies, the most prominent synthetic toxic compounds have a backbone of six carbon biphenyl rings. Synthetic compounds containing two biphenyl rings to which chlorine, fluorine, or bromine are attached to some of their carbon atoms are the compounds that have caused the greatest damage. Their toxicity varies by a million-fold with the number and position of the halogen constituent on the biphenyl rings. The most potent of these compounds is 2,3,7,8-tetrachlorodibenzo-*para*-dioxin (TCDD). Toxicologists rate the toxicity of other halogenated aromatic hydrocarbons relative to TCDD and express the total toxicity of extracts from tissues and environmental media as TCDD-Equivalents (TCDD-EQs). They act via a specific receptor present in cells: the aryl hydrocarbon (AH) receptor, a transcription factor involved in expression of genes. TCDD-like compounds alter thyroid function and other metabolic processes, cause birth defects and permanent neurological damage in embryos and young animals, are endocrine disrupters, and immunomodulators. Some or all of these effects have been seen in fish, amphibians, reptiles, birds, and mammals including humans. Much of what is known about the environmental effects and dangers of these chemicals has been learned from investigations conducted in the Great Lakes. Several studies have shown effects on motor and behavioural development of infants and lower intelligence quotients of older children of mothers who ate significant amounts of fish from Lakes Michigan and Ontario. The severity of these effects was associated with the mother's PCB exposure.

The Fishery. Throughout their history, the Great Lakes have been important for fish, and to people who depend on them for food, subsistence, income, and recreation. The relative importance of these activities has varied over time. Unsustainable commercial fishing activity decimated the Lake Sturgeon in the 1880s

and the Blue Pike in the 1960s. Atlantic Salmon populations in Lake Ontario were also hurt by overfishing. However, although not accepted by many fisheries biologists, there is clear scientific evidence that Lake Trout populations in Lake Ontario and probably elsewhere in the Great Lakes were greatly affected by TCDD-like chemical contamination. Research published in 2003 showed that the extirpation of native Lake Trout from Lake Ontario during the three decades following WWII was the result of TCDD-like contaminants which killed all embryos of the wild Lake Trout for over 20 years, extinguishing the stock. Today the dominant salmonids in the Great Lakes are various species of introduced Pacific salmon whose populations are maintained with hatchery stock, and are harvested mainly by sport fisherman. Recent estimates place the value of the sport fishing industry to the Great Lakes economy at 4 billion dollars, and the commercial fishery at 1 billion dollars. There is a clear conflict between natural resource managers who benefit from the sale of fishing licenses and public health authorities who are issuing consumption advisories for fish taken in badly contaminated locations around the Great Lakes. Ludwig believes this conflict is one of the reasons that funding for health effects research and monitoring disappeared, and that a culture of "good news only" ("One must never allow bad news to be publicized!") pervades governments around the Great Lakes today.

The greatest legacy of the Boundary Waters Act of 1909 was the creation of the binational International Joint Commission. The Great Lakes Water Quality Agreement of 1972 committed the Parties to cooperation in the restoration and maintenance of the chemical, physical, and biological integrity of the waters of the Great Lakes Ecosystem. For many years the Commissioners, Parties, and Great Lakes citizens worked hard at achieving those objectives, supported by sound science. However, as public concern increased concerning the health effects of persistent toxic substances, the Parties adopted a defensive position, limiting support for research, monitoring and information dissemination. The International Commission's work was subverted. The objective of virtual elimination of persistent toxic substances was regarded as too expensive by successive governments. Hence their policy focus became a vague, multi-causal, "Ecosystem Approach" which redirected funding and concern away from the study of biological effects, remediation, and science-based policy. The result was a series of regulatory blunders, avoidance of assigned duties, and far too much reliance on use of models and simplistic indicators. No surprisingly, the chemicals of concern and their biological effects persist.

Ludwig's book includes his 1995 editorial in the *Journal of Great Lakes Research* (21:159-160), suggesting that the Science Advisory Board of the International Joint Commission had degenerated into a

means to achieve a politically acceptable consensus. What else has gone wrong in government? As Al Gore said, "The private foxes have been put in charge of the public hen houses." In the USA, the US Environmental Protection Agency, created by Richard Nixon in late 1970 and the Department of the Interior have been "largely emasculated," "intellectually corrupted," and "a form of ecological insanity" according to Ludwig. No one and no agency is responsible for management of the whole resource of the Great Lakes ecosystem; there is a hodge-podge of funding, too many barriers to effective communication, incredible redundancy, very poor accountability, and no clear place for the public to redress grievances. Sound, evidence-based science is required but no longer encouraged or supported. Although the lifetime and multi-generational needs of the commonweal are far more important than money accumulation by the individual and corporations, this is incompatible with the neoliberal politicians of today.

Jim Ludwig is an "insider" who suggests how to rectify the current disastrous situation. Society needs wise and informed advocates with ecological knowledge, who are committed to change. We need to discard free-market policies of neglect, passivity and deception, and commit to good water quality by restoring powers of the original Great Lakes Water Quality Agreement and the International Joint Commission. Critical analyses

must no longer be suppressed and ignored. If only Ludwig's facts and insight would direct the authorities to appropriate action!

The Dismal State is correctly titled, but is a disappointment in several ways. Its importance deserved a University press, careful external editing, better organisation, more headings, an index, a more complete list of acronyms, and a better binding for the paperback version (twenty two-sided pages of CSH's paperback review copy have already come loose). Sadly, Ludwig's writing will seem too personal and too political for some tastes. However, he has accurately documented what has gone wrong. If nothing else, his testimony will remain as a valid historical record.

The Dismal State of the Great Lakes has not yet achieved the distribution it deserves. I offer a promising possibility for consideration: that each regional nature club invest a hundred dollars to help the Great Lakes' future. Each could order e-book copies for five of its members to pass around and donate one copy of the permanent hardcover version to the adjacent high school, college or University library. We are doing the latter. Ludwig's valuable information assuredly deserves to be more widely distributed.

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