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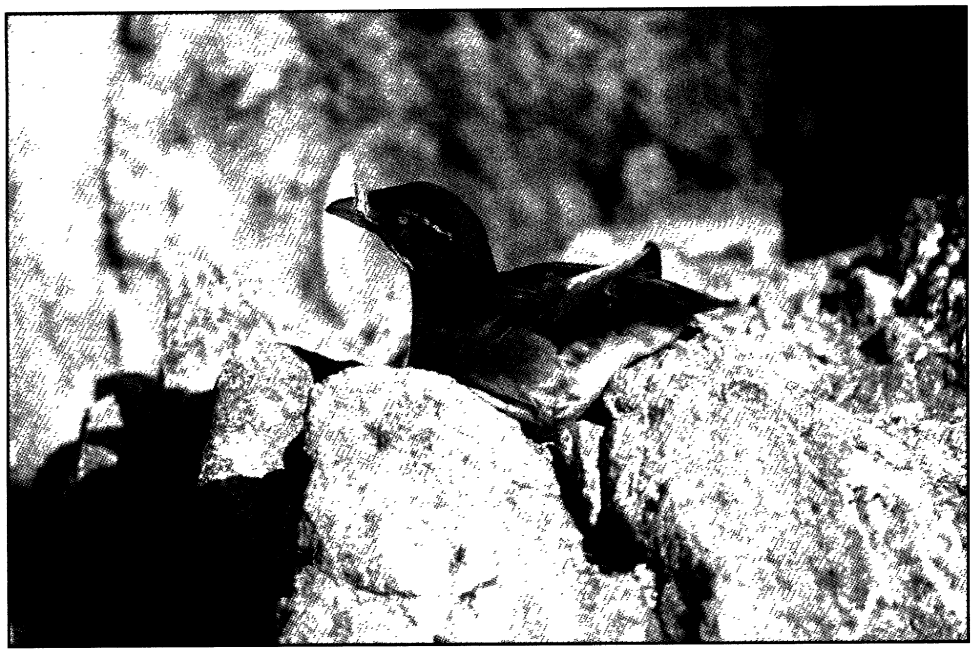

The Poacher's Dilemma: The Economics of Poaching and Enforcement

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Abstract

In April 2000, delegates gathered in Nairobi, Kenya, to consider the worldwide ban on ivory trade governed by the Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES). A point of contention during the meeting was the inequity created by a uniform ivory trade policy, given the significant differences in the size and health of elephant populations in several African countries. Ultimately, South Africa, Botswana, Namibia, and Zimbabwe backed away from their efforts for limited ivory trade and, on April 17, 2000, the delegates agreed to reinstate a ban on ivory trade. A similar ban on the trade of rhino horns has been in place since 1977. This paper looks at alternatives to these one-size-fits-all international trade bans for ivory and rhino horns and explores the economics of the decision-making process of poachers under strict enforcement policies. By understanding poacher's decision-making process, local officials can design anti-poaching policies that can optimize conservation given local conditions. First, this paper provides a brief background on poaching activity in Africa and describes some successful examples of anti-poaching policies. Second, it develops an expected utility model for an individual poacher. This model illustrates the key factors in the poacher's decision-making process. Third, this theoretical model is slightly modified to examine the effects of corruption. Fourth, several of the key assumptions and variables of the model are discussed including the value of a statistical life and the overestimation of low probability events. Finally, the paper offers some concluding thoughts.

Brief history of poaching in Africa

From the 1970s through the early 1990s, the international community became increasingly concerned about the illegal poaching of African elephants (*Loxodonta africana*) and rhinos (Rhinocerotidae). Since the 1970s, the population of African elephants has declined from 1.2 million to approximately 600,000 (Table 1) (Bulte and van Kooten 1999). As the population of large bull elephants decreased, poachers began to take aim at female elephants and adolescents. From 1979 to 1988, twice as many elephants were needed to be killed for each ton of ivory (Chadwick 1991).

During this period, rhino populations experienced an even more dramatic decline. In Africa, the population of black rhinos (*Diceros bicornis*) (Table 2) was 65,000 in 1960, but shrank to 6,000 by 1985. It is currently around 2,000 (Swanepel 1997; Emslie 1996). In Zimbabwe, the population of rhinos decreased from at least 5,000 in the 1960s to essentially zero (only in zoos) in 1990. Only four African countries still have viable rhino populations: South Africa, Zimbabwae, Namibia, and Kenya (Emslie 1996).

These increases in poaching activity paralleled the dramatic increases in the price of ivory and rhino horns. In 1969, uncarved ivory in Kenya was worth $2.50 per pound. In 1978, it was worth $34 per pound and, in 1989, it was worth more than $90 (Figure 1). With tusks weighing as much as 22 pounds each, this made

Table 1. Current African Elephant Population (Overton 1997). Note that "Definite" and "Probable" estimates come from more reliable aerial and dung counts. "Possible" and "Speculative" are based on more general 'guesswork.'

Region	Definite	Probable	Possible	Speculative
Central Africa	7,320	81,657	128,648	7,594
East Africa	90,468	16,707	19,999	1,084
Southern Africa	170,837	16,402	18,983	21,582
West Africa	2,760	1,376	5,305	5,554
Continental	**286,234**	**101,297**	**155,944**	**36,057**

Table 2. Black Rhino Population (Swanepoel 1997).

Year of Count	Estimated Rhino Population	Projected Number of Rhinos Killed
1900	10,000	n/a
1960	70,000	500
1970	65,000	500
1981	10,000-15,000	4,545-5,000
1987	3,800	1,033-1,867
1995	2,200	200

one elephant's ivory worth as much as $4,000 (Simmons and Kreuter 1989). A rhino horn can weigh up to 20 pounds. The retail price for an African rhino horn has ranged from $2,000 to $8,000 per pound (Vollers 1987; Simmons and Kreuter 1989). Estimates of the value of ivory and rhino horn vary widely. Presumably, some of the difference in value is between the wholesale and retail levels, as well as the difference between carved and uncarved pieces. It was estimated, that when the prices for ivory and rhino tusks were at their peaks in the 1980s, a successful hunt could yield a poacher more money than twelve years of non-poaching work (Chadwick 1993).

In response to growing international concern about the illegal poaching in Africa, CITES banned the worldwide trade in rhino horns in 1977 and banned trade in ivory in 1989. While the ivory ban seems to have slowed the rate of poaching and lowered the price of ivory, the population of African elephants has continued to decline, albeit at a slower rate. Since 1994, Bulte and van Kooten (1999) estimated an annual decline of 0.5-0.6 percent. Without poaching, elephant populations increase by an average of 5 percent per year. During the first four years of the ivory trade ban, the price declined by more than 70 percent from its 1989 peak. The price of ivory in central Africa dropped from $90 per pound to less than $10 per pound (Kelso 1993). However, in the years since the ban, the price has slowly climbed.

One of the primary problems with the ivory ban is its impact on southern African countries, which have growing elephant populations that require periodic culls to limit ecological damage. Not only do these southern African countries sometimes have too many elephants, but the ivory ban has also taken away a source of precious foreign currency; currency, that the government claims would be used, in part, for conservation efforts. In response to these concerns, in 1997, delegates at the Conference of the Parties for CITES permitted a one-time auction of ivory stockpiles for Zimbabwe, Namibia, and Botswana. In April 1997, this auction was held. A total of 109,311

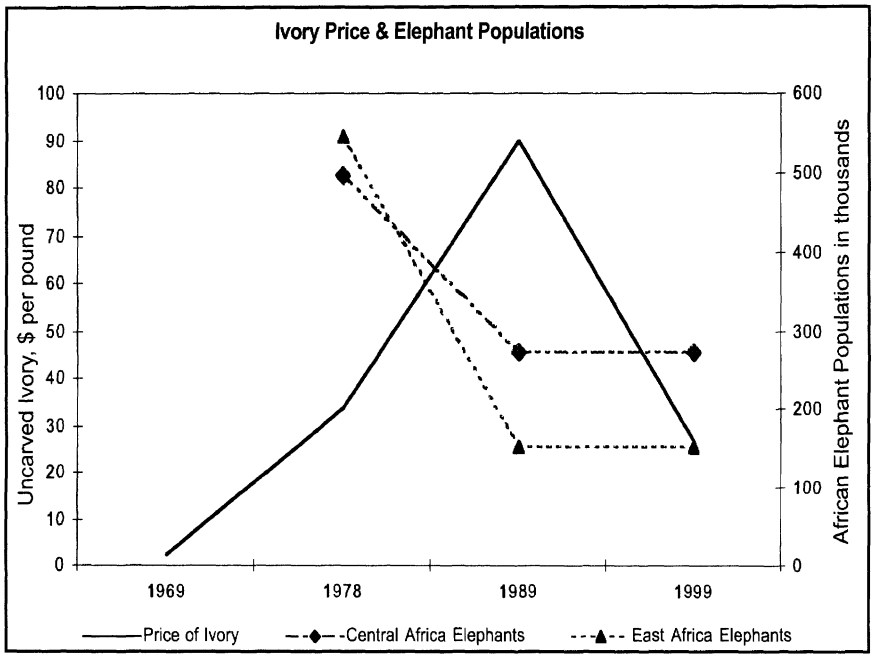

Figure 1. Longitudinal comparison of African elephant populations and the price of ivory.

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Cover: Rhinoceros auklet (*Cerorhinca monocerata*). Photograph courtesy of Julie Thayer.

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pounds of ivory (5,446 tusks) was sold for an estimated $5 million (approximately $45 per pound). Before this auction, southern African countries had an estimated stockpile of 500-600 tons of legally held ivory. An additional 243 tons of illegal stockpiles are also extimated to exist (Milliken 1997). Approximately 8,000 elephants have to be killed to obtain 70 tons of ivory (*The Economist* 1989).

No such controversy exists for the trade in rhinoceros horns as rhinos remain on the Appendix I for the CITES meaning that trade is banned. However, poaching of rhinos continues primarily to supply horns to lucrative markets in Yemen (as dagger handles) and China (as medicines).

While most African countries outlaw the killing of elephants and rhinos, especially in national parks and protected areas, in reality these laws have been poorly enforced. Anti-poaching units tend to be severely under-funded, corrupt, and are often out-gunned by poachers (Simmons and Kreuter 1989). However, examples exist where individual countries have successfully fought poaching and nurtured a growing population of elephants and rhinos. A commonality in these "success" stories is a willingness to use lethal force to enforce anti-poaching laws combined with some type of Integrated Conservation and Development Program (ICDP) that tries to raise the non-poaching wage rate (see Brandon et al. 1998; Wells and Brandon 1992; Barrett and Arcese 1995 for a more complete discussion of ICDPs). Lethal "shoot first; ask questions later" policies (also known as "shoot-to-kill" and "shoot on sight") can offend humanistic ethical sensibilities, especially over the lack of due process and the idea that the punishment should be proportional to the crime. In other words, should the penalty for illegally killing an elephant or rhino be the death of a human? The ethics of these policies will be discussed later.

The Poacher's Dilemma: Model Equations

(1) $$\max EU = [1 - r_d(G) \times t_p] \times U(C)$$

(2) $$w \times t_w + P_E \times E(t_p) + P_R \times R(t_p) + S - r_f(G) \times F - C = 0$$

(3) $$T = t_p + t_w$$

(4) $$\frac{r_d(G)}{[1 - r_d(G) \times t_p]} \times \frac{U(C)}{U'(C)} + w + r_f(G) \times F = P_E E' + P_R R',$$

where $0 < r_d(G) \times t_p < 1$

(5) $$w + B = P_E E' + P_R R'$$

Several instances exist where lethal anti-poaching policies have been used in combination with economic development programs. In 1984, Zimbabwe instituted "Operation Stronghold," a "shoot first" policy to protect rhinos and elephants. As a result of these enforcement, in 1992, only 46 elephants were poached compared to 4,000 in 1989 (Kelso 1993). The Zimbabwean elephant populations grew from 30,000, in 1979, to 43,000 by 1989 (Simmons and Krueter 1989). Similarly, the Zimbabwean rhino population has also rebounded from almost nothing to at least 260 in 1997 (Economist 1997).

Strict enforcement in Nepal has yielded similar results. The rhino population in Nepal has rebounded from as few as 96 rhinos in 1968 to an estimated 550 by late 1997, since the King of Nepal committed units of the army to protect the rhino population (Martin 1998; Martin and Vigne 1995; Starr 1989). Likewise, during Richard Leakey's tenure as Director of the Kenya Wildlife Service, the initiation of a "shoot first" policy resulted in a reduction of the number of elephant deaths due to poaching. Since then, Kenya's elephant population has been increasing at rate of 2.6-4.0 percent (Woods 1999). The black rhino population in Kenya's Masai Mara National Reserve increased from less than 13 rhinos in 1986 to approximately 40 in 1997 (Morgan-Davies 1996).

However, these anti-poaching policies involve the loss of human life. During the first decade of Operation Stronghold, more than 178 suspected poachers were killed (Kelso 1993). Similarly, in Kenya more than 100 poachers were killed during the first two years of a "shoot first" policy (Chadwick 1993).

Poacher's dilemma

A poacher's decision on how much time to spend hunting can be shown by an expected utility model. An expected utility model is commonly used in economics and incorporates key factors that influence an individual's decisions and actions. To understand the model, refer to the model notation on the following page.

The poacher must decide the amount of time spent poaching rela-

The Poacher's Dilemma: Model Notation

C	=consumption
U(C)	=lifetime utility
t_p	=time spent poaching
$r_d(G) \times t_p$	=risk of death per hour†
$r_f(G) \times t_p$	=risk of fine per hour†
t_w	=hours worked
w	=wage income
$E(t_p)$	=number of elephants killed*
$R(t_p)$	=number of rhinos killed*
S	=unearned income
F	=amount of fine
T	=time

*Increases with time spent poaching
†Increases with government enforcement and time spent poaching
Note: primes (') represent derivatives

tive to the amount of time spent in wage employment given the respective risks and rewards. Utility is a broadly defined term roughly synonymous with welfare, satisfaction, and happiness. In this expected utility model several variables are included that affect a poacher's decision on how much time, if any, should be devoted towards poaching.

Equation 1.
A poacher's maximum expected utility, EU, comes from his/her consumption during his/her lifetime, $U(C)$, minus the risk of being killed where risk of death per hour, r_d, is a function of government enforcement efforts, G, multiplied by the hours spent poaching, t_p. This equation is subject to both a budget and time constraint (Equations 2 and 3 respectively).

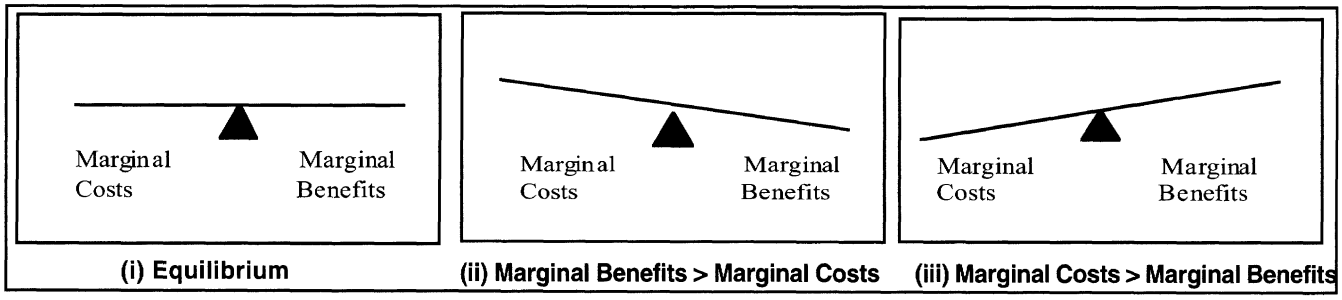
Equation 2.
The budget constraint includes the value of wage labor, w, the hours worked, t_w, the number of elephants, E, and rhinos, R, killed as functions of the hours spent poaching (hunting for elephants and rhinos often occurs simultaneously); unearned income, S; the risk of a fine per hour, r_f, as a function of government enforcement effort; the amount of fine, F; and total consumption, C.

Equation 3.
The time constraint, T, is the number of hours spent poaching plus the hours spent working for a wage.

Equation 4.
Solving these equations using the first order conditions, results in the following equation, which models the decision making process for the time spent poaching.

The left-hand side of the equation represents the marginal costs to the poacher while the right-hand side represents the marginal benefits. The poacher's value of life is represented by $\frac{1}{1 - r_d(G) \times t_p} \times \frac{U(C)}{U'(C)}$, which is multiplied by the risk of death per hour, $r_d(G)$. This value is added to the wage rate per hour and the risk of a fine per hour multiplied by the amount of the fine. A fine could include the cost of imprisonment.

Since this equation is equal on



(i) Equilibrium (ii) Marginal Benefits > Marginal Costs (iii) Marginal Costs > Marginal Benefits

Figure 2. Representation of poacher's decision-making process

the margins, meaning that, at equilibrium, the marginal costs are equal to the marginal benefits. A balanced scale can represent this equilibrium (Figure 2, i). It follows that changes in a number of the variables would influence the poacher to reduce the hours spent poaching, t_p, thus returning the equation to equilibrium. For example, decreases in the price for elephant tusks or rhino horns would lower t_p. Similarly, t_p would be expected to decrease with increases in the risk of death per hour, r_d, the risk of fine per hour, r_f, the amount of fine, F, the non-poaching wage rate, w, or the government expenditures on enforcement, G.

By looking at Equation 4, we can also see the potential disequilibrium in situations with low non-poaching wage rates. In cases where "shoot first" policies do not exist, marginal benefits probably are consistently greater than the marginal costs (Figure 2, ii). This is a likely scenario as even the costs of fines and imprisonment, F, are ultimately limited by the low non-poaching wage rate.

To achieve the conservation objective of having no poaching of elephants and rhinos, the marginal costs of poaching need to be consistently greater than the marginal benefits (Figure 2, iii). Given the difficulty of raising the non-poaching wage rate in a short time period, another option is to raise the marginal costs to the poacher by including the potential of death, represented by the value of a statistical life.

Equation 5.

The expected utility model can be easily extended to include the effects of corruption on the decision-making of poachers. By assuming that a bribe, B, from a poacher makes the risk of detection equal to zero, then Equation 5 follows from analysis at the margin.

In this case, neither the time spent poaching, t_p, nor risk of detection as a function of government expenditures, $r_d(G)$ and $r_f(G)$, are even involved in the equation. The expected benefits from poaching are compared only to the non-poaching wage rate and the cost of the bribe. In addition, we know that the maximum bribe would be equal to the expected costs of enforcement.

Examination of assumptions and variables

When considering this model, it is important to note the underlying assumptions and examine the key variables. First, the model presumes that a poacher receives no utility from death. In other words, a poacher does not place an inherent value in death (such as heaven or hell) or has a bequest value in death. Second, the model does not incorporate the possible negative psychological costs from breaking a law. Psychologists and economists have found that breaking social norms can be perceived as a cost, especially when the law is sustained by social approval or initiated by communal action, such as a vote (Alm et al. 1999). However, it is questionable whether poachers perceive that the anti-poaching laws are sustained by social approval or were established by a vote of their peers. In fact, a significant amount of the poaching activity occurs across national borders, such as Somalian gangs poaching in Kenya or Zambians poaching in neighboring Zimbabwe. Consequently, the psychological penalty is also assumed to be zero.

This model also does not discriminate between "local" and "organized" poaches as described by Bilner-Gulland and Leader-Williams (1992). They describe local poachers as those who go out hunting in pairs on a daily basis. Organized poachers, on the other hand, are formed into a party with hunters, carriers, and a leader. In 1985, it was estimated that local hunters had 0.05 elephant kills and 0.02 rhino kills per expedition, while organized groups had 3.54 elephant kills and 0.15 rhino kills per expedition.

Several studies have estimated the value of a statistical life (VSL) using several different theoretical and econometric techniques. Traditionally, these studies have looked at the correlation between job risk and wage rates and have estimated the statistical value of a life based on the change in wages as job risks increase (holding all other factors constant). Other studies have focused on the expenditures on safety devices. These derived values are frequently used in evaluating the benefits and costs of various public health programs and policies. The majority of these studies have shown that the VSL for a person in the United States is between $3-7 million dollars (Viscusi 1997). However, few, if any studies considered the VSL values for people in developing countries, such as the African countries facing problems with poaching. A critical component of VSL estimates is an individual's expected lifetime wealth, which is derived primarily from current annual income. Consequently, the values for children or the elderly tend to be significantly lower than employed adults. Similarly, the estimates for a poor or unemployed person in a developing country could lead to values considerably smaller than the estimates for the United States.

Some economists have argued that this model is limited and suggest that in addition to lifetime wealth a universal constant for human life should be included in VSL estimates

(Cropper and Freeman 1991). A potential VSL equation that includes this type of universal constant is $VSL = 2(W + C)$, where W is lifetime wealth and C is the constant.

Consequently, a poor person with no annual income and little lifetime wealth could still have a VSL between $1.5 and $3.5 million dollars. When VSL estimates of this magnitude are included in the theoretical model, it becomes apparent that people are unlikely to poach even in situations where the risk of detection is relatively small.

A factor that is not included in the model is the probability of the poacher dying from other causes. This may be especially important in highly impoverished areas where the probability of death from starvation or disease (without the money gained from poaching) may be higher than the probability of death from poaching. In this case, it would still be rational for a person to poach despite the "shoot first" policy.

The estimation of the risk of death or fine is also a key variable in this model. Studies have estimated the probability of a poacher being detected, caught, and successfully prosecuted as between zero and five percent (Bulte and van Kooten 1999). Miliken et al. (1993) estimated the probability of a poacher being killed in Zimbabwae if detected to be 16 percent. An important question is the perceived and real probability of detection. Psychologists and economists have shown that humans tend to overestimate low probability events (Machina 1983; Kahneman and Tversky 1979; Alm et al. 1992). Consequently, a poacher's estimation of his/her risk of detection may not be much different if the odds of detection were either 1 percent or 0.01 percent, yet in reality the consequences for a poacher's expected utility and the governments required expenditures would be quite different. Importantly, the overestimation of low probability events may help reduce the number of poachers killed for the same level of anti-poaching protection.

Implications

The theoretical model of the poacher's dilemma implies that policies that increase the costs or decrease the benefits of poaching will decrease the time a poacher's spends hunting. If the conservation objective is to stop all poaching, then the model suggest that a strict enforcement policy has the best chance of achieving the objective. By dramatically increasing the costs of poaching by including the possibility of death, it becomes irrational for an individual to choose to spend any hours poaching, even with high prices for elephant tusks and rhino horns. Consequently, the populations of elephants and rhinos in protected areas have a chance for recovery. These policies could allow a country, such as Zimbabwe that has excess elephants, to support conservation efforts through the proceeds from selective ivory sales or tourist-oriented hunting expeditions.

A key question is whether local governments have the financial resources to enforce strict anti-poaching policies and whether the anti-poaching units can be free of corruption. The cost of effective anti-poaching enforcement has been estimated as $200 per km^2 (Leader-Williams 1993). It is unclear, however, whether that estimate assumes implementation of a "shoot first" policy. Nevertheless, initiating a "shoot first" policy likely increases the risk of death to members of the government's anti-poaching units, especially in areas where the poachers are highly organized and well-armed. Equipping anti-poaching units with enough firepower to combat these groups may be expensive and hard to sustain. For example, between 1989 and 1994, when Dr. Richard Leakey was Director of the Kenyan Wildlife Service, he raised more than $153 million arming anti-poaching units with airplanes, helicopters, 250 vehicles, and rebuilding the park infrastructure. By 1998, however, the program did not have enough money to keep the aircraft and helicopters properly maintained (Woods 1999). Regardless of the strictness of the anti-poaching policies or the amount of money spent on weapons, efforts must be made to keep the anti-poaching units free of corruption. This can include significantly raising the wages of unit members.

Finally, the ethical and political implications of a "shoot first" policy need to be considered. Placing the lives of wildlife, even charismatic ones such as elephants and rhinos, ahead of the lives of humans would be considered unethical by all humanistic philosophies, such as egalitarianism, libertarianism, and utilitarianism. These philosophies do not grant "rights" or "standing" to non-human entities, such as elephants or rhinos. In contrast, naturalistic philosophies do grant "standing" to non-human entities. While naturalistic philosophies might not assign equivalent values to a human and an elephant or rhino, the tremendous levels of poaching of elephants and rhinos that occurred in the 1970s and 1980s may make "shoot first" policies ethical in terms of naturalistic philosophies (see Kneese and Schulze 1985 for a more thorough discussion).

Whether donor nations would support broad-scale implementation of "shoot first" policies remains to be seen. While it seems likely that these policies would immediately offend donors, the success of fundraising by

Richard Leakey in Kenya, not to mention the successes in Zimbabwae and Nepal, and the lack of international criticism of his program makes the international reaction difficult to predict.

Literature cited

Alm, J., G. H. McClelland and W. D. Schulze. 1999. Changing the social norm of tax compliance by voting. Kyklos **52**: 141-171.

Alm, J., G. H. McClelland and W. D. Schulze. 1992. Why do people pay taxes? Journal of Public Economics **48**: 21-38.

Barrett, C. B. and P. Arcese. 1998. Wildlife harvest in integrated conservation and development projects: Linking harvest to household demand, agricultural production, and environmental shocks in the Serengeti. Land Economics **74**: 449-65.

Barrett, C. B. and P. Arcese. 1995. Are Integrated Conservation-Development Projects (ICDPs) sustainable? On the Conservation of Large Mammals in Sub-Saharan Africa. World Development **23**(7): 1073-84.

Brandon, K., K. H. Redford, and S. E. Sanderson, eds. 1998. Parks in Peril: People, Politics, and Protected Areas. Washington, DC: The Nature Conservancy and Island Press.

Bulte, E. H. and G. C. van Kooten. 1999. Economics of antipoaching enforcement and the ivory trade ban. American Journal of Agricultural Economics **81**: 453-466.

Chadwick, D. H. 1991. Elephants – Out of time, out of space. National Geographic **179**(5).

Cropper, M. L. and A. M. Freeman III. 1991. Environmental health effects. In J.B. Bruden and C.D. Kolstad eds. Measuring the Demand for Environmental Quality. North-Holland, New York.

The Economist. 1997. Shooting the shooters. September 20: 96.

The Economist. 1989. East Africa: The slaughter of the elephants. **311**: 48.

Emslie, R. H. 1996. How many rhinos are left? The Rhino & Elephant Journal **10**: 15-19.

Kahnman, D. and A. Tversky. 1979. Prospect theory: An analysis of decision under risk. Econometrica **47**: 263-291.

Kelso, B. J. 1993. Hunting for cons. Africa Report July-August: 68-69.

Kneese, A. V. and W. D. Schulze. 1985. Ethics and environmental economics. Handbook of Natural Resource and Energy Economics. Vol. 1, Elsevier Science Publishers B.V.

Leader-Williams, N. 1993. The cost of conserving elephants. Pachyderm **17**: 30-34.

Machina, M. J. 1983. Generalized expected utility analysis and the nature of observed violations of the independence axiom. In Bernt Stigum and Fred Wenstop, eds. Foundations of Utility and Risk Theory with Application.

Milliken, T. 1997. The status of ivory stocks in Africa, 1990-1996. Traffic Bull **16** (3): 93-106.

Milliken, T., K. Nowell and J. B. Thomsen. 1993. The decline of the black rhino in Zimbabwae: Implications for future rhino conservation. Traffic International, Cambridge.

Milner-Gulland, E.J. and N. Leader-Williams. 1992. A model of incentives for the illegal exploitation of black rhinoceros and elephants: Poaching pays in Luangwa Valley, Zambia. Journal of Applied Ecology **29**: 388-401.

Morgan-Davies, M. 1996. Status of the black rhinoceros in the Masai Mara National Reserve. Pachyderm **21**: 38-45.

Overton, G. 1997. An update on the African Elephant database. The Rhino & Elephant Journal **11**: 13-15.

Simons, R. T. and U. P. Kreuter. 1989. Herd mentality: Banning ivory sales is no way to save the elephant. Policy Review(Fall): 46-49.

Starr, D. 1989. Rhino warrior. Omni **11**(September): 17-19.

Swanepoel, G. 1997. A criminological perspective on illegal trade. The Rhino & Elephant Journal **11**(1997): 20-24.

Viscusi, W. K. 1993. The value of risks to life and health. Journal of Economic Literature **31**(1993): 1912-1946.

Wells, M. and K. Brandon. 1992. People and Parks: Linking Protected Area Management With Local Communities. World Bank, Washington, DC.

Woods, M. 1999. A burning passion. Geographical **71**(3): 31-33.

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Abstract
People have an emotional and positive connection to the oceans yet express low levels of personal importance to protecting oceans. A collaborative, multi-year approach is required to cultivate substantive change in the way people understand, relate to and use the ocean. The Ocean Project was created to take on this role and facilitate a paradigm shift both in the way that people relate to the oceans and in the way educational institutions approach connecting people to ocean conservation. The Ocean Project represents a new and unprecedented public awareness effort among more than 75 aquariums, zoos and museums that together serve more than 100 million visitors a year. To lay the foundation for its future activities that will develop peoples' affinity for the oceans, last year The Ocean Project commissioned focus groups and a national poll to understand how and why people think about the oceans the way they do, what people know, and the gaps in public awareness about the oceans and related conservation issues. The survey work examined, in particular, the importance Americans place on ocean health and the potential for building greater saliency. The poll shows that telling people how and why the oceans are important to human survival is not enough to inspire the public to individual responsibility and action. This survey work also demonstrates the tremendous opportunity for aquariums, zoos and museums and others to reach the public with new educational efforts that emphasize both science and learning and the inspirational and ecological value of healthy oceans.

Introduction
As populations expand, society continues to urbanize and technology hurtles forward in quantum leaps, real contact with nature, including the oceans, is disappearing for most people at an alarming rate. While research shows that people have positive emotional connections to oceans and sense the importance of healthy oceans as integral to the balance of life on this blue planet, for the most part people have a dwindling comprehension of the simple principles that govern how our ocean planet works and the threats to this vast yet vulnerable watery habitat. Further, most people fail to see the harm that they do individually to oceans as well as the responsibilities and opportunities each of us has to ensure that the oceans remain healthy and productive for the future.

The poor state of the oceans today is less the result of the relatively naïve understanding of the complexity of ocean ecosystems than it is a sad testimonial to the very low importance the ocean has among the people of the world. The general population has a perception of the ocean akin to its understanding of rainforests 30 years ago; the issues seem of little importance to those not involved directly and oceans have been relegated to secondary status behind terrestrial regions when it comes to people's belief of where conservation is needed.

Yet today, while most people may not understand the technical details related to rainforests, the overwhelming majority now do know that they are important and that rainforests have relevance to them personally as well as ramifications for future generations. Many think of rainforests as the 'lungs of the planet' even though photosynthesis in the oceans of the world contribute more oxygen to our atmosphere than all terrestrial plants and ecosystems combined. Over the past few decades, people have assimilated a visceral belief that rainforests must be saved, which has resulted in greater conservation action on a widespread local basis. The challenge we face is to achieve a similar public perception and awareness of the ocean and aquatic resources in much less time.

Table 1. Membership of the steering committee created by the Wildlife Conservation Society (through its New York Aquarium).

The Ocean Project Steering Committee
• **Paul Boyle**, deputy director of WCS's New York Aquarium
• **Vikki Spruill**, executive director of SeaWeb
• **Diane Sena**, managing director of the Monterey Bay Aquarium
• **Kathy Sher**, deputy executive director at the National Aquarium
• **James Hekkers**, executive director of Colorado's Ocean Journey
• **Greg Stone**, director of conservation programs at the New England Aquarium
• **John Nightingale**, executive director of the Vancouver Public Aquarium and Marine Science Center
• **Michael Hutchins**, director of conservation science at the American Zoo and Aquarium Association
• **Bert Vescolani**, vice president of education and programs at the John G. Shedd Aquarium

A collaborative, multi-year approach is required to cultivate substantive change in the way people understand, relate to and use the ocean. A deep scientific and technical understanding is not needed by most people any more than it was in building the belief that rainforests are important. Instead, mechanisms are needed through which people can relate personally to the importance and value of the ocean. This connection is essential if people are to care about the profound changes the world ocean is undergoing today.

Aquariums, zoos, and museums have a unique opportunity to educate the public about the importance of ocean. One in three Americans has visited at least one of these institutions in the last twelve months and polls show that people trust these educational institutions as a credible source of information on ocean protection.

The Ocean Project created

Recognizing the advantage that these institutions possess, a new initiative, called The Ocean Project, formed recently to work with and through aquariums, zoos and science, technology, and natural history museums in order to develop a concerted and coordinated effort to reach people at a fundamental level regarding the importance of oceans and our connections to them. The Ocean Project believes that the single greatest impediment to healthy and productive marine and coastal areas is the public's low level of ocean awareness and see our mission as creating in people a lasting, measurable, top-of-mind awareness of the importance, value, and sensitivity of the oceans.

During the formation of The Ocean Project, SeaWeb joined with Wildlife Conservation Society (WCS) to create a team approach to forwarding this important ocean conservation movement. SeaWeb and WCS now jointly manage The Ocean Project (Table 1). Institutional partners currently include more than 75 aquariums, zoos and museums across the United States and Canada. The Project will focus initially in North America but will expand in the coming years to include institutions from around the world. In addition to creating an unprecedented collaborative effort among these educational institutions, that together serve more than 100 million visitors a year, The Ocean Project is building a diverse and broad network of nongovernmental and governmental partners with whom to develop synergies and complementary conservation activities. Of great importance, The Ocean Project will not duplicate or compete with the many conservation groups already working to save the oceans; instead, The Project aims to significantly increase the overall success of ocean conservation by collaborating in various capacities with local and national nonprofit conservation and environmental organizations, government agencies, universities and schools, dive clubs and others interested in networking to protect the oceans and help create a truly sustainable water planet. In addition to the 75 partner aquariums, zoos, and museums, nearly 100 organizations, agencies, and clubs have expressed interest in partnering with the Project.

The major task of The Ocean Project and its network of educational institutions will be to increase the saliency of the ocean and ocean issues in order to build public commitment to protecting the health of the oceans. To understand best how to proceed on such a major initiative and what to communicate to the public, The Ocean Project needed to explore the public's connections, values, attitudes, and knowledge relating to the oceans.

Public opinion research conducted

To lay a solid foundation upon which to build this far-reaching public awareness campaign, The Ocean Project last year commissioned two major research firms to undertake a comprehensive national public opinion survey in order to understand how and why people think about the oceans the way they do, what people know, and the gaps in public awareness about the oceans and related conservation issues.

The Project worked with the primary firm of Belden Russonello & Stewart assisted by American Viewpoint who together conducted six focus groups in the spring of 1999 and

a national telephone survey between July 24 and August 8, 1999 that sampled 1,500 adults living in the continental United States. The margin of sampling error for the study is plus or minus 2.5 percentage points at the 95 percent level of confidence.

The public opinion research represents the first time that aquariums, zoos and museums have collaborated in undertaking a comprehensive national effort to measure the public's knowledge and attitudes about oceans and adds significantly to a growing body of public perception research on the oceans, an area long ignored in environmental polling.

Table 2. Lessons learned from survey data analysis.

Analysis of the survey data identified salient public attitudes toward the oceans that will inform how aquariums, zoos, science museums and others can strengthen commitment to ocean protection.
• Oceans are viewed as powerful, vast, relaxing, and fun.
• The public possesses little awareness of ocean health, especially of the oceans beyond the beach.
• Protecting the oceans is not an urgent issue.
• The public possesses only superficial knowledge of the oceans, their functions, and their connection to humans' well-being.
• Oceans are viewed as vulnerable to lasting damage, but the public does not see individual actions as having a great impact.
• Currently low levels of personal importance placed on protecting oceans.
• Facts alone will not increase concern for oceans' health.
• Values framework: Balance of nature.
• Effective messages: recreation, responsibility, and future.
• Most salient threat: pollution.
• Americans may sacrifice to protect the oceans.

Research findings

Major findings from the research show reasons for both pessimism and optimism in protecting the oceans (Table 2). Essentially, while Americans have little basic knowledge of ocean functions, there is broad awareness of the oceans' vulnerability. However, people do not generally perceive the oceans to be in immediate danger.

A large majority of the public feels a strong personal and positive connection to the ocean, regardless of where they live. During focus groups, participants viewed oceans as powerful, vast, relaxing, and fun. The survey shows that people tend to value the oceans for their recreational and emotional aspects, and most understand that the oceans are neither a 'bottomless sink' nor indestructible.

People do know that human activities damage the oceans. Eight in ten reject the idea that "the oceans are so large that it is unlikely humans can cause lasting damage to them." A similar percentage reject the idea that "we do not need to worry about the health of the oceans because we will develop new technologies to keep them clean." Importantly, even though they do not know why or how, the public understands that oceans are critical to maintaining the balance of life on the planet. Fully 92 percent of Americans consider the oceans essential for human survival, with 75 percent strongly agreeing.

At the moment, however, Americans remain largely unaware of the threats to ocean health and they greatly underestimate their own role in damaging the oceans. Understanding of why we need the oceans is superficial. When asked about the health of the open, deep oceans, close to half of the public report that they do not know enough about these oceans to give an opinion and slightly over a quarter say so for coastal waters. Most Americans are unable to correctly answer a majority of simple questions about how the oceans function. For example, only 21 percent of Americans know that oceans produce more of the earth's oxygen than forests.

And while the poll found that people believe the oceans are threatened with serious and lasting damage caused by human activities, most people do not understand the role that each of us plays in the health of the oceans. For example, a majority of poll participants blame industry as the leading cause of ocean pollution and are much less aware of other threats to the oceans' health such as those cumulative effects, like runoff, caused largely by individuals. When asked to choose the main source of ocean pollution among three sources, only 14 percent of Americans select the correct answer—"runoff from yards, pavement, and farms." Nearly half of the respondents agree with the statement: "What I do in my life doesn't impact ocean health much at all."

Presently, there remains little acceptance that each us of has a major responsibility (and opportunity) for protecting the health of the oceans and our planet. Part of the problem seems to stem from the fact that, at the moment, people do not perceive the oceans to be in immediate danger, and the need for action to protect the oceans is not readily apparent to people.

The survey shows that telling people how and why the oceans are important to human survival is not enough to inspire the public to individual responsibility and action. Indeed, the survey reveals that people's existing concern for the oceans has little to do with specific knowledge of

the major role oceans play in producing the oxygen we breathe, regulating the world's climate and providing habitat for countless forms of life. The study identified the great importance of connecting people to the oceans through their values and aesthetic appreciation before attempting to get them to focus on ocean problems.

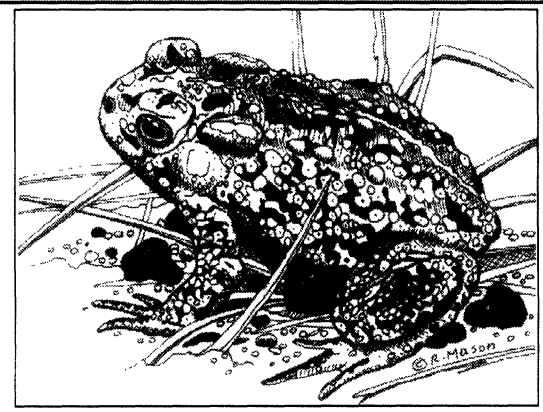
Significantly, the poll demonstrates that there is tremendous opportunity for aquariums, zoos and museums to reach the public with new educational efforts that emphasize both science and the inspirational and ecological value of healthy oceans. Although The Ocean Project's network of partners will need to surmount significant challenges, overall, the survey results portend good news for oceans and clarified the tremendous opportunities that exist for aquariums, zoos and museums to significantly increase ocean awareness. These institutions are in a unique position to channel the public's love for the oceans into a sense of individual opportunity, responsibiliy, and action.

Need for a paradigm shift

A major role for The Ocean Project to play will be to create a paradigm shift both in the way that people relate to the oceans and in the way institutions approach connecting people to ocean conservation. The Project intends to develop and promote people's natural affinity for the oceans and conservation through the creation of messages, communication tools, exhibits, events and projects that effectively mesh science education and conservation values with memorable experiences about the oceans. The Ocean Project's overarching policy will be to use positive messages that connect the ocean to our lives and make the oceans relevant to all. Starting in North America and then expanding around the world, we will collaborate as an extensive network of aquariums, zoos, museums and others to capture people's interest in the oceans, intrigue them, and inspire wonder. We will identify and encourage people to take more active roles in protecting oceans locally, nationally and internationally.

Over time, we hope to stimulate a lasting sense of respect for the oceans that permeates people's lives and transcends geographical boundaries. Through a variety of activities The Ocean Project and our partner institutions hope to instill in people not only a recognition of the interconnectedness of all things and belief that the oceans are an integral part of our lives, but also an empowering recognition that each individual plays a significant and influential role in the future of our ocean planet.

FOCUS ON NATURE ™ *by Rochelle Mason*



The HOUSTON TOAD (*Bufo houstonensis)* measures 2-3 1/4" in length and is light brown to grayish. It breeds in rain pools, flooded fields and permanent ponds from February to June then aestivates (hibernates) in deep, loamy sand until the next spring rains. The eggs and tadpoles need at least 30 days of sustained pools to complete their maturation cycles. The Houston toad feeds on insects and other invertebrates in native woodlands and prairies in east-central Texas. You can donate time or money to a nature conservation organization to help save this endangered toad's critical habitat. *© Rochelle Mason 1999. (877) 726-1544*

Marine Matters

Conservation Biology of Rhinoceros Auklets, *Cerorhinca monocerata*, on Año Nuevo Island, California, 1993-1999

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Abstract

*Rhinoceros Auklets (*Cerorhinca monocerata*) were once plentiful in California, but presently only three offshore islands, Castle Rock, the Farallon Islands, and Año Nuevo Island, provide nesting habitat for approximately 95 percent of the California breeding population of Rhinoceros Auklets, which totals no more than 2,000 birds. Since 1992, we have studied and managed the population of Rhinoceros Auklets on Año Nuevo Island (ANI), part of Año State Reserve (ANSR), and within boundaries of the Monterey Bay National Marine Sanctuary. Annually, our goals are to assess population status, reproductive performance, and food habits of this recovering species. Management efforts have involved protection and enhancement of habitat through the construction of boardwalks, implementation of an Island Research Protocol, and installation of nest boxes. The breeding population of Rhinoceros Auklets on ANI increased from 1993-1997, but dropped substantially in 1998 in response to the El Niño warm-water anomaly. This fluctuation was due mainly to a reduction of birds breeding in natural burrows. The population increased again in 1999, but still remained lower than pre-El Niño levels. The success of nest boxes as a seabird restoration tool has been indicated by the immediate and continuing occupation of nest boxes, the return of chicks reared in boxes to breed in boxes, and the increased productivity (percent successful) of pairs breeding in boxes, fast approaching that observed in natural burrows. Rhinoceros Auklets on ANI have predominantly relied on northern anchovies (*Engraulis mordax*) to rear their chicks; in years of high anchovy abundance we have observed both high chick growth rates, fledging weights, and overall productivity. In relation to our conservation efforts, the El Niño of 1998 was a set-back, but the breeding population seems to have started recovery in the subsequent cold-water La Niña year. However, loss of nesting habitat on ANI continues to pose some problems. We plan on continued Rhinoceros Auklet population monitoring, development of a habitat restoration/stabilization program to minimize erosion of auklet nesting areas, and development of a population viability analysis to look at the long-term progress for the population.*

Introduction

Rhinoceros Auklets (*Cerorhinca monocerata*) are a crevice/burrow-nesting seabird (family Alcidae) that breeds throughout the North Pacific Rim. World population estimates are roughly 1 million individuals. Despite its common name, a reference to the distinct "horn" that develops on its bill each spring, the Rhinoceros Auklet is more closely related to puffins than auklets, based on morphological similarities, life history, and systematics (Storer 1945; Hudson et al. 1969; Strauch 1985).

Rhinoceros Auklets spend much of the fall and winter on the ocean feeding. In the springtime, mature adults return to colonies to initiate breeding activities. Rhinoceros Auklets are believed to be monogamous (Richardson 1961; Leschner 1976; PRBO unpublished data), and they generally breed in the same crevice or burrow, year after year. They are strong diggers, and can use their powerful bill and their sharply-clawed feet to excavate burrows deep in the soil. The female lays one egg and both sexes share in the duties of incubation and chick-rearing.

Rhinoceros Auklets were once plentiful in California, but most of the breeding population disappeared by the late 1800s (Grinnell 1926). A recolonization event began in the 1970s (Scott et al. 1974). Presently three offshore islands, Castle Rock, the Farallon Islands, and Año Nuevo Island, provide nesting habitat for approximately 95 percent of the California breeding population, which totals no more than 2,000 birds (Carter et al. 1992). Currently, expansions have been documented as far south as San Miguel/Prince Islands in the southern Cali-

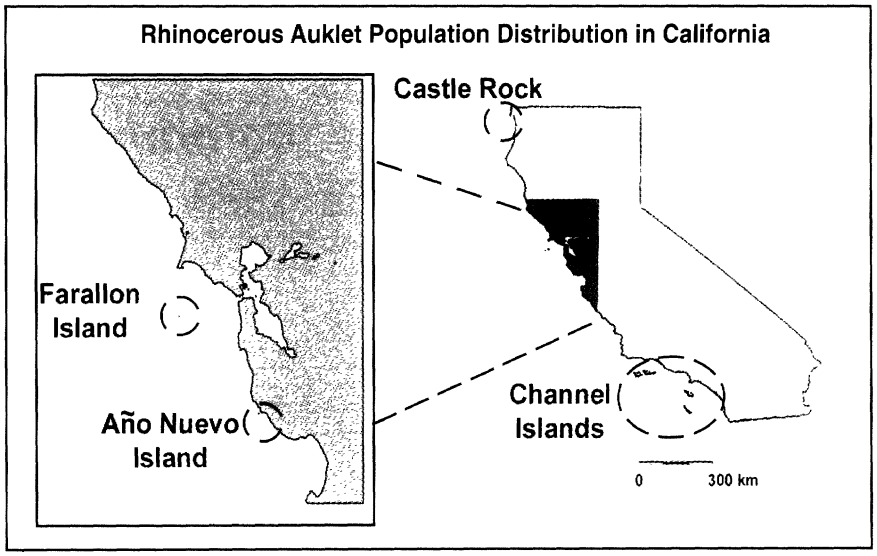


Figure 1. Castle Rock, Farallon, and Año Nuevo Islands.

fornia Bight, though colonies there are small.

Rhinoceros Auklets are designated "a species of special concern" by the State of California and "a species of high priority management need" by the U.S. Fish and Wildlife Service. Threats to the Año Nuevo Rhinoceros Auklet population include oil and chemical pollution (e.g., the 1986 *Apex Houston* oil spill killed or debilitated approximately 1,600 Rhinoceros Auklets in central California (Page *et al.* 1990)), loss of nesting habitat to erosion and trampling by pinnipeds, and human disturbance (Lewis and Tyler 1987, PRBO unpublished data).

In the early 1980s, Rhinoceros Auklets established a small colony on Año Nuevo Island (ANI; 37°N 122°W), approximately 32 km north of Santa Cruz, California, and 1km off the coast. Birds were seen carrying fish in 1982 (presumably back to their offspring on the island; LeValley and Evens 1982), and burrows were documented by Año Nuevo State Reserve supervising ranger G. Strachan in 1986 (Lewis and Tyler 1987). In 1992, ANSR and the Point Reyes Bird Observatory (PRBO) Marine Science Division initiated a project to promote growth of this population. The project has entailed (1) construction of boardwalks to reduce both human and pinniped disturbance to burrows, (2) installation of nest boxes to supplement breeding habitat, provide protected nest sites, and aid in monitoring and management efforts, and (3) studies of demographic traits, population dynamics, and feeding ecology to develop an understanding of factors affecting auklet population dynamics.

Population size

Restoration efforts thus far have been successful for this recovering species. Breeding population size of Rhinoceros Auklets is generally difficult to estimate because auklets are burrow/crevice-nesting seabirds and are usually active on the breeding colony only at night. The Rhinoceros Auklet population on ANI grew at a rate of 16.6 percent per year between 1993 and 1997, doubling the number of breeding pairs from 51

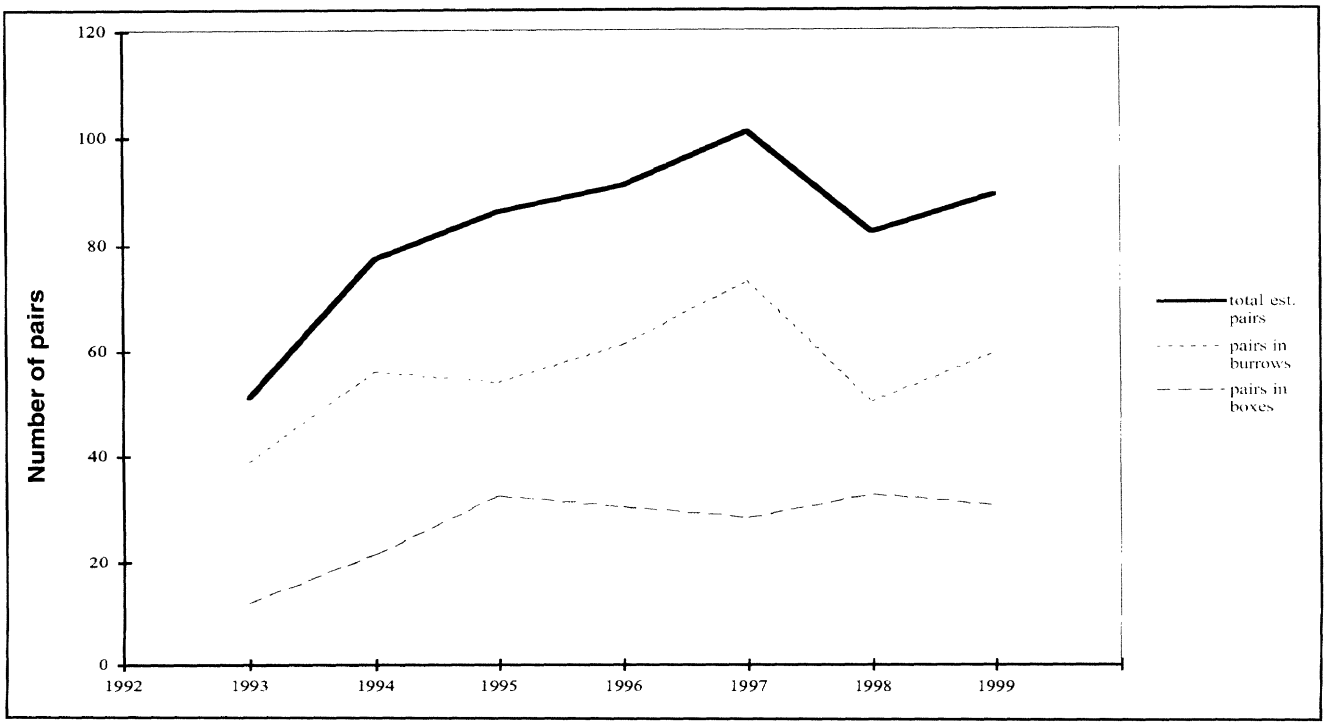


Figure 2. Population trends of Rhinoceros Auklets on Ano Nuevo Island, 1993-1999.

to 101 (Figure 2). During the 1998 "El Niño" event, the population declined considerably, due mainly to a drop in the number of pairs nesting in natural burrows. Heavy winter and spring storms that year may have increased erosion on the island, thereby diminishing habitat availability (see Erosion below). Additionally, poor prey availability as a result of elevated water temperatures off central California in 1998 may have been related to reduced breeding effort. However, the breeding population increased again in 1999, a cold-water "La Niña" year. Although not at pre-El Niño levels, the Rhinoceros Auklet population on ANI has still increased significantly since we began restoration efforts in 1993.

Juvenile recruitment

Auklets born on ANI have now started to return to breed on their own, and some have successfully fledged chicks. This indicates success of the boxes as a restoration tool. Moreover, these are the first breeding observations of known-age Rhinoceros Auklets and provide the first information on age at first breeding and other critical demographic traits. Most of these auklets were banded as chicks on ANI, but we have also observed immigration from Southeast Farallon Island, located 90 km to the north, approximately 42 km off the San Francisco shore. Auklets of known age have also been captured in mist-nets carrying fish, indicating that they are nesting in natural burrows.

Nest boxes versus natural burrows

After nest boxes were installed in early 1993, breeding auklets quickly occupied approximately 60 percent of these boxes by 1995, and this rate has remained constant since then. In 1995, we also started monitoring natural burrows with an minature infrared camera. The occupancy rate of natural burrows has varied from approximately 70 to 90 percent. Thus the occupancy rate in boxes is still somewhat lower than that in burrows.

Rhinoceros Auklet reproductive performance was lower and timing of breeding later during the 1998 El Niño event. The mean egg-laying date usually occurs in early May, and have been as early as 27 April (1997). Yet in 1998, the average egg-laying date was 22 May in nest boxes and 26 May in natural burrows. Reproductive performance in natural burrows has been high at close to 80 percent, except for a dip during the 1998 El Niño (Figure 3). Reproductive success of pairs in nest boxes started out low at 31 percent in 1993, but similar to our findings on population size, we have seen a significant trend of increasing productivity since then, reaching 70 percent in 1999. However, for the four years in which boxes and burrows were both successfully monitored (1995, 1997-1999), reproductive performance was still significantly higher in burrows.

Chick growth and diet

Chick growth rates and fledging weights were significantly lower dur-

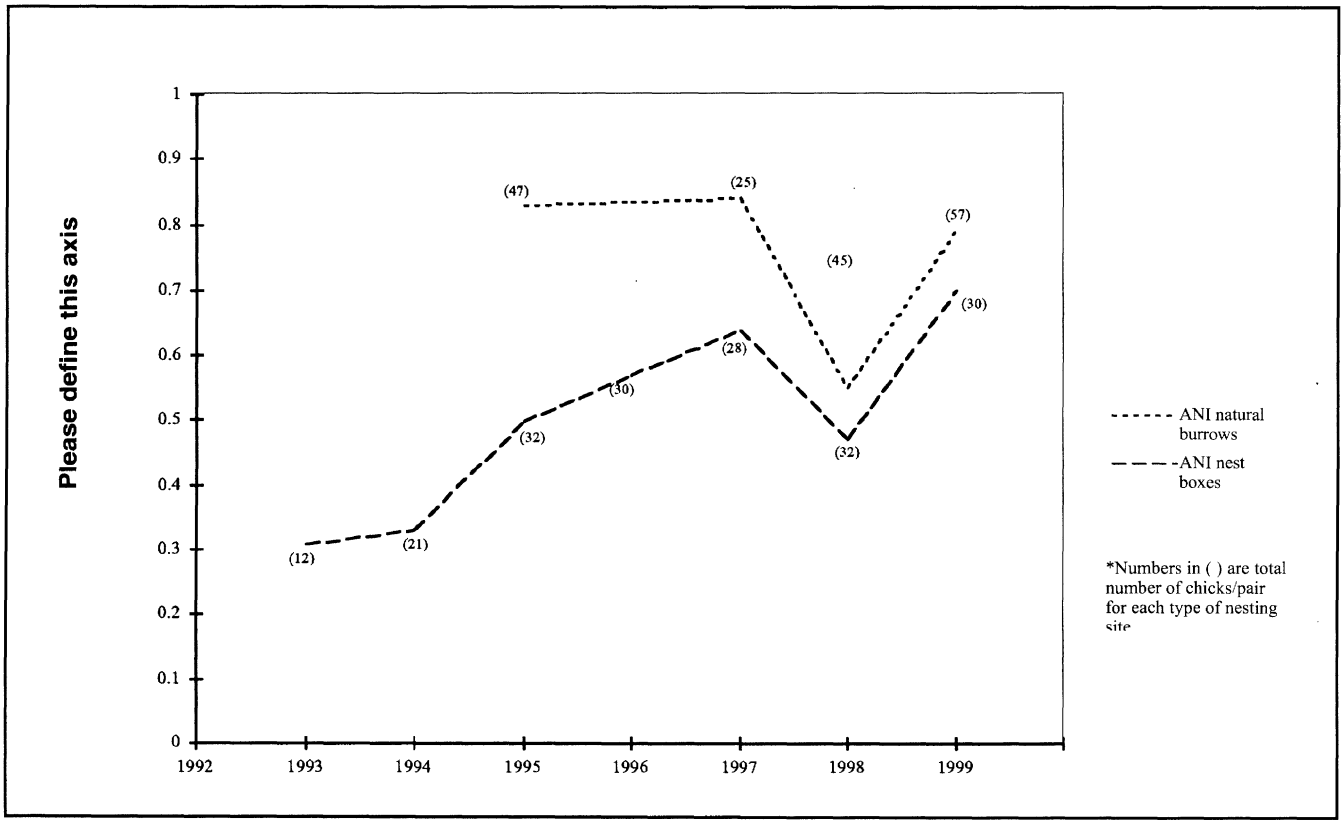


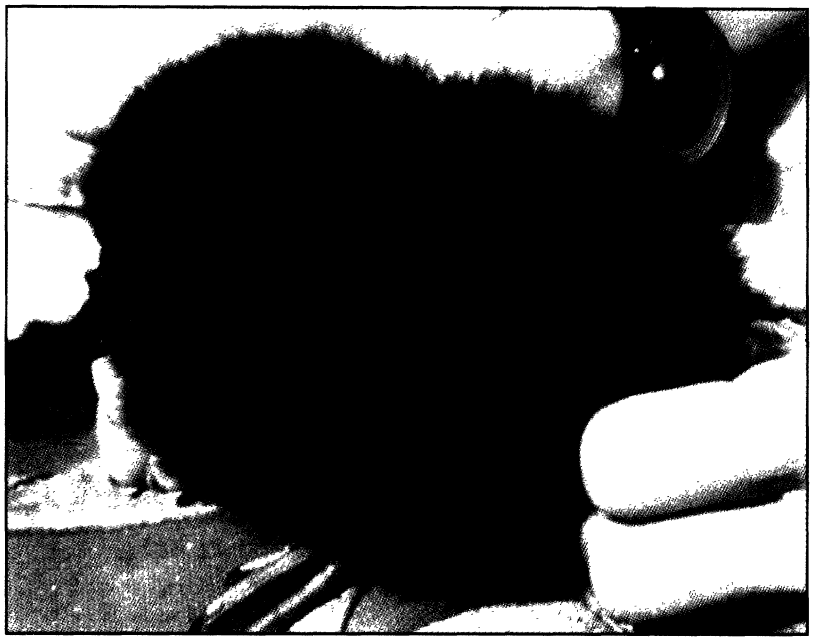
Figure 3. Reproductive performance of Rhinoceros Auklets on Año Nuevo Island, 1993-1999.

ing the 1998 El Niño, as well as in 1996, than in other years, especially 1995 and 1999. Chick growth, fledging weights, and productivity are influenced by food availability. In this ecosystem, predation does not appear to play a significant role in affecting auklet productivity. Rhinoceros Auklets are visual, pursuit-diving foragers, propelled underwater by their wings. They feed primarily on schooling fish, like anchovies, and cephalopods, like squid. A set of ridges inside the bill (know as palantine denticles) allows the Rhinoceros Auklet to hold prey while continuing to forage. Consequently, birds may deliver multiple prey items to their chicks at each feeding. Where Rhinoceros Auklets breed in association with gulls, as on ANI, they generally return to feed chicks at night to avoid kleptoparasitism (i.e. stealing of fish by gulls). We mist-netted adults at night during the peak chick-rearing period to evaluate food habits each year.

Rhinoceros Auklets preyed predominantly on northern anchovies (*Engraulis mordax*) to rear their chicks in 1993-1995 and 1999. Juvenile rockfish (*Sebastes sp.*), squid (*Loligo opalescens*), and Pacific saury (*Cololabis saira*) were selected more frequently than anchovies in 1996, 1997, and 1998, respectively. However, when analyzed in terms of biomass, anchovies also made up the majority of chick diet in 1997. In 1996 and 1998, when anchovies made up less than 35 percent biomass of the diet, chick growth rates and fledging weights decreased. Productivity declined in 1998 as well, when sauries comprised approximately 65 percent of chick diet.

Erosion and disturbance to nesting habitat

Disturbance and destruction of nesting habitat has been substantially reduced by using boardwalks in auklet nesting areas, and educating visitors and other researchers about the sensitivity of Rhinoceros Auklets to disturbance.



Rhinoceros auklet chick.

However, some Rhinoceros Auklet burrows continue to be destroyed and/or damaged each year. We suspect that a large portion of these are damaged by soil erosion. In 1999, exceptionally strong winds scoured the northwestern sides of the island, further eroding portions of Rhinoceros Auklet breeding habitat already affected by severe 1998 El Niño storms. While there is ample vegetation in certain areas of the island, there is little vegetation in established Rhinoceros Auklet breeding areas. Other burrows may be crushed by Brandt's Cormorants (*Phalacrocorax penicillatus*) trying to create new nesting areas, roosting Brown Pelicans (*Pelecanus occidentalis*), or northern elephant seals (*Mirounga angustirostris*) or California sea lions (*Zalophus californianus*) moving through auklet nesting habitat. Trampling by pelicans, cormorants, or pinnipeds would be difficult to prevent, however, revegetation of nesting habitat by native plant species may slow soil erosion and lessen the effects of trampling.

Conclusions

During this work, a trend of overall increasing breeding population size and reproductive performance in nest boxes has been evident. The 1998 El Niño event caused a short-term decline in food availability, resulting in reduced nesting effort and reproductive performance and greater habitat degradation in that year. However, the trend for a growing population returned in 1999.

Reproductive performance in both nest boxes and natural burrows has increased, with nest boxes reaching the highest productivity yet recorded in 1999, lessening the gap between boxes and burrows. In a site-faithful species such as Rhinoceros Auklets, this trend suggests that young pairs may have initially colonized nest boxes, with their reproductive success increasing with age and/or experience. These results also suggest that after some time, productivity in boxes and burrows may not be significantly different, allowing us to rely on data obtained from the more easily-monitored nest boxes.

Continuing efforts to promote growth of Rhinoceros Auklet populations on ANI, as well as nearby Southeast Farallon Island (SEFI), provide a good opportunity to conserve this rare seabird in California. Future studies should continue to monitor and evaluate population trends, especially as the auklet population continues to recover from re-

peated El Niño events and other factors, such as oil pollution.

Documenting the changes in prey availability and selection among years has important implications for evaluating demographic characteristics as well as indicating the status of forage fish stocks in central California. Productivity was high in years when anchovy was the predominant food item. Anchovies are neritic schooling fish found near ANI, with a high caloric content (152 cal/100g, Sidwell 1981). While cephalopods may be an important food item for adults (Morejohn et al. 1978, Croxall 1987), they have a lower caloric content than anchovies (~70 cal/100g, Sidwell 1981) and may not be an optimal diet item during chick-rearing.

We hypothesize that auklets must travel much farther to obtain pelagic-schooling sauries, usually found at least 40 miles offshore (K. Sacuma/ NMFS pers. comm.). Therefore obtaining sauries may be more energetically expensive than foraging for anchovies. It appears that northern anchovy is important for the success of the ANI Rhinoceros Auklet colony, yet not much is known about the status of this central California stock (Hester 1998).

Also important, Rhinoceros Auklet breeding habitat on ANI appears to be degrading. Due to high winds and historical habitat alterations, vegetation on the island is sparse. Vegetation can have profound effects on reproductive performance, as observed on Teuri Island, Japan, where reduced productivity has been found in areas without vegetation (Miyazaki 1996). The few vegetated patches on ANI are dominated by exotic, invasive species which may limit or reduce the amount of suitable breeding habitat available to auklets. The reduction or eradication of exotic plant species on ANI, in conjunction with restoration of native vegetation, may reduce soil erosion and stabilize seabird breeding habitat.

Finally, information on juvenile recruitment, survivorship, and immigration is now becoming available. We have obtained seven years of mark/recapture data from banding efforts. These parameters will contribute to the assessment of the long-term prognosis for the Rhinoceros Auklet colony on ANI. Since estimates of adult and juvenile survival and immigration do not exist for any other Rhinoceros Auklet population, this study will provide unique information needed to manage Rhinoceros Auklets throughout the Pacific Rim.

Acknowledgments

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Literature cited

Carter, H.R., G.J. McChesney, D.L. Jaques, C.S. Strong, M.W. Parker, J.E. Takekawa, D.L. Jory, and D.L. Whitworth. 1992. Breeding populations of seabirds in California, 1989-1991. Unpublished Report of the U.S. Fish and Wildlife Service, Dixon, CA.

Croxall, J.P., ed. 1987. Seabirds, Feeding Ecology, and Role in Marine Ecosystems. Cambridge University Press. 408pp.

Gaston, A.J., and S.B.C. Dechesne. 1996. Rhinoceros Auklet (*Cerorhinca monocerata*). In: The Birds of North America, No. 212 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, sand The American Ornithologists' Union, Washington, D.C.

Grinnell, J. 1926. The evidence of the former breeding of the Rhinoceros Auklet in California. Condor 28:37-40.

Harfenist, A. 1995. Effects of growth-rate variation on fledging of Rhinoceros Auklets (*Cerorhinca monocerata*). Auk 112:60-66.

Hester, M.M. 1998. Abundance, reproduction, and prey of Rhinoceros Auklet, Cerorhinca monocerata, on Año Nuevo Island, California. Masters Thesis, San Francisco State University and Moss Landing Marine Laboratories, California.

Hudson, G.E., K.M. Hoff, J.V. Berge, and E.C. Trivette. 1969. A numerical study of the wing and leg muscles of Lari and Alcae. Ibis 111:459-524.

Leschner, L.L. 1976. The breeding biology of the RhinocerosAuklet on Destruction Island. Masters Thesis, University of Washington, Seattle.

LeValley, R. and J. Evens. 1982. The nesting season: middle Pacific coast region. American Birds 36:1011-1015.

Lewis, D.B. and B. Tyler. 1987. Management recommendations for coastal terrace and island resources at Año Nuevo State Reserve. Unpublished Report to California Department of Parks and Recreation, Año Nuevo State Reserve. Institute of Marine Sciences, University of California Santa Cruz.

Miyazaki, M. 1996. Vegetation cover, kleptoparasitism by diurnal gulls, and timing of arrival of nocturnal Rhinoceros Auklets. Auk 113:698-702.

Morejohn, G.V., J.T. Harvey, and L.T. Krasnow. 1978. The importance of *Loligo opalescens* in the food web of marine vertebrates in Monterey Bay, California. Fish. Bull. 169:67-97.

Page G.W., H.R. Carter, and R.G. Ford. 1990. Numbers of seabirds killed or debilitated in the 1986 *Apex Houston* oil spill in central California. Studies in Avian Biology 14:164-174.

Richardson, F. 1961. Breeding biology of the Rhinoceros Auklet on Protection Island, Washington. The Condor 63:456-473.

Scott, M.J., D.G. Ainley, and C.F. Zeillemaker. 1974. Range expansion and activity patterns in Rhinoceros Auklets. Western Birds 5:13-20.

Sidwell, V.D. 1981. Chemical and nutritional composition of finfishes, whales, crustaceans, mollusks, and their products. NOAA Tech. Mem. NMFS F/SEC-11. 432 pp.

Storer, R.W. 1945. Structural modifications in the hind limb of the Alcidae. Ibis 87:433-456.

Strauch, J.G., Jr. 1985. The phylogeny of the Alcidae. The Auk 102:520-539.

Conservation Spotlight

Cuban Amazon Parrot (*Amazona leucocephala*): Private Sector Participation in AZA Breeding Programs

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Introduction

The American Zoo and Aquarium Association (AZA) has developed various breeding programs to responsibly manage captive populations of selected species. The zoological community utilizes computer software distributed by an organization called International Species Information System (ISIS), based in Minnesota Zoological Gardens. One of the essential elements of an AZA breeding program is accurate studbook data of the species in the Single Population Animal Records Keeping System (SPARKS) format. All recognized studbook keepers utilize SPARKS and an annual class is taught at the AZA Schools for Zoo and Aquarium Professionals.

The AZA Parrot Taxon Advisory Group (TAG) is developing a Regional Collection Plan to develop standards for nomenclature, records keeping, and program philosophies. This will enable zoo facilities to collaborate with private sector breeders. The development of long-range plans that include the private sector is being viewed as a way to utilize their expertise and add resources to propagation programs.

The current managed population of Cuban Amazons (*A. l. leucocephala*), began as a group of U. S. Department of Interior (DOI)-seized birds in Miami, FL, on 4 April 1988. The founder birds were turned over to the Miami Metrozoo on 27 May 1988. With the agreement in place between the AZA and the DOI / U.S. Fish and Wildlife Service, birds were shipped in the summer of 1991 to the selected Participants of the Cuban Amazon Consortium for breeding. The Consortium has been developed into a Population Management Plan (PMP), which means that the studbook data are used to manage the population. This step has formalized the efforts of this program to a higher level of species management.

Private sector participation

Zoological institutions are a major part of species survival, but, as one woman put it, "it takes a 'village'." The involvement of private sector breeders is key to long-term holding capacity and reproduction of species for which zoos have little space. The Parrot TAG has created an AZA listserv to facilitate communication between the AZA Parrot TAG and private sectorbreeders. This is another step in the direction of utilizing the expertise of private breeders.

Within the Cuban Amazon PMP there are two factors that are proving to be important: (1) the ability to house large numbers of Cuban Amazon parrots, due to their habits of flocking; and (2) the ability to allow natural mate selection, due to aggression during courtship. Not

Cuban Amazon parrot at 52 days. Courtesy San Diego Zoological Society/Photo Lab.

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many zoological institutions can allow a lot of space to be utilized by a single species because of the number of species that are in trouble. It is increasingly evident that we may lose our ability to sustain populations unless we can create more holding capacity.

Many private sector breeders can specialize in species not held by zoos because they can use their holding space as they wish. Zoological institutions develop collection plans for exhibition of species. They do not always have the luxury of raising funding for off exhibit breeding, unless the public support and/or donor base becomes interested.

Cuban Amazon parrot chick. Courtesy San Diego Zoological Society/Photo Lab.

Cuban Amazon natural history

The nominate race is found on mainland Cuba. There are five recognized subspecies:

- *Amazona leucocephala leucocephala*—Mainland Cuba;
- *A. l. palmarum*—Isle of Youth;
- *A. l. caymanensis*—Grand Cayman;
- *A. l. hesterna*—Cayman Brac, Little Cayman; and
- *A. l. bahamensis*—Bahamas.

The historical studbook will eventually include all five subspecies, but the current studbook only represents the nominate race in the managed population.

Genetic analysis is not limited to tracing the lineage of the managed population. Much work and funding is needed to create a lab test to karyotype the Cuban Amazon by subspecies. This will facilitate the addition of new birds to the managed population because they can be properly classified and prevent sub-specific hybridization.

The Cuban Amazon is restricted to eastern and central Cuba. According to Juniper and Parr (1998), the main areas of concentrated populations are Zapata and Guanahacabibes Peninsulas and in Sierra de Najasa on mainland Cuba. In 1988, the Cuban Amazon population was estimated at 5,000 individuals. More current numbers are not available as of this writing. They commonly inhabit the woodlands of the mountains and lowlands of mainland Cuba (Bond 1956). A combination of pines and palms are found in the wooded areas of their habitat.

Conservation status

Cuban Amazon parrots are listed on CITES Appendix I (1997) and the species is considered Near-Threatened with extinction. For the most part, the Cuban Amazon has been smuggled into the United States for the purpose of selling them to the pet trade. There are also reports *in situ* by Mitchell and Wells (1997), that people are toppling dead palms to rob and destroy nests. Despite the efforts of a dedicated group of forest rangers in the Zapata region of Cuba, nest disturbances of this kind make nest sites unusable for the next breeding season. Thus, both live chicks and future nesting locations are being lost. Due to a steady decline in the 1970s, the Cuban government enacted legislation to limit the exportation of the Cuban Amazon for the pet trade (Gálvez et al. 1995). In the 1980s, the Empresa Nacional para la Proteccion de la Flora y Fauna initiated a program to protect the areas where the Cuban Amazon was found (Gálvez et al. 1995).

Conservation efforts

There is an effort between the ProNaturaleza a non-governmental organization (NGO), the Roger Williams Park Zoo/Rhode Island Zoological Society, and the Havana Zoo in Cuba to conduct an *in situ* study the Isle of Youth parrot (*A. l. palmarum*). The Isle of Youth parrot is a subspecies of the nominate race and is found on an island off the coast of mainland Cuba.

Through these collaborative efforts, an expanded version of the original census (Gálvez et al. 98) was completed in November of 1998. Surveys were conducted in

the eight study sites and ninety-eight stations that were originally surveyed in 1995.

A component of the conservation effort in Cuba is to educate the local communities where the Cuban Amazon and Isle of Youth Amazon parrots are found. The Havana Zoo Education Department plans to assist with this initiative. Plans are being developed to promote the Cuban Parrot as a flagship species for endangered and threatened Cuban wildlife. This program will hopefully improve awareness about the plight of the nominate race found on mainland Cuba.

Epilogue

Being involved with a conservation effort comes in many forms—some people donate their money, some donate their time and some donate their skills and expertise. For the Participants of the Cuban Amazon PMP, it is a combination of all three forms of involvement. It is not always possible to find people willing to do all three.

If you have any questions or concerns about the Cuban Amazon PMP, please contact the author or you may contact or Grenville Roles, Coordinator, Cuban Amazon Consortium, Disney's Animal Kingdom, P. O. Box 10,000, Lake Buena Vista, FL 32830-1000, ph. (407) 939-6383; fax 939-6391; grenville.roles@disney.com.

Literature cited

Juniper, T., M. Parr. 1998. Parrots: a guide to parrots of the world. Yale University Press, United States and Pica Press, United Kingdom.

Bond, J. 1958. Checklist of Birds of the West Indies, 4th Edition. Academy of Natural Sciences, Philadelphia.

Mitchell, A., L. Wells. 1997. The Threatened Birds of Cuba Report, Cotinga Journal of the Neotropical Brd Club (UK), April Issue; November 7.

Galvez, X., V. Berovides, J. Wiley, J. Rivera. 1995. Population Surveys of the Cuban Parrot (*Amazona leucocephala palmarum*) and Sandhill Crane (*Grus canadensis nesiotes*) in the Northern Part of Isla de la Juventud, Cuba. December Report.

Captive Cuban Amazon parrots. Courtesy San Diego Zoological Society/Photo Lab.

News From Zoos

Wild-Caught California Condor Returned to the Wild

After 14 years in captivity, the last female California Condor caught in the wild was released on April 4th, 2000. Adult Condor-8 (AC-8) was captured on April 19, 1986 by the California Condor Recovery Team, whose plan was collect the few remaining wild Condors and bring them into captivity in hopes of instituting a breeding program that would allow offspring to be released into the wild. The team was a partnership involving several institutions - the San Diego Zoo, the San Diego Wild Animal Park, and the Los Angeles Zoo - and the U.S. Fish and Wildlife Service.

Despite initial protests by those who felt the program would result in the extinction of the species, the program has been a tremendous success. The 27 Condors in captivity in 1987 have flourished, leading to a current population of 155 Condors, with 56 of them living in the wild. During her time in the captive-breeding program, AC-8 produced 9 offspring, and she is the first of the original wild-caught Condors to be released.

For the last several months, AC-8 has been housed in a flight pen at the Los Angeles Zoo with two juvenile Condors who were released along with her, to help them hone their survival skills. They have also undergone power pole aversion training, in which a realistic power pole installed in their flight pen provided a light shock whenever a Condor landed on it, reinforcing the necessity for Condors to stay away from these potentially fatal structures in the wild.

Once released, the Condors will be tracked via satellite through special transmitters that have been fitted to the birds' wings. Observing AC-8's behavior upon her return to her native territory will provide crucial information to researchers, and will greatly assist future Condor releases.

Ohio Zoos Helping to Save Manatees

In two separate incidences this February, manatees that had been rehabilitated with the help of Ohio zoos were returned to the wild. On February 16th, Comet, a 1,000 lb. manatee that had been rehabilitated at the Columbus Zoo, was released at Blue Springs State Park, FL as part of the U.S. Fish and Wildlife Service's (FWS) rehabilitation program. The manatee was fitted with a satellite/radio/sonic transmitter belt purchased by the zoo, to follow his post-release movements and behavior. And on February 22nd, Xoshi, a female manatee that had been abandoned as a calf, then rescued and rehabilitated at the Lowry Park Zoological Gardens in Tampa, was released into the St. John's River near Orlando. Technology paid for by the Cincinnati Zoo Conservation Fund will allow for monitoring of her movements, as well. Visitors to the Cincinnati Zoo and Botanical Garden will be able to see Xoshi's position from a computer terminal in their Manatee Springs exhibit.

Both the Cincinnati Zoo and the Columbus Zoo opened manatee exhibits in 1999—Manatee Springs in Cincinnati, and Manatee Coast in Columbus. The manatees that inhabit the exhibits were lent as part of a FWS program designed to free space in Florida facilities for the critical care of manatees that are injured by boat propellers or become tangled in fishing lines.

Zoological Society of San Diego Receives $7.5 Million Grant

The Zoological Society of San Diego (ZSSD) received the largest grant in its 83-year history this month, when it was awarded seven and a half million dollars by the Arnold and Mabel Beckman Foundation. The donation, of which $5 million is an outright gift and $2.5 million is a challenge grant to be matched by other donors, will help construct a $20 million Center for Reproduction of Endangered Species (CRES) facility at the San Diego Wild Animal Park. CRES, the research and conservation branch of the ZSSD, melds high-tech science with *in situ* field work to study and preserve endangered animals and their habitats.

"Because the CRES staff and projects have increased significantly since the CRES was founded 25 years ago, we desperately need new research facilities," said Dr. Kurt Benirschke, president, Zoological Society. "The generous Beckman Foundation grant is an incredible beginning to building our new facility and will enable us to continue leading the world in research and wildlife conservation efforts."

CRES will be built as a second phase of the Paul Harter Veterinary Medical Center, which will open at the Wild Animal Park later this year.

Information for News from Zoos *is provided by the American Zoo and Aquarium Association.*

News & Events

Conservation Biology Institute launches Pacific Northwest Conservation Assessment on the web

A wealth of information on 40 terrestrial ecoregions of the Pacific Northwest is now easily accessible via Conservation Biology Institute's (Corvallis, Oregon) website: http://www.consbio.org. From CBI's home page, click on the map of the Pacific Northwest or go directly to: http://www.consbio.org/cbi/assess/assessmain.htm

The site reviews 40 terrestrial ecoregions of the Pacific Northwest as defined by World Wildlife Fund. These encompass all of Alaska, Yukon Territory, British Columbia, Washington, Oregon, Idaho and portions of the Northwest Territories, Alberta, Montana, Wyoming, Nevada and California. For this entire region of North America, there is a current summary of protection status and more than 125 web links to valuable geographic data sources (with brief descriptions available from federal, state, provincial, NGO, and commercial internet sites.

Canada enacts Species at Risk Act

The Government of Canada unveiled its first-ever bill designed to protect endangered Canadian wildlife from extinction. *Species at Risk in Canada* has a web site at http://www.cws-scf.ec.gc.ca/sara/. You can search for information either by selecting an area on a map (coming soon), or by a species search (by risk category, range, Latin name, and common name). The status of these species is assigned by the Committee on the Status of Endangered Wildlife in Canada.

New journal of native plants

Native Plants Journal is a new journal providing a forum for dispersing practical information about the growing and planting of North American endemics for conservation, landscaping, reforestation, and restoration. Twice each year, the journal publishes papers that are useful to, and understandable by, growers and planters of native plants, and that contribute significantly to scientific literature. The first issue of *Native Plants Journal* is now available with full articles with information on fern propagation, *Eriogonum* seed germination, conservation biology of an endangered goldenrod, establishing native grasses with herbicides, *Meehania cordata*, and more. Future articles include growing subaquatic vegetation, field performance of California oaks, registering pesticides, a low-tech seed collection system, several propagation protocols using coir as a growing medium, and much more.

First-year, complimentary copies are available while supplies last. Request yours on-line at http://www.uidaho.edu/nativeplants, or by email at nativeplants@uidaho.edu.

Announcements for News and Events *are welcomed. Some items have been provided by the Smithsonian Institution's Biological Conservation Newsletter.*

Endangered Species UPDATE

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