Conservation Strategies for Invertebrates: Thirty Million to Choose From

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Thank you for giving me the opportunity to speak this morning. This is truly an historic occasion. Invertebrates have turned a corner of fantastic proportions in the arena of cultural attitudes as exemplified by this very first session devoted to invertebrate issues at an AAZPA conference. Everyone in this room should feel proud of his or her participation in that long road and the exciting process of education that you have nurtured and for those of you that haven't there are 30 million opportunities. Invertebrate exhibits are definitely a growth industry. The story of insects, arthropods, yes invertebrates is now at last being told to millions and millions of people in the northeast, in the southeast, in the midwest, in the southwest, in the northwest, in Europe, in the United Kingdom, in Asia, in Australia, and even in Russia with live invertebrate exhibits numbering well over 100 now (Saul 1992 in publication, Dunn 1991). Last week we did a radio show on insects on "Voice of America" which goes out to 45 countries and 250 million people in Africa alone. Everywhere you go insects are becoming more popular with the public. Indicators of dramatic changes in cultural attitudes abound. These are changes that we have witnessed occur over the last decade. Books on insects, insect toys, insect jewelry, insects in fine art and sculpture abound in the public and private sector outside of the realm of their zoo and aquarium promoters. Last week I even saw a designer suit with an insect motif prominently displayed selling for a mere $1050.00. People in this country in particular but also throughout the world are becoming sensitive to inappropriate use of pesticides. Insect and invertebrate exhibits have played a positive and I believe major role in this attitude shift. This year our modest insect exhibit at the San Francisco Zoo received the highest good/excellent ratings from the public of all the exhibits at the zoo.

Even the great ecologist Aldo Leopold took a long journey of consciousness raising to reach a conservation and management ethic that moved beyond game species. At last the word is getting out. But what is the word?

Today, we as entomologists, arachnologists, invertebrate biologists, conservation biologists and educators have one of the greatest conservation challenges. Whether you believe their are 30 million or 10 million species of insects, clearly we are faced with conserving a group with overwhelming biological diversity representing 99% of the animal life on earth (Erwin 1982, 1983, Adis 1990, Gaston 1991). Are Species Survival Plans (SSP) and captive propagation the only path? Should we focus our energies on only on what we know and do best? I believe we must grow and reach out to meet the challenge that faces all who are concerned with biodiversity conservation. What other group is as keenly aware of the long processes of coevolution that bind animals, plants and their environment together? We must take a broad multi-disciplinary and inter-disciplinary approach.

1. Fear No Weevil-Spread the word.

Obviously the primary purpose of having a public exhibit is to educate the public. Few people are knowledgeable about even the most basic information about this group. Most people don't even think they're animals. Children and adults separately and together, other zoo and aquarium or botanical garden staff (this made be your greatest challenge), government officials, the UPS delivery guy -- everybody needs to be reached --bugs are great –invertebrates are exciting and they're our friends, they're beautiful unto themselves and we need them. After all, what good is building a biodiversity library if there's no one to

check out the books. Building an informed public is probably the single most important thing we can do. After all, these are the voters, the consumers, the policy makers of today and their children represent tomorrow.

Our exhibits must be a commitment to the very best and the most exciting presentation because the potential to produce a negative impression is always there. We have to counteract all the information coming from movies, television commercials, and other misinformed media that are still pushing a 50's attitude toward bugs. We must go beyond "this is an ant" into the "why" territory- why are these so interesting, why are they so important, why do all ecosystems depend on these small creatures. Labels, graphics, interactive displays, preserved specimens, sounds, multimedia, computers, programming, printed materials are some of the tools available to tell the stories. Ten years ago books on invertebrates written with the general public in mind were few but that has changed. The word is getting out and there are thousands of niches to fill. It is our job to make them want to know more.

Reach beyond your exhibit door. Do a butterfly garden or better an insect garden or better yet a wildlife garden. Label the plants that the bees nectar on, label the caterpillars feeding on your favorite rose. Expand your reach. In each institution there are maybe only one, two or four people , if any, on staff that are knowledgeable about this group. There is only so much time in the day to teach classes and do school tours. Teach the teachers, create university internships and course credit opportunities for students, pre-service and in-service teacher training and training for future biologists and zoo professionals. We have models for these programs at the San Francisco Insect Zoo and have trained interns from U.C. Berkeley, U. C. Santa Cruz, University of San Francisco, San Francisco State University and others. Many institutions have zoomobiles that go out to schools or teacher workshop programs but do they have a section on insects, arthropods, invertebrates, ecology or conservation biology? Teachers and parents are overwhelmed today. Bring the disciplines together-systematics, ecology, physiology, genetics, chemical ecology, biogeography, botany, wildlife landscaping and conservation biology into a format that they can digest and use.

2. Practice the highest level of exhibitry technique available utilizing all disciplines available from biology, ecology, art, horticulture, museum techniques, theater, computer technology, sound, olfactory design, etc. Zoo exhibitry has lagged behind the educational sophistication of television audiences. Often this can be difficult for lack of financial resources but perhaps too often from a lack of vision and reaching out to the next ledge. It can be done expensively or inexpensively.

3. Provide good invertebrate management information for captive settings and for the design of preserves that will protect the invertebrate fauna as well as the flora, the fungi, the soil bacteria and in turn the mega-vertebrates. As we well know no man, no animal or plant stands alone. Working in this world of detail we are made keenly aware of the need to conserve intact healthy systems. We are lucky in the knowlege that over 60 food crops in California alone are pollinated by the honey bee (*Apis mellifera*) (McGregor 1976). The species of plants that are the staples of past, current and probably future human diets are pollinated by insects. Hence, the conservation of insects and plants is inseparable and indeed, I n the web of life, the conservation of mega-vertebrate depends completely on the conservation of invertebrates, plants and fungi and microorganisms that participate in nutrient cycling and ultimately the survival of humans.

4. Adopt an acre, it's habitat forming ©:
Participate actively in ecosystem preservation. My colleague Norman Gershenz and I initiated a zoo conservation program in 1988 that has purchased and protected 1000 acres of

rainforest in Central America. This program was conceived to get everyone actively involved in educating the public about systems and in preserving them. In zoos, aquariums, botanical gardens and museums we have access to millions and millions of people from all segments of society. What potential!

5. Hi, ho Papilio:

We all know that setting aside land to protect ecosystems will not guarantee protection if economic and population pressures rise. Beekeeping has been promoted as an alternative income source by the U. S. Peace Corps for years. How can zoos and aquariums participate in alternative and sustainable systems of agroforestry? Robert Pyle (1988) has written eloquently about the potential of butterfly ranching and farming. These programs must be designed to directly benefit the local people and it must be designed to yield a variety of products. The idea of extractive reserves is not new, but certainly has not reached its potential. Butterfly houses can be a direct market for these extractive reserves just as Ben & Jerry's ice cream is for Brazil nuts. Insects, because of their short life spans and quick generation time, present a problem for long term propagation due to inbreeding depressions. We can use our expertise to help train local populations in culture techniques and egg collection so that there is no impact on populations due to over-collecting year after year. In turn, this can become a direct source of income to indigenous and other local people. We can be part of a solution instead of a potential part of a problem especially with the growing popularity of butterfly houses and insect exhibits. One such model program has been set up in Papua New Guinea (Pyle 1988). One day, field collection of invertebrates will be as difficult and as regulated as it is for vertebrates. The more we teach people to value them the more they will care, which is of course our goal.

6. Beetle juice:

Alternative food sources for humans and domestic animals. While this topic has been written about seriously (Brues 1946) and whimsically (Taylor 1976) for many years, it is still facing overwhelming cultural prejudice. The Food Insects Newsletter put out by Gene DeFoliart of the University of Wisconsin is an invaluable resource of references and summaries on this topic. Cook some up sometime. After all, all the other animals eat them. Of 22 species of caterpillars analyzed in southern Zaire, the crude protein content averaged 63.5% and ranged from 45.6% to 79.6% (Malaisse and Parent 1980). The use of invertebrates as human food is well documented has been going on for a long time. If re-popularized and designed properly it has enormous potential to conserve remaining forest fragments, to feed hungry and malnourished humans and provide sustainable yields for income and food (Leleup and Daems 1969, Holden 1986). The resulting reduction of human pressure on reserves is a key component that should not be underestimated. A chronicle of over 50 species of insects eaten by the Yansi, a local people in a 200 km area points to some possible mechanisms for both insect and forest conservation(Muyay 1981, Holden 1986).

7. Caterpillars of wisdom:

Advocate public policy and law that promotes the preservation of invertebrates, ecosystems and sustainable systems of land and water use locally and globally. Current legislation to protect wildlife focuses on single species and primarily protects high profile individual species. The 1983 IUCN Invertebrate Red Data Book listed only 142 molluscs, and 108 arthropods (Wells et al 1983). The latest IUCN List of Threatened Species recognizes 2250 invertebrate species as threatened with extinction (IUCN 1990). This compares with 2761 species of vertebrates recognized as threatened. Obviously if invertebrates represent 90 to 99% of the diversity of life on earth an erroneous conclusion can be made from these figures which is often done. That first, we don't have to worry about these little guys and second, invertebrates in general are not threatened and are not vulnerable to the same pressures and forces that threaten large animals. Both are incorrect. Only 10 snail, 41

clams, 10 crustaceans, 22 insects and 3 arachnids indigenous to the United States were afforded federal protection under the Endangered Species Act (Hughes and Bennett 1991). Rohlf (1991) points out that Congress has repeatedly made efforts to encourage governmental agencies to institute guidelines that protect ecosystems rather than single species and in 1988 amended the Endangered Species Act to require that recovery plan development and implementation proceed "without regard to taxonomic classification" (16 U. S. C. Section 1533 [f] [1] [A]) (Rohlf 1991). However, single species orientation is still the rule in protection, in the press, in the messages we give out.

8. Caught in the web:

Avoid the siren press pitfall. If it is endangered, we will come. In our culture rare is better, more valuable, only endangered species are important. This is crisis conservation or emergency room conservation (Rohlf, 1991) at its finest. It's great headline copy but not great conservation practice. We have repeatedly watched as common species of yesterday have become the rare species of today. We begin to care about them when they become rare, threatened or extinct. Is there something wrong with this message? The passenger pigeon has passed, and now we are witnessing the decline of the "common" rufous-sided towhee , which may become the rare bird of tomorrow (Hagan 1991). We, as educators, along with a lot of other cultural messages have taught the press, our children, our public and our staff that if something is rare, it is more valuable from Ming vases to Stratavarius violins from rare records to rare coins; from rare birds to rare butterflies, we are a society of collectors of rare things. In fact our entire economy is based on this notion of supply and demand. We need to protect species, populations, and systems while they are still healthy and fully functional not when they are teetering on the brink of collapse. Additionally, the road that a species must travel to become designated as "threatened" or "endangered" status is a long, costly legal process, one that is not functioning well for invertebrates and their requisite systems. This is not cost effective conservation. So little is data is available about so many invertebrates that few have been able to be listed.

9. Breeding endangered species in captivity and reintroduction plans (SSP).

Our institutions are in a unique position. We are not obligated to house and breed invertebrates for agricultural research as are the USDA labs and some the universities, we are not obligated to raise insects of medical importance, we are not obligated to conduct pesticide efficacy tests as are the commercial labs. We are not obligated to create mass cultures for sources of new human food as are some marine labs. Though there are many different kinds of institutions that culture invertebrates our goal is unique in its educational and conservation mission. We have millions of species to choose from, from all reaches of the world, many whose habitat is threatened. Participate in the captive propagation programs that are well thought out and designed for success. Resources for our facilities are extremely tight so spend time to develop a good plan. The American burying beetle *Nicrophorus americanus* is one such example (Kozol 1988). Several institutions have valiantly taken on the *Partula* snail complex which is face with extinction due to human intervention in its native habitat (Kinney 1980).

9. To know a fly:

Basic research is always important. It is especially important for groups in which the majority of species are still being discovered and named. Only a handful have been observed in detail at closed quarters. We have barely scratched the surface with basic natural histories. Often, the species we are exhibiting have never been kept in captivity let alone cultured. There is no encyclopedia of insects to refer to. We have often done literature searches and come up with absolutely nothing beyond the original species description written in the last century. Occasionally, we have been unable to get even a species name, nor find a living taxonomist that could put a name on a particular specimen. Keep good records, take good notes, be as systematic as time and facility permits. I know

each of us has several papers in our records. At the S. F. Insect Zoo we have documented the biology of the Costa Rican katydid *Lirometopum coronatum* and this data is being prepared for publication in the journal American Zoologist (American Zoologist 1993 33(2):139-143).

10. Taxonomic tango:
Support, conduct or contribute to entomofauna and other invertebrate inventories. The need for baseline data is enormous and the regulations of most endangered species protective legislation necessitates baseline population data and documentation of population decline. This is an impossible task without good taxonomic experts to identify the species. This brings us back to building relationships with institutions involved in research and educating future generations of children to be comfortable with and excited about science and invertebrates so that they perhaps might become the entomologists, invertebrate biologists, ecologists, conservation biologists, eco-economists of the future.

11. Jiminy says "Let your conscience be your guide":
Promote species diversity as an ethical goal (Wilson 1984). Preserving biological diversity is an admiral goal in itself. We are often driven to find a monetary or human oriented reason for saving wildlife from extinction. These arguments are valid, but also help promote an anthropocentric outlook. The balance and diversity of nature is in itself worthy. Are humans more important than all other life on earth? Indeed, I believe that this intrinsic value of wildlife is what keeps our national parks filled with millions of people each year.

13. Play cricket:
Practice good captive management techniques and ethics. Don't wait for outside agencies to develop codes of practices and management policies. Breed rather than rely on repeated collecting. Cooperate with colleagues in a noncompetitive and non-monetary fashion.

14. Reach beyond the zoo and aquarium world. Live invertebrate exhibits are true crossovers. Today, insects in particular are exhibited in zoos, aquariums, natural history museums, nature centers, theme parks, botanical gardens and universities. (Saul 1992, Saul 1982, Dunn 1991). Build relationships with other institutions involved in research such as universities and museums. Avoid duplication of effort, develop relationships with other conservation organizations. In this way your impact can be amplified and less fragmented.

15. Pure shellfishness or beetlemania:
Be an advocate for invertebrates.

If all this seems ambitious, overwhelming, filled with a million paths well I think that perhaps that is the very appeal of nature, its incredible complexity and diversity. Please feel free to add to this list as often as possible.

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