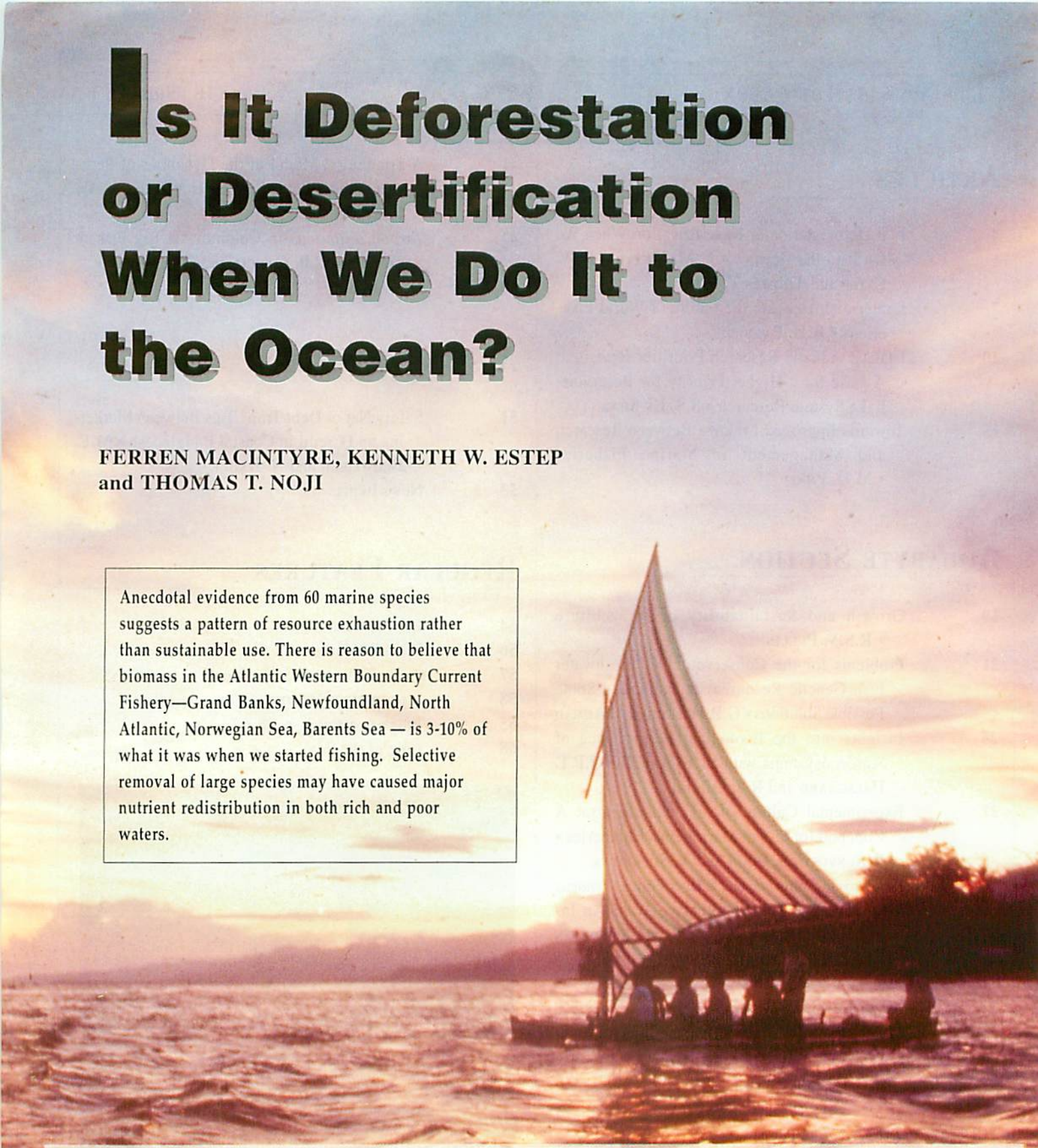
Is It Deforestation or Desertification When We Do It to the Ocean?

FERREN MACINTYRE, KENNETH W. ESTEP
and THOMAS T. NOJI

Anecdotal evidence from 60 marine species suggests a pattern of resource exhaustion rather than sustainable use. There is reason to believe that biomass in the Atlantic Western Boundary Current Fishery—Grand Banks, Newfoundland, North Atlantic, Norwegian Sea, Barents Sea — is 3-10% of what it was when we started fishing. Selective removal of large species may have caused major nutrient redistribution in both rich and poor waters.



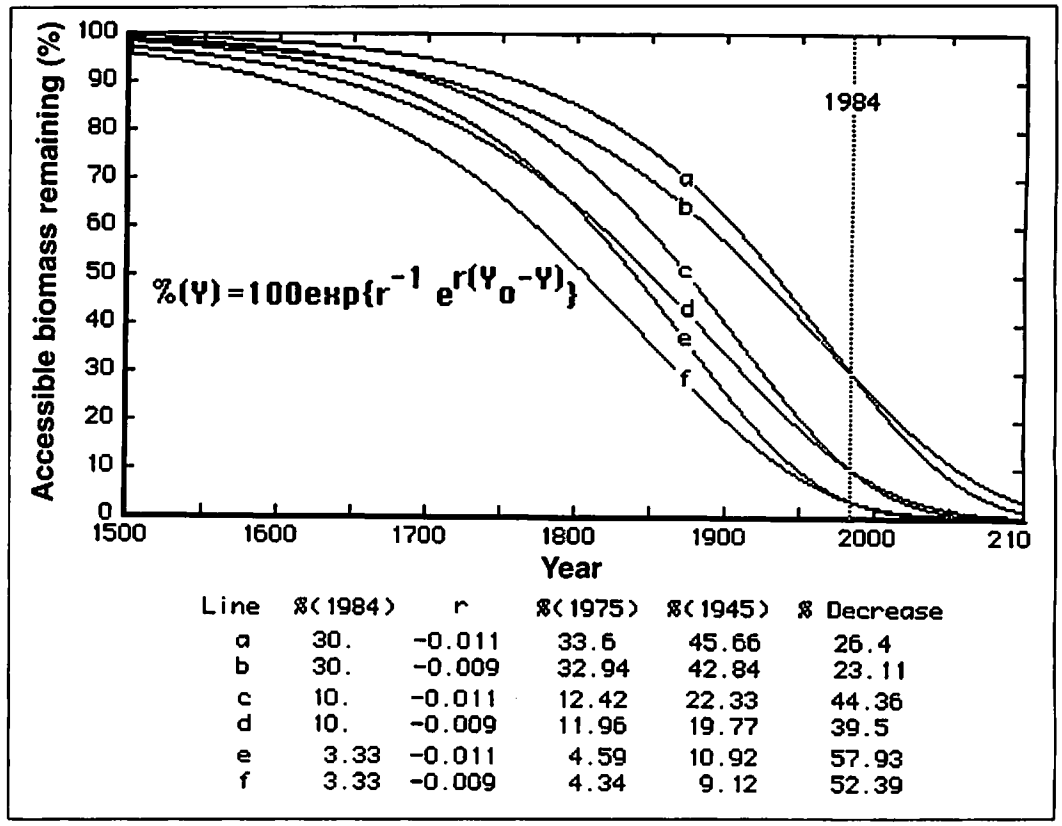
Impoverishment of the Ocean

Long-term carbon storage occurs as cellulose in terrestrial flora, but (twice as efficiently) as fat in marine fauna. If we remove terrestrial floral biomass, the results, depending on where we are, are:

Temperate humid → Weedy regrowth
Hadley-cell arid → Desertification
Tropical humid → Lateritization

Which of these processes is the removal of marine faunal biomass most like? Although both the analogy and our attempts at quantification of marine biomass loss are inexact, the question seems important. Fig. 1 is a first attempt to depict biomass loss in the best understood region of the ocean.

Whence Fig. 1? Farley Mowat's *Sea of Slaughter* (Atlantic Monthly Press, Boston, 1984) is the source of the "data", which are almost entirely anecdotal, but collectively record "the massive diminution of the entire body



Line	%(1984)	r	%(1975)	%(1945)	% Decrease
a	30.	-0.011	33.6	45.66	26.4
b	30.	-0.009	32.94	42.84	23.11
c	10.	-0.011	12.42	22.33	44.36
d	10.	-0.009	11.96	19.77	39.5
e	3.33	-0.011	4.59	10.92	57.93
f	3.33	-0.009	4.34	9.12	52.39

Fig. 1. Attempts to reconstruct the 600-year history of the Atlantic Western Boundary Current fishery, including the Grand Banks, North Atlantic, Norwegian Sea, and Barents Sea. The Basques had exterminated an Atlantic grey whale by year 1400, so the curve cannot be at 100% in 1500.

corporate of animate creation". Mowat spent five years reading letters written by nonscientists and untrained observers describing the Grand Banks. He worked his way through 50-odd commercially interesting species[1], with hardly a reliable number in sight, but the same pattern repeating itself every time. Three slight paraphrases from Mowat's sources show the pattern (the nonsequential dates result from discussion of different species):

- The _____ are so thick that they stopped the boat." (Peter Martyr 1516)
- "The _____ fishery is a true mine." (Pierre de Charlevoix 1761)
- "The _____ have all left these shores." (Gov. Robert Hunter 1718)

Where Mowat could find official estimates of biomass remnants a decade ago, they were 4%, 5%, 10%. Some species were commercially extinct. He offers one solid anchor: of the historical seabird nesting sites along the US Atlantic coast, 3% were occupied in 1984. If this proportionally includes cliff-nesting birds (largely unaffected by human population pressure), it reflects failure of the food supply, as for North Sea puffins in recent years. Hence a testable hypothesis: Seabirds are top predators on the marine food web, and their numbers reflect their food supply. Ergo, the 1984 marine biomass was 3% of what it once was. Fig. 1 also plots 10% and 30% remnants.

The slope of Fig. 1 can be gauged from a well known scientist who now does not want it known that he said, "There seems to be about 1/3 as much life, wherever I work underwater, as there was 30 years ago", lest in the spirit of killing the messenger, his research funds will dry up. (But Mowat also heard him.) The last column under Fig. 1 lists the percentage decrease over this period: His subjective 67% seems high, but supports lines *e* and *f* passing through 3.33% in 1984.

"Percent biomass remaining" may omit noncommercial organisms and those which by behavior or habitat evade capture. Antarctic whales have been partially replaced by krill, crab-eater seals and penguins; there are anecdotal reports in the Atlantic of large increases in salps (A.C. Pierrot-Bults, pers. comm., 1994) and noncommercial benthic species (B.B. Collette, pers. comm. 1995), but we have talked to fisheries biologists on three continents without finding anyone who has asked the question of biomass replacement, let alone studied it.

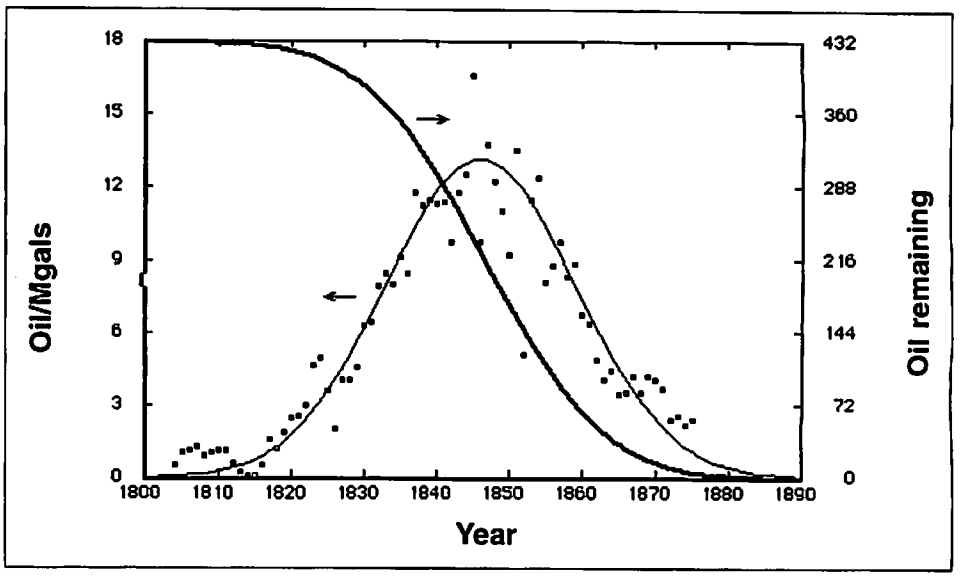
In the absence of better data, we submit Fig. 2 as the prototypical curve for each of the 60-odd commercial species behind Fig. 1. That we cannot immediately extrapolate Fig. 1 to all oceans is shown by Fig. 3: Antarctic cod unequivocally survived as recently as 25 years ago.

Consequences

1. Surviving commercial species and bycatch have all been irreversibly selected by net mesh size (Haedrich 1994). Nearly all surviving fish are genetic dwarfs which breed at a younger age and smaller size than they once did.
2. Subtle points concern the redistribution of nutrients by large organisms. Whales, sharks, tuna, seals, etc., feed in rich waters and cross desert waters, and thus once contributed nutrients to blue-water central gyres where circulation does not. A million whales crossing a gyre twice a year could have left behind enough nutrients to make a difference, although no one seems to have

[1]Dutch newspapers have subsequently added another 10 species to Mowat's list (Lankester, K. 1994. Vissen-oorlog [Fish-war] NBC Handelsblad, 18 August. Wetenschap & Onderwijs, p. 1.)

Fig. 2. "So remorseless a havoc": one genocidal component of the disappearance of biomass from the oceans is the 19th-century US whaling record. The data are from Starbuck (1878) and represent the sum of "gallons of whale-oil" and "gallons of sperm-oil"—otherwise, the slaughter of 193,500 right and 225,500 sperm whales. The bell-shaped curve centered near the steepest part of Fig. 1 d-e.



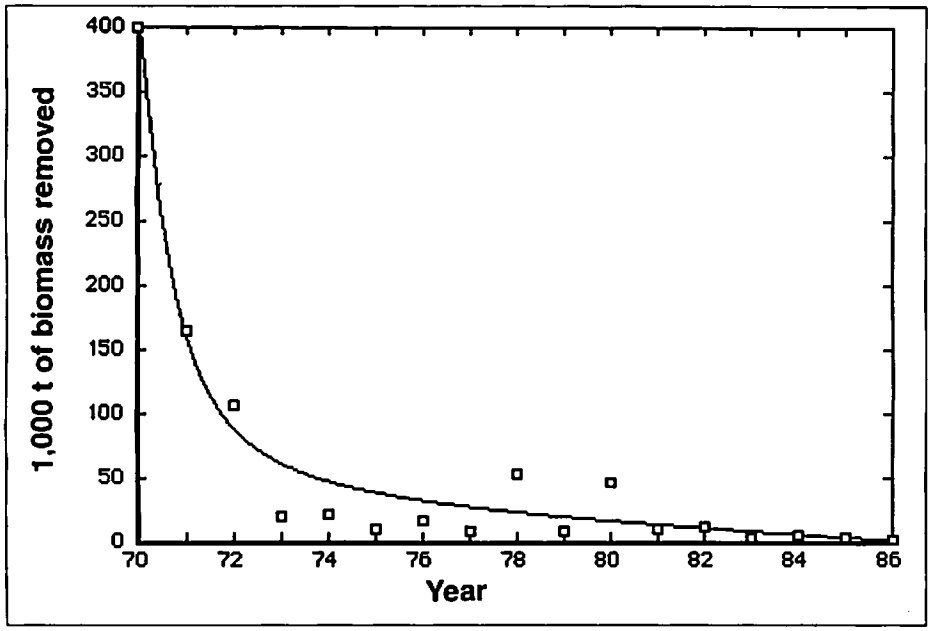


Fig. 3. Modern methods enable faster annihilation. This was the Antarctic cod fishery (after Goldsmith and Hildyard 1988).

made estimates. Hence "desertification" in the title: have we removed the base of the food chain in these areas? Similarly the removal of large grazers has affected nutrient recycling in Antarctic waters, probably hastening removal from surface waters.

3. A rough rule of thumb holds that in a balanced marine ecosystem, biomass is the same order of magnitude across major taxa: the mass of bacteria equals the mass of phytoplankton equals the mass of zooplankton equals the mass of fish equals the mass of whales[2]. One is entitled to suspect that this represented the maximum supportable biomass, so that any change is for the worse.
4. Fishing, as it has been done for 600 years, appears from Fig. 1 to be a "sustainable activity" until about 2040 AD. Does this mean that we can expect meaningful fishing quotas to be enforced in, say, 2035, when re-election possibilities sensitize politicians to the issue?

Further Reading

Haedrich, R.L. 1994. Impact of overfishing on size structure in a shelf-fish community. Proc. 3rd Internat. Ichthyol. Cong., September 1994, Oveida, Spain.

Goldsmith, E. and N. Hildyard. 1988. The Earth report. Mitchell Beazley, London.

Starbuck, A. 1878. History of the American whale fishery from its earliest inception to the year 1876. Waltham, Massachussets. Reprinted 1989, Castle Books, Secaucus, NJ. 779 p.

F. MacIntyre and K.W. Estep are from ETI, Institute of Systematics and Population Biology, University of Amsterdam, PO Box 94766, NL-1090 GT Amsterdam, The Netherlands. Dr. Estep died on 20 January 1995. **T.T. Noji** is from the Institute of Marine Research, Box 1870 Nordnes, N-5024 Bergen, Norway.

[2]This insight is by the late Kenneth W. Estep, who never had the opportunity to develop this idea.