

# THE ECONOMICS OF VANISHING SPECIES

FRANK T. BACHMURA†

The disappearance of living species is a fact of the world's current natural history.<sup>1</sup> This fact has important consequences for both internal and external economic policy. Systematic analysis of this phenomenon is not conspicuous in economic literature. Economic analyses of what are called "fisheries" and of forestry resources have appeared,<sup>2</sup> as have systematic analyses of the depletion of mineral and other non-renewable resources.<sup>3</sup> None of these approaches, however, specifically deals with the economic aspects of the disappearance of species.

The "fisheries" literature deals with relative numbers of individuals within a species rather than with species disappearance. The influence of fishing techniques upon catches of various species, the regulation of open seasons and fishing equipment, and the relative supply and demand of various species are among the topics analyzed.<sup>4</sup> In the case of some fish and aquatic mammals included under the "fisheries" heading there has been peripheral mention of the possibility of extinction.<sup>5</sup> Systematic study of the exploitation of "non-fisheries" animal populations is relatively new.<sup>6</sup>

The extensive economic literature of non-renewable resources does not concern itself with the "extinction" of a particular element or

---

† Associate Professor of Economics, Indiana University.

1. See Comm. on Rare and Endangered Wildlife Species, U.S. Dep't of Interior, Rare and Endangered Fish and Wildlife of the United States (Resource Pub. 34) (1968) [hereinafter cited as *The Red Book*]; G. Allen, *Extinct and Vanishing Mammals of the Western Hemisphere* (Special Pub. 11, 1942); S. Anderson & J. Jones, *Recent Mammals of the World: A Synopsis of Families* (1967); P. Darlington, *Zoogeography* (1957); J. Fisher, S. Noel, & J. Vincent, *Wildlife in Danger* (1969); J. Greenway, *Extinct and Vanishing Birds of the World* (1958); F. Harper, *Extinct and Vanishing Mammals of the Old World* (1945); 8 Int'l Cong. of Zoology Proceedings: *The Protection of Vanishing Species* (XVI Int'l Cong. of Zoology 1964); G. Munro, *Birds of Hawaii* (1960); E. Schuhmacher, *The Last Paradises* (1967); and V. Ziswiler, *Extinct and Vanishing Animals* (1967).

2. See F. Christy & A. Scott, *The Common Wealth in Ocean Fisheries* (1965); S. Ciriacy-Wantrup, *Resource Conservation: Economics and Policies* (1952); J. Crutchfield, *The Fisheries: Problems in Resource Management* (1965); Gordon, *The Economic Theory of a Common-Property Resource: The Fishery*, 42 J. Pol. Econ. 124 (1954); Scott, *The Fishery: The Objectives of Sole Ownership*, 43 J. Pol. Econ. 116 (1955); and Smith, *On Models of Commercial Fishing*, 77 J. Pol. Econ. 181 (1969).

3. See President's Materials Policy Commission, *Resources for Freedom* (1952) [hereinafter cited as *The Paley Report*]; H. Barnett & C. Morse, *Scarcity and Growth* (1963).

4. Smith, *supra* note 2.

5. Christy & Scott, *supra* note 2.

6. L. Talbot, *The Meat Production Potential of Wild Animals in Africa*, Technical Comm. 16, (Commw. Agr. Bur. 1965); Pearsall, *The Conservation of African Plains Game as a Form of Land Use*, in *Exploitation of Natural Animal Populations* 343 (E. Le Cren & M. Holdgate eds. 1962).

compound in its natural form, but rather with depletion or "partial exhaustion." The question of the complete disappearance of any mineral is as yet unknown, although individual deposits have been exhausted in terms of economic workability. Moreover, except for fuels, fuel additives, and some radioactive substances, minerals are often not destroyed in the process of "consumption."<sup>7</sup>

### SPECIES SUPPLY MANAGEMENT

It is helpful to view the subject of species survival as a supply management problem in which the living stock is approaching zero. Although the stock of domestic animals fluctuates widely in response to price signals emanating from dynamic supply and demand conditions, the possibility of extinction of domesticated animals appears remote. We can conceive of a national, or of a world herd of cattle or swine, or of a world flock of chickens. We can also conceive of a world herd or flock of wild or feral animals and then ask the question, "Why is it that the continued existence of many species is so precarious?" The answer to this question rests upon the basic difference between supply management of living stocks in which ownership and management are internalized, usually in the form of private or tribal ownership, and those in which the living stocks constitute a common property resource. Domestic animals are protected from harm, fed regularly, and bred selectively, on lands which are reserved for the use of these animals. The flow of goods and services from domestic animals, for example, for food and draft purposes, are marketed with proceeds returning to the human managers, who are able to recognize the value of these products. The managers control the harvest of the stock by reducing or increasing it in response to economic signals. The management of a natural stock differs markedly in most of these details.

The economic analysis of species extinction builds upon the economics of a common property resource coupled with highly inelastic and ultimately, irreversible (i.e. non-symmetrical) supply conditions.<sup>8</sup> The aspects of common property historically characteristic of common lands, apply also to other common property including fish, wild bird, mammal and other populations.<sup>9</sup> The supply inelasticity phenomenon applies to both animate and inanimate assets. Perhaps the closest comparison to the extinction situation is that of the supply of unique objects such as national monuments and of objects of art, where there is a stock of only one.

---

7. The Paley Report, *supra* note 3, at 10; Barnett & Morse, *supra* note 3.

8. N. Georgescu-Roegen, *Analytical Economics* 83 (1966).

9. Cf. Gordon, *supra* note 2.

Careful analytical distinction has to be made between the individuals comprising a species and the species itself. Living species follow a life cycle in which individuals with a relatively short life constitute an ever-renewing stock. Such a wild stock is subject to diminution through the operation of forces which require sacrifice of the animal or preemption of part of the species' habitat. Among inanimate objects an analogous supply condition exists in the arts in the distinction between unique, single copy productions, such as paintings and drawings and unique, multiple copy productions, such as etchings and woodcuts. The aesthetic satisfaction flowing from such items does not require destruction of the stock. Destruction, however, does occur because, in economic terms, insufficient resources are allocated to the preservation of these unique works from fire, flood, mildew and similar destructive forces. The preservation of monuments, whether of Abu Simbel or Storm King Mountain, usually involves collectively organized support, although many are privately preserved. In this context, the designation of Ryukyu Rabbit (*Pentalogus furnessi*) as a "national monument" by the Japanese government is worth noting.<sup>10</sup>

Individually, wild animals constitute a renewable resource. Species are not renewable, however. The species exists as a stock of one, automatically self-preserving for extended periods. Economic demands which require sacrifices of individual members of the species or which effect the habitat influence the size of the stock of individuals constituting the species and the probability of continued self-preservation.

Another way of stating the characteristic of a non-renewable resource such as an animal species or the Florentine Baptistery is a fundamental recognition that preservation implies asymmetry of supply, that is, extinction of the unique is irrevocable. Survival of a species, given the constant turnover individual members and the irrevocable nature of extinction, implies that the species supply management decision takes place in a dynamic, evolutionary context. Substituting a species, such as cats, rats, and mongooses, for one that is exterminated in a given area is by no means a desirable goal.

Species preservation recognizes the existence of an extinction threshold, the point beyond which the possibility of maintaining the species disappears even though some individuals of the species may still survive. The determination of the threshold is impossible to make with precision, since it involves a wide range of considerations including the behavioral and mating characteristics of the survivors,

---

10. E. Walker *et al.*, *Mammals of the World* 652 (1964).

their relative dispersion and related factors. As a matter of historical record a population of 2,000 individuals did not achieve preservation for the Heath Hen (*Tympanuchus cupido cupido*).<sup>11</sup>

Greater knowledge and improved technology may lower the extinction threshold for at least some species. The Trumpeter Swan (*Olor buccinator*) population, for example, numbered fewer than forty<sup>12</sup> before protection of breeding sites and identification and control of predators permitted supply reversal. This species was recently removed from the U.S. Fish and Wildlife's Endangered List (The Red Book).<sup>13</sup> However, a species population of less than forty is almost always below the vertebrate extinction threshold given present levels of knowledge and technology. The survival of the Whooping Crane (*Grus americana*)<sup>14</sup> with a population low of thirty-one<sup>15</sup> and of the California Condor (*Gymnogyps californianus*)<sup>16</sup> with an estimated total of no more than eighty<sup>17</sup> is in considerable doubt. Although still in existence, the size of the Ivory-billed Woodpecker (*Campephilus principalis*)<sup>18</sup> population is unknown and its survival improbable.<sup>19</sup> These examples are for the nation with the highest technological level and the highest capital accumulation in the world.<sup>20</sup> Survival of the Japanese Crested Ibis (*Nipponia nippon*) with a population of twelve, of the Mauritius Kestrel (*Falco junctatus*) with a population of less than twenty, and of the Javan Rhinoceros (*Rhinoceros sondaicus*) with a population of twenty-five<sup>21</sup> are even more problematic.

Knowledge concerning extinction thresholds for certain species depends upon knowledge of the natural history and habits of those species. Unfortunately many species, even among the more complex, mobile species such as vertebrates, are known only in a taxonomic sense. For some species knowledge is based solely upon two or three museum specimens. For fully one fifth of all mammal genera, the latest, most definitive work on mammals, state no more than "Nothing is known of its natural history (or behavior)."<sup>22</sup> Often the preservation of a species will depend upon a new general discovery as

11. Greenway, *supra* note 1, at 190.

12. Fisher, Noel & Vincent, *supra* note 1.

13. The Red Book, *supra* note 1, at v.

14. Greenway, *supra* note 1, at 207. See also R. Allen, *The Whooping Crane* (1952).

15. The Red Book, *supra* note 1, at B-22.

16. See C. Koford, *The California Condor* (1966).

17. The Red Book, *supra* note 1, at B-11; Greenway, *supra* note 1, at 179.

18. See J. Tanner, *Ivory Billed Woodpecker* (1966).

19. The Red Book, *supra* note 1, at B-36.

20. See, e.g., *The Paley Report*, *supra* note 3.

21. Ziswiler, *supra* note 1, at 115.

22. Walker, *supra* note 10.

well as upon specific descriptive natural history or behavioral characteristics of the species. Three examples of such general discoveries may be cited: "imprinting" of species identification upon nestling Whooping Cranes (*Grus americana*), homing to natal beaches by the Atlantic Green Turtle (*Chelonia mydes*),<sup>23</sup> and the relationship between territoriality and fecundity in the case of the Vicuna (*Vicugna vicugna*).<sup>24</sup> This type of information about specific endangered species is seriously lacking. It is illustrative of this deficiency that the Redbook of endangered species in the United States mentioned the search for more knowledge for almost every endangered species as among proposed or implemented activities. For one hundred and twenty-two U.S. species, present knowledge is not even sufficient to declare whether or not the species is unendangered.<sup>25</sup>

Supply management of species stocks requires knowledge not only of specific behavior, but also of inter-specific relationships. Historically we have seen the disastrous consequences resulting from ignorance of these relationships in the unanticipated effects of the introduction of new species into an area. The deliberate or accidental introduction of rabbits, house cats, foxes, rats, catfish, and water hyacinths into areas where they upset the ecological balance stresses the continuing low state of the "arts" in understanding interspecific relationships.<sup>26</sup>

Of particular importance is an understanding of the relationship between predatory species and their prey. Human exploitation of a non-predatory species but not its predator may contribute to ultimate extinction of the non-predator as predator pressure becomes greater on the reduced non-predator population.<sup>27</sup> Non-predatory species introduced into environments without their predators frequently become destructive of habitat.<sup>28</sup> Viewed from an economic perspective these facts illustrate a facet of the externality problem<sup>29</sup> with respect to species supply management.

Survival of species is sometimes jeopardized by such externalities as technological discoveries in other fields. Examples are to be found

---

23. J. Parsons, *The Green Turtle and Man* (1962); and P. Pritchard, *Living Turtles of the World* 199 (1967).

24. Schuhmacher, *supra* note 1, at 304.

25. *The Red Book*, *supra* note 1.

26. See K. Wodzicki, *Introduced Mammals of New Zealand* (1950).

27. Ziswiler, *supra* note 1, at 58.

28. See Harper, *supra* note 1; G. Herklots, *Birds of Trinidad and Tobago* (1961); H. Hinton & A. Dunn, *Mongoose: Their Natural History and Behavior* (1967); Wodzicki, *supra* note 26.

29. Davis & Whinston, *Externalities, Welfare, and the Theory of Games*, 70 *J. Pol. Econ.* 241 (1962).

or not the demand requires the sacrifice of the animal itself. It is also significant if the demands reflect an areal contiguity with the management of supply. Finally, it will always be necessary to make some estimate of future as well as of present demand.

Consumer demands which require the harvest of the animals necessarily have a direct effect upon species stocks. If properly related to the natural increase of the species, harvesting is quite consistent with stock maintenance and growth. Unfortunately, for species threatened by extinction, supply responsibilities are not fixed nor adequately related to demand. Though some degree of internalization is conceptually possible, it is only occasionally a functional reality. Internalization is particularly difficult to achieve in low income countries with uncertain political articulations and limited enforcement capacities. In such countries, effective, though unlawful, "demands" by poachers seriously endanger the continued existence of species stocks.<sup>42</sup> Historically, continued existence of such commercially valuable animals as the Sea Otter (*Enhydra lutris*) and the Northern Fur Seal (*Callorhinus ursinus*) depended upon the clarification of political articulations matched by effective means of enforcement. A classification of products which require the harvest of animals includes meats, skins, hides, furs, feathers, scent glands, trophies, and such curiosities as rhinoceros horns. The latter commodity, erroneously reputed to be an aphrodisiac, is so much in demand that survival of several species of rhinoceros is jeopardized.<sup>43</sup> Although it does not require sacrifice of the animal itself, a demand for their eggs, whether for food or for collections, also jeopardizes survival. Judicious collection of eggs is compatible with species stock increase, but injudicious collection, typified by the case of the Green Turtle eggs seriously endangers species survival.<sup>44</sup> Although live trapping of animals for captive breeding may enhance species survival possibilities, the contrary probability is suggested by recent United States legislation.<sup>45</sup>

In direct contrast with demand forces requiring the sacrifice of the animal or its separation from the species' breeding nucleus, the "demand" for the services of the species as objects of aesthetic or religious satisfaction does not usually require the animal's death. Examples of this include wild life photography, nature study, and the designation of certain animals as "sacred." In addition, to many

42. See Allen, *supra* note 1; Greenway, *supra* note 1, at 4-137; Harper, *supra* note 1, at 8; Ziswiler, *supra* note 1.

43. Int'l Congress of Zoology, *supra* note 1, at 34.

44. Parsons, *supra* note 23.

45. Act of Dec. 5, 1969, Pub. L. No. 91-135, § 7(a), 83 Stat. 279, amending 18 U.S.C. § 43 (Supp. V, 1965-1969).

people interested in the aesthetics of scenery and outdoor recreation, the observation of wild life constitutes an integral, though somewhat subordinate, part of the individual's "demand." Consumers of this general type have a direct interest in the preservation of the species stock. On the other hand, it is often less practicable to charge a fee for the privilege of observing or photographing wildlife, than it is to charge a fee for a hunting privilege.

Demands emanating from sources outside the species range give an international and consequently, worldwide, character to the species survival problem even when the natural range of the species is sharply restricted. Individual ranges of the various species of rhinoceros are quite restricted but the international demand for rhinoceros horn creates hunting pressures prejudicial to species survival. Given the high income elasticity of demand for this product,<sup>46</sup> and for others such as furs, international demands generated by the high income countries have a pronounced effect upon the survival possibilities of many species. Recent restrictions upon importation of endangered animals or products thereof into the United States,<sup>47</sup> could be sensibly extended to other developed countries, in order to assist individual lower income nations in their efforts at species stock maintenance. Direct assistance in species supply management, including game law enforcement, would further aid species survival.

Another force is the role that tourist expenditures for wildlife observation play in the economies of many countries, particularly those in East Africa. The magnitude of this important demand constitutes one of the most positive forces for species survival in that area. Thus a combination of restriction of international demand for endangered animals in higher income countries, expanded efforts to promote tourist trade built on the aesthetic appeal of wildlife, and direct assistance for development of species stock management constitutes a formula for species survival in a number of the less developed countries.

The demand for produced goods from a wild animal species is the same as it is for domestic livestock. This means that to produce goods there will be a derived demand for the inputs of land, water, and labor used in production of stocks. One of the characteristics of wild species in their natural state is that they do not depend upon labor inputs for their survival. Moreover, in the absence of man, the species habitat is a given, and habitat changes are natural and not induced by man's enterprises. Many species have survived in close

---

46. Harper, *supra* note 1, at 375.

47. Act of Dec. 5, 1969, Pub. L. No. 91-135, § 7(a), 83 Stat. 279, amending 18 U.S.C. § 43 (Supp. V, 1965-1969).

proximity to man because they are not in direct competition with him in his productive activities. They live in interstitial areas, such as fence rows, and stream borders, or in areas of limited alternative use to man such as wetlands and rivers. Expansion of economic production coupled with population growth has changed and intensified the competitive and preemptive force of man with respect to wild animals. Within the agricultural sector of most countries, particularly the less developed ones, population growth leads to the conversion of forest or other natural habitat into an environment which consists largely of plowed fields. In grazing areas more and more acreage is preempted by domestic animals to the exclusion of wild animals. In each case, the effects upon species survival are adverse. In such cases as Madagascar, the progressive land clearing operations have jeopardized the continued survival of many species.<sup>48</sup> In the United States, the use of wetlands and streams as waste receptacles has preempted habitats otherwise usable by wild species.

Three classifications will be useful in analyzing the factor inputs needed for species survival: (1) factors which are already internalized to an alternative use, say agricultural land, (2) factors which must be expressly internalized for the survival of the species, and (3) common property factors which are themselves used for the externalization of costs competitive with wild life survival, primarily in the form of water or air pollution.

The first factor requires recognition of the concept of private property as a limited and not an absolute power a position is summarized by Coase, "what the land-owner in fact possesses is the right to carry out a circumscribed list of actions."<sup>49</sup> Thus, overflight by a flock of Whooping Cranes does not imply ownership of the birds nor the right to shoot them. Judicious supply management of community-desired species even including predatory animals such as the Timber Wolf (*Canis lupis*)<sup>50</sup> would, of course, entail an effort to compensate owners for destructive acts or even relax protective laws.

Although important in all cases, the proper registration of community preferences is especially important where land must be expressly reserved for management of the endangered species. We know of breeding and nesting sites which are reserved for species use. More generally important today is the preservation of the habitat of endangered animals. In the United States, efforts to buy land to prevent its use for purposes of urban real estate development or as garbage dumps are significant in the cases of the Key Deer

---

48. See Harper, *supra* note 1, at 17.

49. Coase, *The Problem of Social Cost*, 3 J. Law & Econ. 1, 44 (1960).

50. See Pimlott, *supra* note 38.