ES: Thanks, Ollie. Those are some big feet....

Our next speaker our final speaker for the session before the panel is a colleague and an extremely good friend of mine, who s probably shaking in his boots right now. Because I have definitely more to say about him than I have to say about anybody else here. But I ll be nice.

So George Amato works at The Wildlife Conservation Society, in the Science Research Center and you have heard more and more about his past than probably anybody else here and his focus is on conservation genetics. And I just thought I d give you a little anecdote from his youth that puts into perspective his job there at The Bronx Zoo-based Wildlife Conservation Society. I did hear this morning, when I was mining for pieces of information, that George, in fact, broke into the zoo when he was eight years old. (Laughs) Maybe he ll tell us some more about that. George?

(Applause)

CONSERVATION GENETICS MEETS ECOLOGY: TOWARD A MORE INTEGRATED APPROACH

George Amato, *Director for Conservation Genetics, Wildlife Conservation Society*

GA: No, I won t tell you any more about that. (Laughter)

Was anyone as startled as I was, when we went up the stairs for lunch, to see that thylocene at the top of the steps? I just have to draw your attention to that. It seemed like it was placed there by Phil Damiani, just as a punctuation to his talk this morning.

One of the things that we tried to do with this conference was to ask a really distinguished group of speakers to think thoughtfully about conservation genetics where we ve come from; where we re going; what does it mean in the Age of Genomics?

I m feeling very thoughtful today, in part, because when I was having coffee this morning, I sat down with my good friend and old colleague, Bob Lacy, and we were talking about the fact that, in the paper this morning, apparently, was an announcement about the closing of the research programs at The National Zoo.

Now, I think Bob and I looked across the table a bit uneasily at each other, since, you know, he and I that s what we do for a living. And the notion that it would be sort of looked at as either so irrelevant or unimportant, or whatever as to disappear probably struck us in a way that s a bit different from how it might strike some other folks. And, so, with that being said, I wanted to, you know, share some of my thoughts about this field and where I think we re going.

I realized, also, that the last time that I got up to give a presentation that wasn t a data presentation, or with data slides, was when I gave an address at my 8th-grade graduation which was 31 years ago. And that s probably the appropriate frequency that I should give such talks. But, that said, I ll go on.

The debate over reductionism versus holism has been ubiquitous among the different disciplines within biology. As a technician and graduate student in evolutionary biology at Yale University, this debate dominated our intellectual environment. I worked, learned and resided in Osborn Memorial Laboratories, which then housed the ecologists and evolutionary biologists.

Evelyn Hutchinson s and Charles Remington s presence provided links to the past, while we excitedly explored the cutting-edge technologies of isoelectric focusing. And then leapt to southern blotting, as we sought to understand evolutionary processes by examining and characterizing genetic variation. Admittedly, at times, a bit indirectly.

Osborn Memorial Laboratory is an old stone building, looking a bit like a medieval castle, sitting at the bottom of Science Hill the geographical high point of the Yale campus. And high above us on the hill, casting an enormous shadow, was the modern 14th-story brick-and-glass monument to biological reductionism Klein Biology Tower.

It was here that the secrets of living systems were being revealed by examination of each individual molecule. Those of us who continued to hold faith in our core belief as Dobzhansky said: Nothing in biology makes sense except in the light of evolution criticized the small-mindedness of the Tower s reductionist approach. While adopting their techniques as ours, and watching most of the funding go to them.

While it remains unclear how much we are a product of our environment, it certainly plays a significant role in how we view the world. And this experience certainly shapes how I feel the field of conservation genetics needs to evolve. The ever-expanding impact that humans have on the environment, and the concomitant extinction crisis, is the reason why many of us turned our interests in the natural world to a calling in conservation. While we frequently talk about this as some sort of objective, reasoned decision, it can only honestly be viewed as a subjective appreciation for living systems that continue to persist in human-dominated landscapes. However, the current trend is obviously clear to anyone who shares this admittedly subjective appreciation and concern.

At the beginning of the conference, Bill Conway provided us with the facts and figures, as he has so often in the past, that reinforced the bleak future that confronts us. And, yet, so many of us feel compelled to marshall a challenge to these trends. Though I frequently wonder if the notion that it is within our power to alter this future is not simply just another example of the remarkable hubris that seems to define our species.

As everyone who has thought about and discussed conservation has observed, it will require changes in commitments from nearly every element of human society to implement meaningful and sustained conservation. As is natural, those who respond to the calling look to their own interests and talents, as they seek to make a contribution to this effort.

Conservation biology arose out of the notion that traditional disciplines within the biological sciences could provide important insights and tools for this conservation effort. While I believe that most humans think of science as a set of facts that change with sufficient frequency as to cast doubt on their certainty in the belief of that set, scientists tend to be committed to the discipline and process of science as one that has enormous explanatory power. And that is grounded in sufficient objective and repeatable rules as to distinguish it from cultural superstition and other nonscience systems. Since the goal is to conserve living systems, it seemed especially logical to conclude that science would be a necessary, if not sufficient, component of a successful conservation effort.

Those of us who had an interest in and understanding of population genetics, evolutionary biology, combined with a conservation ethic, saw the emergence of a new discipline, conservation genetics, as a specific and obvious example of the value of this new conservation-biology paradigm. Populations that were declining in numbers, while becoming increasingly fragmented, would be subject to the effects that result when genetic variation declined, individuals become inbred, and natural patterns of dispersal and recruitment are disrupted.

Using theoretical and experimental methodologies from these established disciplines, scientists including many in this room helped conservation managers by documenting and exposing intrinsic genetic threats in specific endangered species, by more accurately identifying the natural distribution of genetic variation, both below and above the species level, and by providing insights into the complexity of these living systems.

Interestingly, to many conservation geneticists, this discipline has been viewed as a high-tech approach by other conservationists and even by other conservation biologists. In fact, conservation genetics has seemed always to be associated with a controversy pitting the hyperbole of overstatement of its importance by its proponents, contrasted by the implication of statements, such as Michael Soul s, that there is no example of a successful high-tech approach to conservation.

This intramural debate within the conservation community was elevated to near-civil war proportions by Graham Cauley s posthumously published paper relegating the argument to his division of declining versus small-population paradigms. And the implication that a focus on detailed read molecular-genetic analysis and examination of intrinsic biological factors was of less or no importance in comparison to examining the broader anthropogenic reasons for the species decline.

This argument, taken a bit out of context, became a classic straw-man debate on both sides. When it is obviously clear that to understand and ameliorate the threats it was necessary to examine and research each conservation challenge as a single problem rather than to artificially divide it into two competing paradigms.

This brings us precisely to the point that I would like to make about the direction that conservation genetics needs to follow if it is to contribute more substantively to conservation of biodiversity. What we need to do is move towards a greater integration of research and synthesis with the other disciplines of conservation biology and conservation management and we need to continue and expand it in a holistic framework.

In the debate concerning reductionism versus holism in ecology, it was the notion that ecosystems have emergent properties that could not be understood by only examining their components. Similarly, conservation issues involving such complex systems will have even a greater need for attention to be paid to the interrelationships of biological and nonbiological phenomena, in a way that is challenging to traditional science.

However, this is not a call for less detailed or less basic research. On the contrary. We will need to bring renewed efforts of applying the highest-quality scientific research to these complex problems, while attempting to elucidate and modify human impacts on these systems. We start down a slippery slope when we try to artificially divide applied and basic conservation research. We must resist the tempting but simplistic call for cookie-cutter approaches based on the conservation paradigm of the week. It reduces the opportunity to make the novel discoveries necessary to better understand the impact of our actions on these complex systems.

In the Age of Genomics, we find both opportunities and challenges to moving forward in this direction. The opportunities primarily lie in an increased capacity to rapidly accumulate data, to test the numerous hypotheses, and answer questions confronting conservationists. Other opportunities include the development of some novel ways of manipulating living systems.

However, there are a great many challenges. In terms of data collection, one of the challenges will be to not simply lose sight of the endangered forest, as we genetically characterize every single tree. Another challenge is to avoid letting the press and the public s fascination with genetic manipulation lead to a false sense of optimism and hope for a technological solution to this extinction crisis. It is also important that we avoid allowing technological manipulation of individuals to further separate these organisms from the environments in which they are uniquely connected and defined.

The overriding message is that context and connection is the necessary framework. We have now largely sequenced the human genome, a technologically remarkable achievement but we remain challenged by what the sequences do not yet reveal. Back in Klein Biology Tower at Yale University, one of my old colleagues, Frank Ruddle, is beginning to think that some of the answers lie in what we used to call junk DNA. This is clearly a less reductionist approach. And whatever genomics has to offer to conservation genetics, it is not a call to further reductionism.

I remain optimistic that we are beginning to head in the right direction. In recent years we have seen a merging of conservation genetics and ecology in the new field of molecular ecology. Using molecular markers to better understand the life-history traits of organisms that are difficult to observe directly provides a very powerful way of understanding behavior, ecology and genetics simultaneously. Similarly, molecular forensics applied to the trade in wildlife integrates an understanding of human behavior and the law, while giving insights into species distributions and other biological information.

In our own program here in New York, we have moved to using a very different approach than when I began nearly 13 years ago. Sometimes I worry a bit. It s more difficult to administratively wrap hands around our program in this less-reductionist approach since a few of the lines are a little more blurred, as I strongly feel that they should be.

I ve never felt that the program was precisely a genetics program nor that it should be. I understood why the administration was comfortable describing me as a geneticist which is murky enough even though I always felt that I had been trained and was an evolutionary biologist.

Our program has become an authentic combination of population biology, genetics, systematics, molecular ecology and forensics. Our staff postdoctoral fellows and graduate students come from varied backgrounds. But nearly all have authentic field-research experience, excellent laboratory skills, and are broadly trained in interdisciplinary approaches in biology. They are encouraged to develop conservation programs that bridge the basic research in science with a conservation-management and training focus.

Our experiences and successes have taught us to resist the institutional push to reduce this work to more service-oriented, uncreative routine analyses that, ultimately, will not result in high-quality work or synthetic understandings of biological processes necessary for conservation.

A few brief examples are illustrative of this approach. Science Resource Center biologist Howard Rosenbaum continues to direct a major cetacean conservation project that includes molecular genetics, population biology and demography, GIS, remote tracking, local training, graduate-student training, capacity-building and ecotourism.

Another example is provided by a Columbia University graduate student in our Science Resource Program. Michael Rusello has developed a novel microsatellite marker for endangered St. Vincent Amazon parrots; optimized a method of noninvasively sexing the birds; worked with Bronx Zoo staff and resource managers on the island of St. Vincent to genetically manage the XE2 population; has revealed illegal smuggling of birds by genetic testing; will be conducting ecological studies in the eastern Caribbean in a few weeks; and is collaboratively working on a long-term, on-the-ground conservation effort with local NGO s and other NGO partners.

These two examples reflect how our program has tried to encourage, and train a new and different generation of conservation geneticists. In all of our current projects we seek to find that greater understanding, or application, to effect conservation.

Over the last couple of years we received a lot of press attention for the work that Mary Egan did in our program describing new species of deer from Southeast Asia, in collaboration with George Schaller and Alan Rabinowitz in our field-research program. However, this was never a research project about deer taxonomy and systematics nor about the excitement of new discovery. It was a well-articulated and novel attempt to add rigor to prioritizing areas for conservation, based on measures of species richness and levels of endemism. We sought to demonstrate that linking molecular genetics and systematics with biological surveys could result in an enhanced protected-area strategy.

Finally, we found that an important strategy to using a holistic approach was to develop meaningful strategic partnerships. Our primary one has been our long-term collaborative relationship with The American Museum of Natural History and Rob DeSalle s molecular-systematics program. Also, The Museum s Center for Biodiversity and Conservation has provided support for additional collaboration with Museum scientists and staff. Cathy Lehn from my department is currently developing new important partnerships with this museum, as well as with other institutions. Our program linkages with Yale, Columbia, New York University and Fordham University add immeasurably to these efforts, while providing conservation context and experience for students in these programs.

While I have used our own program to illustrate these goals, I do want to acknowledge that we have been inspired and learned from many creative colleagues, including individuals in this room today. As conservation genetics continues to evolve as a discipline, we need to be open to new, more integrated approaches; a further integration with ecology and other subdisciplines of biology; a further integration with the abiotic issues in conservation; and a holistic, systems-based approach, utilizing all of the innovative techniques synthesized from our past successes and failures.

We must avoid unnecessary intramural wrestling matches while developing collegial strategic partnerships. In this way we position ourselves to better understand these living systems, the effects of human impact on these systems, and the options that are open to us to conserve significant elements of these systems into the future.

Thank you very much.

(Applause)