A Feathered River Across the Sky. The Passenger Pigeon's Flight to Extinction

By Joel Greenberg. 2014. Bloomsbury Publishing Inc., 1385 Broadway, 5th Floor, New York, NY, USA, 10018. 304 pages, 26.00 USD, Cloth.

The Passenger Pigeon is perhaps the most iconic species representing modern extinction and its story has been repeated many times, but only rarely in any detail. The bird's plummet from vast numbers to extinction has often served as a parable illustrating our own species' merciless, Darwinian penchant to convert the rest of nature into ourselves. This year is the 100th since the last Passenger Pigeon expired in a Cincinnati zoo. This centennial is being observed in several events across North America. Joel Greenberg's book is the first detailed account in decades of the Passenger Pigeon's unbelievably rapid descent from billions to none. Greenberg provides meticulous descriptions of our treatment of *Ectopistes migratorius*; our responses to its decline and extinction, our overwhelming ignorance in trying to explain what happened, our unrelenting avarice in "harvesting" it, and our staggeringly short-lived and embarrassingly superficial record of what it was like to have billions of pigeons fly overhead for days at a time, and to have hundreds of millions swoop in to occupy a roost or nesting ground. And what have we learned from this tale of the pigeon of Biblical abundance? I think an accurate answer would be, not much so far, but this book gives us some food for further thought and a basis to consider critically some current approaches to conservation of biodiversity and even our place in nature. Such considerations are appropriate on this centennial of the

Passenger Pigeon's extinction especially given the recognition that we are facing a new so-called 6th global extinction for line which, as is usually assumed to be true for the Passenger Pigeon, we have ourselves to blame. Perhaps new assessment of the conservation implications and lessons of the facts of the Passenger Pigeon's biology and decimation will help us mitigate the current biodiversity crisis; or perhaps it won't.

First, some Passenger Pigeon background, gleaned from this entertaining book. It was a *bona fide* pigeon, closely related to the extant Band-tailed Pigeon (hint to Passenger Pigeon fans; it would be truly helpful in thinking about Passenger Pigeon biology to apply some phylogenetic analysis and direct study of this living bird), and similar to, but slightly larger than our ubiquitous Mourning Dove. It was colourful, a fast, agile flier reputed to zoom along at 60 mph. It produced varied vocalizations, though the descriptions seem somewhat conflicting (screaming, cooing, wooing, bell-like, sleigh bells …), so it is not clear to me what their voices sounded like. The Passenger Pigeon was a typical pigeon in that it built sloppy, rickety nests and fed its squabs pigeon milk ("a curdy substance resembling loose rice pudding") produced by the lining of the crop of both sexes. They usually laid only 1 egg per nest, nested once per year (though this seems uncertain) and probably lived for 10-20 years or more in the wild. They ate almost anything although especially fond of nuts including American Chestnuts, acorns of most species of oaks, and beechnuts all of which to Thoreau's astonishment they swallowed whole. They also ate plants, fruit, invertebrates, seeds, green veggies, grains and more. Their catholic, omnivorous diet is one of their oddly human traits. They occupied most of eastern North America from the Gulf Coast all the way to Hudson Bay (where it is worth noting, there are no nuts) moving about in large flocks of 1000's to millions to billions. These movements were unpredictable, but in part appeared tied to availability of food, especially mast of nut trees. Many times these flocks saved Native and European villages from starvation and, hence, to the immigrants at least, proved the existence of a benign Providence when he showed largesse in sending in the pigeons to feed deprived colonists. In gratitude, "we" eradicated this splendid gift of the Creator.

Greenberg's book is a wealth of interesting factoids, here is a small sample to whet your interest. The largest flock ever "counted" flew over Fort Mississauga, Ontario, Canada in 1860 and numbered 3,717,120,000 (confidence limits undoubtedly huge) individuals. Mayor McCallion in her inaugural term was only mildly thrilled, and expressed concern about the effect of guano on business development and tourism. The main flock zoomed along at "60 miles per hour", took 14 hours to pass and of course blotted out the sun. Smaller flocks continued to fly over for the next several days. The largest nesting "roost" was reported from Wisconsin and "occupied 850 square miles". The total number of birds in North America was thought to be about 5 billion. A large flock (greater than 50,000,000 say), sounded like a "loud rushing roar succeeded by instant darkness", "a noise like the crackling of a fire among dry leaves", "a low pitched hum as they appeared on the horizon …that increased to a mighty throbbing… children screamed, women sought shelter, horses bolted". Audubon recorded a huge flock and mentioned the blocking of the sun, and how the dung fell "not unlike melting flakes of snow", definitely a bravely quaint way to describe being engulfed in a guano storm. The volume of these avian missiles never abated for 3 days, during which of course the sun was eclipsed. Other claims are made (e.g., it outnumbered every other bird species on earth or every other terrestrial vertebrate in North America). All the foregoing is subject to the error of eyewitness testimony and reporting. But an unassailable fact is that less than 50 years after the Ontario super flock, the Passenger Pigeon was extinct in the wild constituting, if nothing else, a tribute to human ingenuity. (See http:http://passengerpigeon.org /index.html (Project Passenger Pigeon), for many more details)

Greenberg spends much of the book chronicling the Passenger Pigeon's abundance, decline and ultimate extinction. He apologizes for the amount of detail he incorporates into the latter topic, and perhaps he should, as it does become a tad tiresome ploughing through pages describing when, where and by whom the last one was lost from the wild, particularly when there seemed to be bigger issues being largely ignored. His excuse is that he wants to be as scholarly as possible, but it is a monotonous litany of shooting pigeon–like birds for the notoriety of bagging the last wild Passenger Pigeon. There is not much of significance to be learned from this, except perhaps that many people crave acclaim, especially when it is as easy as pulling a trigger. The end of wild birds came in about 1902, I think.

I would like to focus on 4 questions that Greenberg discusses less intensively than the awe inspiring abundance and slaughter. What was the ecological "role" of the Passenger Pigeon? How could we know so little about them given their importance and ubiquity? How did 19th century attitudes toward their decline and extinction compare to those we express today about the nature of species at risk? This question is inextricably tied to the big question; what caused the extinction of the Passenger Pigeon, and Greenberg leaves little doubt about his answer; humans. A fourth question, not really covered by Greenberg, is whether we can or should 'de-extinct' the species, or at least some sort of facsimile.

What was the impact of the Passenger Pigeon on North American ecosystems? Greenberg discusses this with interesting possible examples in Chapter 1. The huge numbers of Passenger Pigeon's were enough to

make people wax poetic, express wonder and so on. Some also quailed and were fearful and described consequences that are not generally thought of when we lament the loss of this icon. When the huge flocks whirred, cooed and jingle-belled into an area to roost, their sheer numbers and cumulative mass caused their roosting trees to lose large limbs or to collapse or uproot. In sound and destruction, big flocks were similar to a tornado, leaving destruction everywhere, except tornados don't routinely deposit vast amounts of guano. Soon after the birds arrived the faecal output was over half a metre deep and equivalent to "thousands of wagon loads". Therefore, after the masses moved on not only were all edible fruits, nuts, vegetables, grains, small invertebrates and valuable timber gone, there also was a huge mass of downed woody debris, thousands of pigeon carcasses, remaining trees festooned with excrement, and a choking ground cover of murky indigestibles smelling like a poorly managed factory farm for poultry. The remaining trees cried, the understory died and then it all dried and a lightning bolt converted the forest to ashes, just like modern logging. In many cases, people didn't wait for lightning, but set fire to the roosting/nesting areas, especially if it was a nesting colony, so as to fry the birds and their flightless squabs. They also burned down potential roosts to discourage the arriving flocks from staying and siphoning up local crops. All of this is worth thinking about when one considers how these days a few hundred starlings, crows, rock doves, or geese elicit bitter complaints from the citizenry because of noise, droppings, collisions with aircraft, and occasional direct aggression. What would we do with a few billion pigeons and their whimsical falling flakes?

The impact of these birds on eastern North American ecology must have been prodigious as Greenberg suggests. What that impact was is not at all clear, nor much discussed in the Passenger Pigeon literature, which makes this book interesting in that Greenberg does speculate on some possible effects of the pigeon's passing. We hear a great deal these days about the "functional role" of species X on the "ecosystem" and how ecosystems will change or even collapse if we pull out just one species. But the Passenger Pigeon was not just any species; it was the most abundant terrestrial vertebrate on earth. Couple that with the American Chestnut, population 30 billion and both going extinct within the same century, and it is surprising that any native land forms of life still exist in North America. What was the impact? Well, we don't have native sweet chestnuts to roast nor those gigantic smelly heaps of guano. Greenberg gives some specific hypothetical scenarios resulting from pigeon extinction, one being the rapid decline and now near extinction of the American Burying Beetle (a species worth its own book), and another being the spread of Lyme disease. Lyme carrying ticks are fed largely by *Peromyscus* mice which undergo rapid population increases in high mast years. Greenberg suggests that billions of Passenger Pigeons would stem these mouse peaks and in turn keep tick populations "in check". But on the other hand, mice eat gypsy moths, so Passenger Pigeons competing with mice would lead to moth outbreaks, loss of mast trees and lower Passenger Pigeon numbers. And so such fun speculation goes. The only certainty is that most North Americans have never noticed or thought about these impacts at all.

Well never mind hypothetical ecological roles; how is it that we know so little about the biology and behaviour of Passenger Pigeons beyond the anecdotal and mostly dubious anecdotal at that. At times reading descriptions of the flocks sounding like a "1000 threshing machines…plus 1000 locomotives running full throttle in a covered bridge" , makes one thinks of those low budget movies, called 'invasion of species X'. Let X = Passenger Pigeon. There were lots of pigeons and many people recorded that fact, but there, apparently, serious interest died, except to Hunt them, Kill them, Eat them, Sell them, Market them, Use them as Stoolies, and Marvel at their indestructible abundance. In the 1800's, there were few resources to be wasted studying birds, especially destructive pests. No one investigated their ecology, life history, or behaviour, beyond what was practical knowledge to assist hunting. We can be absolutely certain that no one was trying to conserve or protect them until it was much too late. There was no need, because it was beyond the realm of possibility that they could be exterminated. There are no known photos of Passenger Pigeons in the wild, although there are 2 of wild birds being used as stool pigeons. There is only one known photo of a squab (young pigeon). Even the number of eggs in a clutch was a mystery with the two greatest ornithologists of the time, Alexander Wilson and John James Audubon, feuding over whether it was one or two. Apparently, it didn't occur to them to look. (Greenberg tells us that it was 1, as depicted on the book's cover).

How have attitudes changed since the halcyon days of Passenger Pigeon hordes? This strikes me as a useful question, and one not really addressed by Greenberg. Before I read this book, and more correctly, before I read other sources, I never had much doubt that the extinction of the Passenger Pigeon was caused by humans, not just humans, but humans slaughtering the Passenger Pigeon in market hunting. My experience in the species at risk game has however taught me that when there are large numbers of a species, there are many skeptics who believe that over harvesting cannot extinguish a species. Think of Northern Cod, Bison, Eskimo Curlew, and many others. Even after intense harvest seems to have driven a species to the brink, there are those, particularly those doing the driving, who argue that either it is not at the brink, because they are still abundant, or if they are no longer abundant it was not the harvesters who caused the problem. The cod is a good example of denial from fisher persons,

and the blame being shifted to seals, foreigners, mysterious changes in the water temperature, or that the cod have moved elsewhere (a special case of blaming the victim). Similarly, most 19th, 20th or 21st century accounts of the decline of Passenger Pigeons seem determined to find something more complex than mere slaughter by pigeon hunters. What is delicious about these debates is that the arguments remain so self-servingly constant. In summary the argument goes like this: whatever one thinks, the species is not in danger of extinction, but if it is, then it is not us that caused the problem. Climate change is similar. It is not occurring, the measurements are suspect, they are measuring the wrong things, but if it is true, then it is not man made. I like Greenberg's summary for his bird, "*Homo sapiens* slaughtered the bird methodically and relentlessly. Most everything else is a matter of speculation"

Denial of Abundance

I think there are at least two significant ways that people express skepticism of the Passenger Pigeon story, that are reflected generally today when there is doubt that an "abundant" species is 'truly at risk'. The first and most fundamental is the claim that there never were that many Passenger Pigeons. This skepticism is not surprising given the hyperbolic nature of the descriptions and the paucity of serious effort and ability to quantify numbers. Dismissal of the estimates of billions is easy when one can blame the errors on uneducated, credulous bumpkins from the distant past. And others disparage a few billion, pointing out that there are a lot more chickens today, so what is the big deal. True, there are about 20 billion chickens globally, and 7 billion are slaughtered annually in North America. And come to that, there are over 7 billion of us and we are a much bigger deal than mere pigeons. Greenberg reluctantly reports a more politically correct skepticism expressed recently that the species was naturally uncommon historically because Native Peoples somehow kept their numbers down by hunting and competition. Then when the Europeans arrived and decimated Native populations, the pigeons exploded and for a brief period dominated the skies. There is no support for this odd argument.

In a recent paper in the Proceedings of the National Academy of Sciences (Hung *et al.* 2014; pages 1–6, PNAS Early Edition), a research team reported that the effective population size was much smaller, (on the order of 130,000-24 million), than the 3-5 billion usually indicated. The PNAS team based this astounding conclusion on analysis of the partial genome of 3 Passenger Pigeons from museum collections and from "ecological analysis". The latter led the team to suggest that Passenger Pigeons underwent inherent, frequent, severe fluctuations in population size, and had a population biology like that of lemmings, voles, or even locusts, driven by the periodicity of mast (nuts). So, in a nutshell (sic) population lows, combined with hunting and loss of habitat caused the great demise. The utter lack of similarity between Passenger Pigeon (or Band-tailed Pigeon) and lemming/vole life history, demography, and food habits was never considered in the analyses, or at least not mentioned. No one has reported Passenger Pigeons, or any pigeon or perhaps any bird, with a lemming-like population cycle. It is interesting that they note that *Homo sapiens* has an even smaller effective population size (90 000-170 000) despite its current robust abundance. The team notes that humans achieved this difference by recently starting with a small population and a rapid recent rise, whereas their "ecological analyses" support a Passenger Pigeon history of repeated rapid rises and falls in abundance over the past millions of years. It appears that this model assumes that pigeon carrying capacity depended on annual acorn production. It is true of course that oaks and beech may fluctuate their mast crop dramatically, but not so true that the different species do so neither in synchrony, nor in synchrony with American Chestnut which fluctuated much less than oaks, and which dominated eastern forests until after the demise of the Passenger Pigeon. The notion that Passenger Pigeons underwent fluctuations might be true, but that the evidence and basis for such is sadly lacking or misrepresented in this paper, which has no reference to Greenberg's book or to the known biology of Band-tailed Pigeons, Passenger Pigeons or lemmings.

Denial of Decline

Before the arrival of Europeans, natives hunted the Passenger Pigeon extensively. It is perhaps the most common species in native middens throughout the eastern half of the continent and presumably was a dietary staple. This interaction continued with the early settlers. When the birds came, everyone turned out to stock up on meat, eggs, oil (from the fat squabs), and feathers. They didn't make a much of a dent in their numbers, as far as anyone could tell (but who was counting?) There were not that many people and it was hard to preserve the birds, so the early impacts may not have been large, like the impacts of fishing on the Grand Banks until the factory ships came. In the early days of Native or Settler harvest, cod, bison, Passenger Pigeons and their fellow teeming species were not greatly affected. As the later stages of this tale proceed, we learn that even when the declines became noticed, it was more often than not assumed that the birds were not declining, but merely hiding in remote pigeon secure zones in the far west of the US with the Dalton Gang, or in Argentina, or had crossed the oceans to Europe or Asia. My favourite explanation was presented by Cotton Mather, he of the Salem witch trials, who argued that the birds "migrated to an undiscovered satellite, accompanying the earth at a near distance". One hears similar arguments today about declining species, 'they have moved to where you scientists can't find them', or 'we haven't searched thoroughly enough'.

Denial of Humans as Cause

In the past month, I have watched an interesting video (http://www.youtube.com/watch?v=FpXkA-BY3YE) of a PhD talk suggesting that hunting helped to cause extinction, but loss and fragmentation of habitat was the real culprit. Of course, this doesn't absolve humans from causal agency, but does suggest that we were only guilty of second degree extinction or maybe negligent speciescide. We didn't intend to destroy the species and there was no malice or intent, we were only a little stupid. In this video, the student presents one of her "models" and suggests that this particular model indicates that if in the mid 19th century, conservationists had applied today's IUCN (or COSEWIC) criteria, Passenger Pigeon would have come out Threatened. That was interesting. But her model also showed that hunting was not enough, there had to be a major impact from habitat loss. One of her assumptions built into her models was that hunting pressure decreased with declining Passenger Pigeon numbers, whereas Greenberg's painstaking descriptions lead to the opposite conclusion.

I originally found out about this book through a thought provoking review in the New Yorker (Rosen 2014). In the review, Rosen also suggests that Greenberg is biased in his fingering over harvest as the cause of decline. Rosen makes a confusing, to me at least, argument that hunters were the true conservationists and that rural subsistence hunters in regions of economic hardship often overlap with areas that harbour species at risk. I think this means that if people were to blame, well their sins were justifiable. What Rosen finds less justifiable are "elitists" who conserve vast tracts of wilderness for the public good without a broad consensus. Greenberg doesn't seem to anticipate these sorts of arguments, nor Rosen's expansion on the book's mention of racism in the writings of a scientist who dissected Martha the last Passenger Pigeon. It is of course these digressions by Rosen that made the review interesting.

The Final Days

In this era of climate change and the inevitable deniers, there were Passenger Pigeon extinction/threat /decline deniers. The deniers rested their position on the assertion that humans could not possibly exterminate such an abundant, prolific species, just as we have later argued that we could not possibly decimate Northern Cod, or the myriad other species we have decimated. The story is startling for its monotonous repetitiveness. First, no one thinks about risk at all, then there are feeble concerns expressed that decline is occurring, then denial combined with often bizarre explanations to refute the declines (they have moved, there are still lots of them, there are more than you think, jobs and subsistence food are at stake), then frantic, sometimes futile efforts to "save" the species.

I agree with Rosen that Greenberg is quite ready to blame the less noble properties of humanity for the demise of this splendid creature. But I think Greenberg has a case. After providing a picture of the bird's numbers and habits, he embarks on a seemingly endless account of how they were killed. Nets, bigger nets, shotguns, rifles, pistols, slingshots, air guns, arrows, clubs, fire, saws (cutting down nest trees), cannons and potatoes (this latter only in Orillia, Ontario). In the 19th century, 3 things changed the playing field for the Passenger Pigeon to a near vertical tilt. The telegraph, the railway and the refrigerated rail car. The wandering habits of the Passenger Pigeon now could be tracked via the telegraph, and a huge number of birds could be killed in a short time, preserved and shipped to big city markets for profit. Then ensued relentless and technically improved hunting, the volume of which Greenberg relates with gusto. The story of the fur trade, the feather trade, the timber trade and the fish trade was repeated here. A market was created with little regulation, then the harvest began to reduce the numbers, this led to more hunters per bird than before, especially as more hunters got involved to take advantage of the growing market. The birds helped by being highly social allowing large numbers to be killed on the breeding ground after being located by via a telegraph network. The intense hunting pressure further disrupted breeding and suddenly they were nearly gone, the last big flocks being decimated in final harvest frenzy, and then the trickling remnants hunted casually for dinner or specimens. For the folks who think we couldn't push them to zero, think again, rationally. In other areas, conservation measures and primitive wildlife management saved many once abundant widespread species before it was too late; the goose, the beaver, the fisher, the white pine, and for a while the northern cod, but for the Passenger Pigeon, the bison, the Eskimo Curlew species that were highly clumped at some point in their life history, conservation enlightenment was too late. To illustrate this 'too little too late', Greenberg has several examples of measures to save the Passenger Pigeon that were so late, they seem humourous. Ontario is a typical example. An 1887 Act that protected small birds excluded Passenger Pigeons. A decade later the province gave the pigeon protection, 8 years after the last known specimen was taken in the province. Often the regulations passed in various jurisdictions protected the hunters' rights not the birds' lives. Nothing changes; can anyone say Ontario Snapping Turtle.

Raising the Dead

One can't speculate about the Passenger Pigeon and its collapse without mention of "de-extinction". Rapid advances in genetic tech have beckoned the bio-entrepreneurs out of their basements smelling the colour of money and the lure of fame. TED (Technology, Entertainment, Design) italks abound as speakers ask the rhetorical question, "wouldn't it be fabulous to see extinct species return to life?" And of course, Passenger Pigeon sans guano is one of the most popular candidates. Greenberg spends little space on this, briefly

mentioning cloning in a neutral way. I will be less neutral. De-extinction is in general a foolish idea, and to quote Stuart Pimm, "a spectacular waste of everyone's time". The idea that we can erase the losses of the 1000's of species going extinct right now by resurrecting the lost is ludicrous. Jurassic Park shows what is really involved, hucksterism. In the case of the poor Passenger Pigeon, the current hype suggests using the extant Band-tailed Pigeon as the 'host' for Passenger Pigeon DNA. The irony here is that the Band-tailed Pigeon is itself a species at risk indicating we can't even maintain it much less some chimera cobbled together by biotechnology. Of sad double irony is that while people generally get excited to hear of restoring the glory of abundant Passenger Pigeons, they have no idea what a Band-tailed Pigeon is, and if it goes extinct, I am supremely confident there will be no enthusiasm to de-extinct it. Metaphorically, this effort is like ignoring the wounded in a battle and trying to resurrect the dead. It would be best to wait for the end times then call on the guy who did it 2 millennia ago.

At the end of my Passenger Pigeon odyssey, I offer this thought. It struck me one day that the Passenger Pigeon in its heyday was a lot like us. Think of them and us as sharing a Darwinian background, being molded by overproduction, genetic variation and natural selection. There were 5 billion of them, and there are 7 billion of us. Both are hugely destructive patch disturbers, although we do it on a grossly larger scale befitting our greater intelligence, bulk and numbers. We both have limited genetic variation and much smaller effective population sizes. We are both slow breeders, and long-lived. Both of us are omnivorous and highly social, and we both use Tweets. I won't mention guano again. My point here is not that we are going extinct, but simply that if we think we are a curse on the earth, then so were Passenger Pigeons, even if a more modest one. If we think that their destructiveness and fabled abundance were wonderful, then we can't complain about humans. Nature is such a bitch, and this book will get you thinking about life and biodiversity and us...

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