Proceedings of the Special Meeting of the Amur tiger EEP

Moscow, November 2-3, 1995

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Russian version available; translated by Tanya Arzhanova of Moscow Zoo

German version available; translated by Petra Wesuls of Leipzig Zoo

All three versions have been produced in limited numbers.
Each institution participating in the Amur tiger EEP will receive one copy; supply of further copies is subject to availability

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Introduction

Sarah Christie, EEP Co-ordinator for the Amur tiger

On November 2nd and 3rd 1995 a Special Meeting of the Amur tiger EEP (European breeding programme) was held in Moscow with the assistance of a grant from the Save the Tiger Fund, a joint project of the US National Fish and Wildlife Foundation and Exxon International. The Proceedings of this meeting are presented here.

The purpose of the meeting was to improve the operation of the Amur tiger EEP, with particular reference to those participants in the CIS. To this end, informative presentations on various aspects of tiger conservation, in zoos and in the field, were given, using simultaneous translation facilities throughout. These Proceedings contain the texts of the presentations.

The November meeting was not limited to presentations; another very important aspect was the formation of working groups, co-chaired by one Russian and one English speaker, to discuss problems in various areas of the operation of the EEP and formulate possible steps towards solutions. The recommendations of the working groups were compiled into an Action Plan for the Amur tiger EEP and this will be implemented in 1996, again with the aid of a grant from the Save the Tiger Fund.

The full text of the Action Plan is not included here as it has already been circulated to all interested parties. It involves the supply of educational materials such as a slide set and tiger graphics panels to all Amur tiger EEP participants in the CIS and Eastern Europe; the translation into Russian and distribution in the CIS and Eastern Europe of the SSP/EEP manual "The Management and Conservation of Captive Tigers"; translation and distribution of other papers on various aspects of tiger conservation; the first steps towards the setting up of a Russian Zoo Veterinary Group; the provision of a limited amount of vitamin and mineral supplements and hand-rearing equipment; and a visit to a limited number of zoos in the CIS by the "EEP Tiger Support Team", which will consult closely with curators, keepers and veterinarians at all zoos visited, anaesthetise tigers, fit transponders, give any treatment necessary, take blood samples for disease testing and genetic work, and ejaculate male tigers for semen storage as part of the EAZA Research Group's plans for a European Genome Bank for endangered species.

There have already been great improvements in communication and co-operation in this important breeding programme as a result of the meeting, and implementation of some of the working groups' recommendations has begun. A number of important policy points have also been settled; for example, an Amur tiger EEP policy on "problem" wild tigers was formulated during the meeting at the request of Mr Valentin Ilyashenko of the Moscow State University (and was circulated in the Action Plan). The EEP has also been able to assist in the analysis of data gathered in the census of 1996, by providing pugmark measurements from Amur tigers of known age and sex to add to the reference dataset used by the field workers.

Overall this project has so far been a great success. I very much look forward to continuing to work with everyone concerned over the next few years, so that between us we can bring about further improvements; in tiger welfare and breeding success; in co-operation with Amur tiger field projects; and in the provision of informative tiger education materials to the Russian public, through their zoos.

Opening address

Vladimir Spitsin, Director, Moscow Zoo

I am glad to be able to greet you at the opening of the Special EEP Amur Tiger Meeting in Moscow. We realise that we have been honoured with hosting the meeting mostly due to the fact that this subspecies, which is one of the most rare and beautiful tigers in the world, is still found in this country, in the Prymorye and Khabarovsky regions in the Russia Far East. This definitely increases the responsibility of our zoos to the world conservation community in regard to the future of this wonderful species.

Quite recently at the Conference of the World Zoo Organisation - The International Union of Directors of Zoological Gardens - the basic strategy was clearly formulated with regard to the zoos' participation in the breeding programs for rare and endangered species, and their role in the preservation of biodiversity has been determined. The evolution of Zoos, which has always followed the historical processes occurring in this country and in the whole world, has clearly affected many aspects of the public attitude towards captive animals and their role that they are supposed to play. The last two decades were marked by especially radical changes in the public perception of the role of Zoos in conservation. The Amur tiger represents one of the species for which captive breeding programs can become a powerful means in the struggle for their survival.

Since the first Zoos appeared in Russia, the Amur tiger has historically been one of the most typical exhibits, and of course it was also one of the most impressive representatives of wild fauna. Since 1976 and towards the end of 1980s, there was a clearly defined increase of the Amur tiger population in the Zoos of the Soviet Union, and later of the former Soviet Union, followed by a drastic decline of the number of animals kept by the Zoos of the area during the first half of the 1990s. At this time I do not have to go into a detailed analysis of this phenomenon proceeding from the universally accepted principals of running captive breeding programs, since we are going to hear and discuss serious reports by highly qualified specialists from Europe and the USA, but I would like to note the correlation between the numbers of the captive population and the social and economic changes that have taken place in this country during the last decade. The situation that our Zoos have now found themselves in is quite difficult, while at the same time it should be noted that the Moscow Zoo is one of the few happy exceptions, thanks to the tremendous support provided to us by the City government and its Mayor. I would like to hope however, that even under those strained circumstances, the staff and the administration of these zoos will do their best in order to fully participate in international and European conservation programs, and the reason that I can have this hope is the great interest for this Meeting that has been displayed by former Soviet Zoos.

We are all fully aware of the fact that in the modern world that is threatened by a deepening ecological crisis and is facing habitat destruction and the extinction of many species, international cooperation is an indispensable condition for the preservation of wildlife on the planet. We have gathered here at this meeting in order to discuss the ways of such cooperation and to develop a strategy for optimum solutions for the most critical problems that we are now facing while implementing the program for the conservation of this most wonderful species, the Amur tiger.

I would like to wish us all a successful meeting, which should enable us to take another step towards the preservation of wildlife on our planet.

A request to the Meeting

Mr Valentin Ilyashenko, Director of the Department of Biological Resources and Deputy Head of Management Authority for Russia CITES.

In recent years the preservation of the Amur Tiger has become an especially critical problem for the Government of the Russian Federation. Since the middle of the 20th Century tiger hunting has been forbidden, and in the early 1980s the Amur Tiger was included in the Red Data Book of the USSR and that of the Russian Federation as an endangered species. There is a penalty that equals 200 minimal salaries for poaching, trade or export of the tiger. The Amur Tiger inhabits some strictly protected areas, including the Reserve Sikhote-Alinsky (349 950 ha), Lazovsky (120 000 ha), Ussuriysky (40 400 ha) and Kedrovaya Pad' (17 900 ha).

Thus the regulations for the preservation of the tiger seem to be sufficient for tiger preservation. However, unexpected problems have developed due to the break-up of the Soviet Union and Russia's transition to market economy. The transparent borders between the newly independent republics of the CIS, relaxed customs regulations at the Russian-Chinese border and tens of thousands of illegal immigrants from China, Korea and Vietnam living in the Russian Far East have created an exaggerated demand for products used in eastern traditional medicine and their smuggling. While according to the official data, 5 to 7 tigers were poached annually earlier, now these numbers are estimated at 25 to 30, and according to some experts, even 70 - 100. However, this last estimate is hardly reliable, since the total number of tigers in the wild in the two recent decades was estimated by experts at 150 - 200 specimens.

Proceeding from the above, in 1994 the Ministry of Protection of Environment and Natural Resources of Russian Federation, with financial support from WWF Germany and from the Tiger Trust, created the Department for the Control of Poaching and Illegal Trade in Tigers at the Primorsky Krai Committee for Environmental Protection. There are plans to create a similar Department in Khabarovsky Krais in charge of implementing additional special measures for the conservation of the tiger and other rare and endangered animal and plant species of the Far East, including the control of poaching and smuggling. These measures include plans to conduct a survey in the winter of 1995-96, as well as the development of a national conservation strategy and of an action plan for the preservation of the tiger.

One of the major problems is presented by the more frequent tiger encounters by people, which is caused primarily by the extensive use of natural resources of the Far East. Forced shooting of "problem" specimens and poaching result in orphaned cubs. Besides, conservation organisations regularly receive permit applications from zoos for the capture of tiger cubs for their collections.

Considering the above, I am asking the Conference to include in its resolution that a competent international organisation should develop and submit to the Russian CITES Authorities a detailed proposal stating if there is a demand for wild tigers among world zoos, and what that demand is, including a list of those zoos; financial support should be provided for the holding and shipping of those tigers. This equally concerns the Amur leopard, the Steller's Sea Eagle and other endangered animal species.

Editor's note;

The relevant working group at the meeting discussed this request and formulated a suitable policy, which was later agreed by the meeting in plenary session. The full text of the policy can be found in the Action Plan; briefly, it states that tigers should remain in the wild wherever possible, that the Amur tiger EEP (and indeed the global captive population) does not need and is not requesting further founder stock; but that in the case of a problem tiger having to be removed from the wild by the authorities the EEP will of course do its best to locate a suitable home

The International Tiger Studbook as a basis for regional and global breeding programmes.

Dipl. Biol. Peter Müller, International Tiger Studbook Keeper

History

In 1966, it was suggested to initiate an International Studbook for the tiger. There were two zoos applying for this studbook at that time; besides Leipzig Zoological Gardens, Prague Zoo was also willing. After its meeting in June 1966, IUCN entrusted this honourable task to Prague Zoo on September 1. An external staff member of Prague Zoo, Dr Vratislav Mazak, was appointed administrator of the studbook.

Originally, the studbook was to contain only the rare and threatened subspecies *P. t. altaica, P. t. amoyensis, P. t. balica, P. t. sondaica, P. t. sumatrae and P. t. virgata* - so excluding *P. t. corbetti* and *P. t. tigris* - according to the agreement between the IUCN Species Survival Commission and Dr Mazak; it was therefore begun under the title "Studbook for the rare subspecies of the tiger". The compilation of the primary data was very difficult, especially since he had to find out the relationships between the animals with the help of animal reports of different thoroughness from the individual collections, and he had to find out the origin of the ancestors. Only when all these questions were solved could the individual tigers be entered into the studbook as proven pure-blooded representatives of their subspecies.

Unfortunately, without having published the studbook, Dr Mazak had to give up the responsibility in 1972 because he could not manage this workload as well as his professional tasks any longer. In September 1973, all documents compiled by this time were given to Leipzig Zoological Garden. Professor Dr Siegfried Seifert, then the Director of Leipzig, was entrusted with the studbook keeping while I was made responsible for studbook data processing. By 1972 Dr Mazak had registered 428 Amur tigers and 12 Sumatran tigers.

The first edition entitled "International Tiger Studbook 1976" was published in 1976; it was already intended to expand the registration to all subspecies, which was considered absolutely necessary because of the stock situation. Since 1976 the tiger studbook has been published every year - in 1976, 1980, 1985 and 1990 as a general register, and in the years between as a supplementary volume containing only the stock changes in the previous year.

Since the 1980 studbook we have not used the term Siberian tiger any more - it was then usual and is still in heavy use in the English-speaking countries. We refer to the subspecies as the Amur tiger - it roams in the area around the river Amur, while the geographical region of Siberia was never part of its range. After Professor Siefert's retirement in 1993 I was appointed studbook keeper and have been supported by my assistant Petra Wesuls since then.

Organisation

The International Tiger Studbook is one of the oldest studbooks, after those for European bison (1923) and Prezwalski's horse (1960), and has developed into the most voluminous of all with more than 6000 registered individuals. Therefore it became necessary to organise data compilation and printing preparation through the SPARKS 1.3 computer programme in order to be able to manage the work. Consequently the 1995 General Register, the 20th edition of the International Tiger Studbook, is published for the first time in a new format and a slightly different presentation. In order to guarantee clarity, it contains all tigers registered so far and the individual data has been compared and synchronised with that in ISIS and in the regional studbooks, so the data are confirmed.

Necessity

The tiger stocks in the habitats of individual subspecies had noticeably recovered in the 1970s and 1980s (e.g. Amur tiger, Indian tiger, Indochinese tiger); and on the other hand the number in zoos had grown so much that it already became difficult to place offspring reasonably (especially with Amur tigers), so one could have asked whether a large-scale studbook like this one was really necessary at all. Since then the situation of the wild stock has deteriorated again, dramatically, because tigers are hunted or poached in large numbers in order to sell their body parts for usage in traditional Chinese medicine. The latest estimates for 1994 are between 6 and 7 thousand individuals overall. However, the situation in the wild is only one reason to continue studbook keeping. Additionally, it is of eminent importance to gather all recordable data and information in order to create a basis for pure subspecies breeding and to manage the populations under human care, thus for example keeping genetic variability at its highest possible level.

Problems

At the end of every year we send out the latest edition of the International Tiger Studbook together with announcement sheets. We ask all owners we know who keep clearly pure-bred tigers of the five subspecies to provide information about the tiger stocks and their changes in the previous year. The data supplied by zoological gardens, safari parks and also circus enterprises or private persons, are compared with data received from regional co-ordinators and studbook keepers, respectively, and the semi-annual Studbook Keeper Update Report (SKUR) supplied by ISIS. After this the data are published in the new edition of the International Studbook. Differences, unavoidable with such varied sources, are cleared by corresponding enquiries. The CD ISIS Specimen Reference sent out by ISIS for the first time this year proves to be a powerful tool when clearing smaller discrepancies like transfer dates etc. However, in any case where it is not possible to clear up inconsistencies we decide in favour of the most original and direct information, i.e. that supplied by the owner.

Since the International Tiger Studbook, unlike most of the other studbooks, is published regularly, containing data current to 31 December of the previous year, we would like to ask the tiger owners to send the first announcement to the International Studbook Keeper -

perhaps concurrently with that to the regional co-ordinator. For the analysis, it is important that the information is identical, complete and exact, including stillbirths and cubs that died young etc. In order to promote later biological and veterinary analysis on a rather wide dataset, we are grateful to receive birth weights and post-mortem data etc.

Normally, an ARKS Taxon Report is sufficient for the annual announcement. Only if an animal died or if a lot of individual data (e.g. about rearing) are entered in ARKS does it make sense to send in Specimen Reports. If the data are received every year, information about the changes in the last year is quite sufficient, there is no need to send a historical report! But if you have newly entered data about your historical tiger stock that had not been in ARKS before, please send us a historical report - once. When doing this it is necessary to include the International Studbook numbers in your ARKS data, because it makes our work - the clear attribution of information - considerably easier. From the opposite point of view, we include local IDs in the studbook, now that we are working with SPARKS, so clear identification of the individuals becomes easier for every user of the studbook, with the help of the studbook number and the several local IDs each animal gets in the course of its life. Here we would like to ask you to understand that not all local IDs have yet been entered. In the previous months a number of zoos sent us historical reports, which we have not yet been able to process. Please, allow us to point out that changing ARKS accession numbers means an enormous amount of additional work. Therefore we want to ask you to stick to local IDs once these have been assigned. The above hints and requests refer mainly to ISIS members, but of course all studbook announcements made on our announcement sheets are just as welcome as computer printouts.

Unfortunately there are tiger owners who never, seldom or irregularly announce their stock to the studbook keeper. These are mostly private persons, circus enterprises and safari parks but also include zoological gardens. Additionally, there are some animal dealers who do not inform us - not even on direct request - where each animal went. Since these tigers are uncertain for breeding planning or even lost, all tigers about which we are not informed for two consecutive years are excluded from the current stock, and therefore their owners do not appear in the owners list. All unconfirmed tigers are declared dead 20 years after their birth.

Missing or irregular announcements lead to inexact analysis like, for example, a peak in the mortality rate at 20 years. When animals leave the actively manageable population by being disposed of to private persons, or institutions that don't announce their stock, the breeding basis and thus the genetic basis is reduced.

The International Studbook is to serve as the foundation for scientific analysis and findings, for regional breeding programmes as well as for a global breeding plan. Only when receiving comprehensive, exact and modern data can it meet this requirement. Yet it can only be as good as the preparatory work by the tiger owners allows it to be!

Regional Amur tiger breeding programmes.

On the basis of the International Studbook a number of breeding programmes developed which ought to be shown in a summary here. In 1983, the Siberian tiger Species Survival

Plan (SSP) was brought into being by Dr Ulysses Seal as a first model for a regional breeding plan in North America. He got this idea and encouragement at the International Tiger Symposium held in Leipzig in 1978. Responsible Co-ordinators are Ulysses Seal and Ronald Tilson (Minnesota Zoo). Since 1988, an SSP journal has been published - Tiger Beat. In 1994, a comprehensive publication titled "The Management and Conservation of Captive Tigers" was edited under the responsibility of R Tilson in the framework of the tiger SSP.

The Amur tiger EEP was decided upon at a meeting in Leipzig in June 1985. Dr Georgina Mace (Regent's Park, London), was appointed Co-ordinator. After five years she could not continue with this work due to other tasks. So at the EEP meeting in Cologne in 1990 I was entrusted with the work additionally to the International studbook keeping. After having been appointed Director of Leipzig Zoological Garden in January 1993 I was not able to manage both functions, so since then Sarah Christie has been responsible for the Amur tiger EEP - hence this important work is being done at Regent's Park once again.

Within the JAZGA, the Japanese Zoo Association, a Siberian tiger breeding plan was started in 1988, co-ordinated by Takashi Miyake (Shizuoka City Nihondaira Zoo) and Madayoshi Gondo (Kobe Oji Zoo). In October 1994 the position of SSCJ Tiger Co-ordinator was taken over by Shinji Yasuda, also from Kobe Oji Zoo.

Relations between International and Regional Studbooks

During recent years separate publications with stocks of the corresponding subspecies in the zoos of the regions concerned were published by some regional co-ordinators or other appointed regional studbook keepers, partly containing extensive analysis and detailed recommendations. All these editions are based on the International Tiger Studbook and contain, additionally, data announced directly to the regional studbook keeper. Inevitably this is a source for mistakes or differing information so a regular and co-operative data update between the international and regional studbook keepers is vital, though not yet optimally realised in all cases so far. It is to be desired that before entering new tigers into a regional studbook their data be sent to the international studbook for comparison and correction.

Another problem arose through the regional studbook numbers, like those used in the Japanese Amur tiger studbook or in the Indian Bengal tiger studbook. In future they should be clearly marked as regional numbers. Moreover, it is absolutely essential to include the international studbook numbers in a separate column, in order to enable cross-comparison and prevent confusion. For this reason, we state regional studbook numbers in the 1995 edition of the International Studbook.

Global Breeding Plan

In order to guarantee an indispensable world wide co-ordination of tiger breeding, in 1985 Ulysses Seal, the AAZPA Conservation Co-ordinator Tom Foose and the International Studbook keeper proposed that a Global Tiger Survival Plan be produced. In April 1986, at the meeting about World Conservation Strategies of Tigers in Minneapolis/St Paul, this proposal was confirmed. The first draft, produced by Ulysses Seal, Peter Jackson and Ron Tilson, was published in 1987 in "Tigers of the World", the proceedings of this conference. On behalf of CBSG and the IUCN SSC, Ron Tilson, Tom Foose, Frank Princeé and Kathy Traylor-Holzer advanced this draft to the Tiger Global Animal Survival Plan (Tiger GASP) and presented it at the international Tiger Workshop following the Edinburgh EEP meeting in 1992. The Tiger GASP Committee, led by Ron Tilson, Global Tiger Co-ordinator, consists of the International Studbook Keeper, all regional co-ordinators, Ulysses Seal (Chair, CBSG) and Peter Jackson (Chair, Cat Specialist Group). A revised version of the Tiger GASP was presented in September 1993 after the CBSG meeting in Antwerp.

In addition to the International Tiger Studbook, the Tiger GASP also takes into account the wild stocks, and integrates the corresponding conservation measures. Numerous activities were also initiated and organised by our American colleagues in Russia (international symposium about the Amur tiger in Chabarowsk - March 1993), Indonesia (Captive Breeding Workshops in Padang and Bogor - November 1992), and India (international symposium about the tiger in Delhi - February 1993), during recent years. Unfortunately the International Studbook Keeper was not invited to co-operate in these measures and events.

Final remarks

Besides all the conservation efforts in the wild, the optimal development of the tiger populations kept in zoological gardens is of special importance, yet the reintroduction of this dangerous large carnivore is impossible because of habitat destruction, missing prey base and the proximity of human settlements. The international and regional studbooks form the indispensable foundation for this development. Their exact data serve as a basis for all breeding programmes and hence for the conservation of tigers under human care. On the other hand, experience in keeping and breeding tigers gathered by zoological gardens can result in conclusions regarding conservation measures in the wild. So I would like to ask all of you to contribute to the huge project of conserving one of the most impressive and beautiful animal species by regular, exact and complete announcements to the International Tiger Studbook!

EEP: European Zoos care about the conservation of endangered animal species.

Drs Koen Brouwer, Director, EAZA/EEP Executive Office

Introduction

Approximately 100,000,000 people visit the some 300 zoos throughout the European breeding program region yearly. The ready availability of the zoo network - extending from Finland to Italy and Ireland to the former Soviet republics - makes it possible for the great majority of people, whether young or old, rich or poor, to make a zoo visit on a regular basis. They have the opportunity to develop a feeling for the amazing diversity of life, and the necessity of preserving the creatures they see, their co-habitees in nature, and the environments in which they exist. Providing the public with this opportunity is the most important role that the zoo network can play in nature conservation. There is no other institution or medium that can bring home this message so forcefully to such a large number of people.

Animals for zoos

The contribution that zoos can make in nature conservation is dependent on the presentation of live animals. However, the maintenance of live animal collections is no easy task. One characteristic shared by all animals is that sooner or later they die, regardless of the quality of care that they receive. It was a simple matter to obtain replacements for lost specimens in former times; they were simply imported from the wild. This has become increasingly impractical in recent years for a number of reasons. In the first place, some species have become exceedingly rare due to human hunting pressure and/or destruction of their habitats. Even if zoos were willing to pay exorbitant sums to receive such animals, they would be difficult to find. Secondly, and most fortunately, more international laws have been created that regulate wild animal trade, thus providing strong protection for threatened species. Thirdly, good zoos feel a moral responsibility to keep the importation of all animals from the wild, threatened or otherwise, to an absolute minimum.

Therefore, zoos now strive to build up and maintain self-sustaining captive populations that do *not* require the addition of new specimens from the wild. Achievement of this requires efficient management on several levels. The most basic is that individual animals must be guaranteed a long life of quality. On the second level, breeding pairs or groups must be managed so that reproduction is sufficient to assure the continued viability of future generations. On a world wide scale, the total zoo population of each species must be managed.

It is clear that the first two levels relate to quantity, or to population sizes of the animal species in the zoo. It is only possible to maintain adequate numbers if animals do not die prematurely and reproduction is successful. Much attention must consequently be given to important management factors such as housing, feeding, medical care and the establishment of suitable breeding pairs or groups of animals. Zoo personnel draw on the knowledge and experience accumulated through more than 150 years of zoo history to approach management problems.

Zoos continue to collect useful data through new experiences as well as research in all areas of biology and veterinary science. In this age of serious animal management, communication between zoos to disseminate useful information is increasingly important. Gone are the days when zoos could afford to be secretive and competitive; cooperation is now an essential management tool.

The third level of management deals not with quantity, but rather with quality of zoo animal populations. Conservation of a threatened species is not only a matter of having sufficient numbers of individuals, but also of preserving the original characteristics found in wild populations. This is not easily accomplished, and now zoos are working together to meet this objective through formation of co-operative breeding programs.

EEP: European breeding programs for threatened species

For zoo visitors to have the opportunity to see how wild animals look, live, and behave, zoos must ensure that truly wild animals, with all of their natural characteristics, are presented. Zoo animals are vulnerable to three very serious breeding problems inherent to small, artificial populations: inbreeding, loss of genetic variability, and unnatural selection. These problems can easily result in loss of original wild traits, and in the expression of heritable abnormalities. If what was once a pure, wild population of animals deteriorates through generations of uncontrolled breeding into inferior or partially domesticated stock, then the animals are no longer suitable for any conservation effort, and the zoos have failed to perform an important educational task.

Fortunately, the effects of breeding small populations of wild animals in zoos over periods of many generations has been well studied in the past ten years, by researchers both within and external to the zoo field. Based on these studies and genetic theory, guidelines for breeding such small populations have been developed. Following such guidelines should sharply reduce possibilities of above-mentioned breeding problems and concurrently should maximise the number of generations in which the original wild traits can be maintained. Guidelines for small populations follow some basic principles: For example, it is highly desirable to begin with as many "founders" for the population as possible, preferably at least several tens of animals. The number of individuals within the population should be rapidly increased, and all individuals from the founder population should have "equal genetic representation" while inbreeding of closely related individuals should be avoided. It is important that the number of males and females in the breeding population remain balanced.

The application of these guidelines, and many others tailored to specific populations, results in strictly controlled breeding programs in which nothing is left to chance. Only in this manner can healthy and truly wild populations be maintained over a period of one or two hundred years. Such strict control is entirely dependent on cooperation among zoos that hold individuals of the species, as single zoos generally do not have the facilities to maintain a population of adequate size independently.

It is in fact usually the case within Europe that not even all of the zoos within one country have sufficient numbers of individuals of a species to manage it well. Thus, international cooperation in breeding programs is necessary, and to this end the EEP organisation was formed in 1985.

The EEP, an abbreviation of European Endangered species Program", has been the official breeding program of the European Association of Zoos and Aquaria since March 1992. Programs for seventeen species, such as the Przewalski's horse, the European otter, the Bearded vulture and the Amur tiger, were undertaken by the organisation in 1985. The number of taxa targeted has steadily increased to over 150 since then, and assuming the trend continues, programs for some 200 species will be underway by the year 2000. The EEP programs are directed towards species threatened in nature, as these are most critically in need of such efforts. It is important to protect as many of these species as possible in zoos, where they can fulfil their important roles as ambassadors of nature conservation.

Within the EEP framework, a "species coordinator" is appointed for each species program; usually this individual is an employee in one of the participating zoos, and is an expert on the species in question. The coordinator compiles a studbook that includes a listing of all individuals of that species held by European zoos, together with all the relevant information about each individual, including all data concerning kin and offspring. This information is then analysed: family relationships and past breeding are assessed, sex ratios determined, and degree of inbreeding are calculated. The representation of different lines stemming from the "founder" population are scrutinised; some lines may be over-represented while others are under-represented. Numerous such calculations are made, and the entire procedure can become quite complicated, particularly if the species in question has been breeding in zoos for many generations. Fortunately, the species co-ordinator's task is made easier through the use of specialised computer software, such as ZRBOOK and SPARKS, that is designed to assist in data input and processing.

The interpretation of the analyses is far from simple, but the species coordinator is aided in this endeavour by a "species commission", made up of five to ten elected representatives of participating zoos and other institutions from different European countries that have experience in keeping the species in question. Based on the analyses, the species coordinator and commission recommend strategies for breeding the species in the upcoming year, determining which animals should breed, but also which animals should <u>not</u> breed in a given year or period. Further logistics that need to be worked out include: which animals must be exchanged between zoos so that they can reproduce but will avoid inbreeding. In which genetic lines should breeding be discouraged or stimulated? Is it necessary to rapidly increase the population size at this time? Are there currently sufficient facilities in the zoos holding specimens, or should some more zoos be encouraged to participate in this species' program? Are the housing conditions adequate, or do they need to be improved in order to stimulate breeding? These and a number of other questions need to be answered, and breeding strategies reviewed and revised on an annual basis, according to the previous year's event.

Each year the species co-ordinators have a three-day meeting, the EEP Annual Conference, in which they come together to discuss the EEPs, and to acquaint themselves with the most recent developments in the area of breeding programs. Many of the EEP co-ordinators and their species committees also conduct special meetings for their species, such as giving them an opportunity to resolve practical problems, and to set organisational policy and recommendations.

The largest problem encountered in the functioning of the EEP organisation is undoubtedly the actual execution of breeding management recommendations: it is often difficult to develop policies applicable to an entire group of zoos (varying from 10 to well over 100 depending on the species program) when these are spread throughout several countries with different languages and laws, and with dissimilar political and economic backgrounds. Just the incongruencies in laws can sometimes make exchange of specimens for breeding purposes by two closely situated zoos a formidable task if a border happens to lie between them. Additionally, interference by animal dealers or brokers can seriously jeopardise the success of an EEP breeding program and it is recommended that approved transfers between EEP participants should not be implemented via brokers or dealers, but directly by the involved zoos.

Yet successes have been achieved: the growth of the EEP organisation has been considerable since its initiation in 1985. Now more than 375 zoos, universities and private breeders from 34 European and 11 non-European countries are involved in EEP breeding programs.

The EEP species co-ordinators receive support and guidance through EAZA's "EEP Committee", a group consisting of leading zoo representatives from European countries, currently chaired by Dr Dieter Jauch of the Wilhelma Zoo in Stuttgart. This committee sets the guidelines for the general policy and development of the EEP, it formulates procedures for the selection of species for breeding programs and for the establishment of regional collection plans. It also appoints EEP co-ordinators, studbook keepers and TAG chairs for approval by EAZA Council. The "EEP Executive Office" of EAZA in Amsterdam is responsible for the daily business under supervision of the EEP Committee.

The EEP in the world

The European EEP breeding program organisation does not stand alone. It is one of the world-wide assembly of such regional breeding programs for threatened species in zoos. The Species Survival Plan (SSP) is the North American counterpart. Australasian, Japanese, Indian and Chinese zoos all have similar programs, and zoos in other regions will soon follow these examples. Combined, there are now many hundred zoos throughout the world involved in the regional breeding programs.

Although these diverse programs in principle operate independently, there is an underlying world-wide co-ordination in the form of the "Conservation Breeding Specialist Group" (CBSG). This important organisation is one of the many "Specialist Groups" of the "Species Survival Commission", a section of the World Conservation Union (IUCN). The membership of the "Conservation Breeding Specialist Group" consists of more than 700 specialists from the captive community, wildlife agencies, and other Specialist Groups world-wide. The primary goal of CBSG is to facilitate an integrated approach to species management for conservation; thus zoos play an important role in this group's activities. The CBSG provides recommendations for which threatened species captive breeding programs are necessary, and fine-tunes the united efforts of the various regional programs in cooperation with IUDZG, World Zoo Organisation (International Union of Directors of Zoological Gardens and Aquaria).

There is a very important connection between zoos and conservation of threatened species that has led to the involvement of IUCN in captive breeding programs; this being that a number of species have become dependent upon zoos for their very survival. Some species that illustrate this point particularly well are Père David's deer, Przewalski's horse, several species of *Partula* snails and the Arabian oryx; all became extinct in the wild but are flourishing in captivity. A number of other species are not yet entirely gone from their natural habitats, but are in such jeopardy that their continuation is highly uncertain. Breeding programs undertaken by zoos, in which the animals enjoy protection from the threats facing their wild counterparts, may be crucial to these species' survival. It is particularly important in such cases to abide by breeding program guidelines that will help maintain the wild traits in the captive populations.

Slowly, nature conservation organisations have begun to look more frequently to zoos for aid in saving species that would otherwise by lost. In some cases zoos have undertaken "rescue operations" at the urging of conservationists, wherein the few remaining individuals of a critically threatened species were caught and a captive breeding program initiated, thus keeping the species from the eternity of extinction.

Back to nature?

Populations of animals should be able to remain in zoos for many generations with their wild traits entirely intact, provided that breeding is strictly controlled. Theoretically they should be able to return to their natural habitats, adjusting to the brutal selective pressures wrought by nature, after generations of relative security and protection in captivity. Such animals could be welcome additions to populations low in numbers ("restocking"), or could be used to establish entirely new groups in the wild ("reintroduction"). This would indeed be the consummate contribution that the zoo world could make to nature conservation of such species.

Ensuring the success of a project involving the translocation of zoo animals into the wild for reintroduction or restocking purposes is not as easy as it may seem. In practice, all sorts of unexpected problems may be encountered. It must be assured that the animals have indeed retained enough of their natural behaviours to enable them to survive in the wild. Will the White-tailed sea eagle still be able to capture its prey? Or will the Golden lion tamarin still know which plants are poisonous and which are edible? Another important consideration is whether or not the factors that led to the species' decline are still operating - animals should not be reintroduced until these factors no longer pose a threat. In some cases, it may be difficult to find any site suitable for reintroduction efforts, as the species' habitat has largely, or even completely, disappeared. Animals used for restocking must be disease free, and enhance the health of the remnant wild population.

It is clear that reintroduction and restocking efforts involving zoo animals must proceed with great care. A well-elaborated plan must be developed by all parties involved, such as the national and local government, nature conservation groups and the local population within the country where the reintroduction is to be attempted The animals should be extensively prepared for life in the wild proper to their release, and once released they should be closely monitored and protected for many years. Presently, reintroduction and restocking projects have been attempted for over fifty species, ranging from the Arabian oryx, Przewalski's horse and European bison, to Mauritius pink pigeons, European black vultures and Mallorcan midwife toads. The results have been variable, but the best organised programs have demonstrated that the numerous practical problems can be overcome and success can be achieved.

Thus, reintroduction and restocking do offer a realistic chance of survival for at least a number of species. However, it is an infinitesimal number. Fifty thousand species of plants and animals are now threatened with extinction, and some authorities predict that more than one million species will disappear from the earth during the coming century. With all the attention zoos can now give to threatened species, they can properly maintain only several hundred species. If this effort was maximised, perhaps a thousand species could be targeted. A futile battle, thus? We don't think so!

This brings us back to the most important function that zoos have in conservation, that of carrying the conservation message The example set by efforts with these few species is far more important than the actual number of species that are worked with. Just as the presence of threatened animals in the zoo can be useful in bringing home the idea of conservation generally, reintroduction and restocking efforts can focus attention on conservation and protection of the last natural areas in which these animals can be suitably released. The focus is then not only on the reintroduced species, but also on the entire habitat, with the hundreds or thousands of other species that occur there. This will have a far reaching impact, as people in both the country in which the reintroduction is being made and the countries providing the zoo animals are able to see that no exertions are too great to save the precious pieces of nature.

Past and Present Status, Present Threats, and Conservation of the Siberian (Amur) Tiger in the Wild

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Abstract

Viable populations of the Siberian, or Amur tiger (*Panthera tigris altaica*) now exist only in two provinces of the Russian Far East, where an estimated 335-425 individuals remain in the wild between 1985 and 1992. Although some fragmentation has occurred, most tigers are part of one metapopulation. This population is endangered by a range of issues, but poaching is the critical short-term threat, and habitat degradation is the primary long-term threat. A rapid increase in the rate of poaching in the 1990s was a direct result of the recent collapse of barriers to international trade, and overseas sales of forest products has increased with the need to develop international trade and acquire foreign currencies. The primary prey of the Siberian tiger, wild boar (*Sus scrofa*) and Manchurian elk (red deer, *Cervus elaphus xanthopygus*) probably respond differently to harvest regimes. Wild boar appear to depend on the mast from either Korean pine (*Pinus koraiensis*) or oak (*Quercus mongolica*) forests, and may require large tracts of mature forest, whereas Manchurian elk likely prefer a range of forest types.

A number of conservation actions have been implemented since 1993 in attempts to protect the Amur tiger, and the habitat upon which it depends. The Amur tiger can act as an umbrella species to protect the integrity of the functioning ecosystems and the biodiversity of this unique forest complex.

Introduction

Although the Siberian, or Amur tiger (as it is called in Russia) is well represented in zoos throughout the world, its ecology in the wild is virtually unknown outside of Russia. This is true despite considerable research by Russian biologists since the 1940s. The results of their work have remained largely unavailable to the outside world due to former political, and still existent language barriers. These same political barriers to a large extent protected a sizeable population of Amur tigers throughout the second half of this century, until 1992. However, in the last 4 years, dramatic political and economic changes have so greatly altered the balance of forces in the Russian Far East that the survival of this subspecies in the wild is now in question.

We provide a brief overview of the historical range, and recent changes in population size and distribution, as well as the primary threats to the Amur tiger. Although the threats to this subspecies are many and complex, they are by no means insurmountable. Substantial advances have been made in the last two years. We hope that recognition of these problems both within Russia and internationally will act as a catalyst for change.

Distribution and numbers of Amur tigers, past and present

Formerly, tigers ranged throughout northern China (Manchuria), the Korean Peninsula, what is now the southern portion of the Russian Far East (Primorye and Khabarovsk Krais, Amur Oblast), and west into easternmost Siberia. Somewhere in central to northern China the Amur and the South China subspecies (*Panthera tigris amoyensis*) apparently merged, but information to delineate such a merger point is now not available (Allen 1940, Houji and Helin, 1986). Although speculative, the highest quality habitat was probably originally in China, and perhaps the Korean Peninsula, where more moderate climates, and more productive ecosystems, probably resulted in higher prey densities, and therefore higher tiger densities than in the now existent range in Russia. In general, tiger densities in the absence of severe human impact are correlated with prey densities (Sunquist 1981, Rabinowitz 1993). Habitat destruction associated with burgeoning human population growth in China and Korea in the 19th and 20th centuries, in concert with a demand for tiger parts for traditional oriental medicines, probably acted together to bring the demise of the tiger in much of its original habitat.

Houji and Helin (1986) believed that as late as the 1940s and 1950s there were still 4000 South Chinese tigers in China, but do not provide an estimate of the Amur tiger population in China. In 1974-1976, Ma (1979) estimated that 150 individuals still existed in north-east China, 1974-1976. Despite legal protection as early as 1969. this subspecies continued to be reduced by heavy harvest, and a burgeoning human population that destroyed tiger habitat and reduced its prey base (Houji and Helin 1986). By 1988, the population was estimated at 30 (Ma, in Jackson 1993). A more recent survey completed in 1992 estimated the number of tigers in Heilongjiang at 12, with most individuals in pockets of habitat along the Russian border, or a few sites further inland (Xu Li pers. comm.). There are probably the same or fewer animals in Jilan Province.

In South Korea, the last tigers were reported in 1953 (pers. comm.). Troop activity and the abundance of firearms during the Korean conflict probably hastened the demise of tigers in this country. Although tigers from North Korea were a potential source for recolonisation of South Korean, fencing and intense patrolling of the Demilitarized Zone probably prevented movement of tigers south. As recently as 1979 there were an estimated 50 tigers in North Korea (Anon. 1979). The present status of tigers in North Korea is unknown, but there are unconfirmed reports of up to 10 animals still living in a protected territory around Mount Paektu and other reserves in the northern reaches of North Korea, near the Chinese border (Dobson 1995).

In Russia, a reconstruction of tiger range at the end of the nineteenth century suggests that a permanent population of Amur tigers was restricted almost entirely to the Amur Basin (Heptner and Sludski 1972). There are records of tigers west of Lake Bail, and far to the north in the Lena River Basin, but all indications suggest that these records represent single individuals dispersing well out of traditional tiger range. The western limit of permanent historical tiger distribution along the north bank of the Amur was approximately 129° -130°

latitude (Maak 1859, in Matyushkin et al. 1980). Although there is not sufficient information to clearly identify the historical northern boundary, available evidence suggests that tigers rarely strayed above 52° latitude (Heptner and Sludski 1972), and the boundary for a permanent population could more likely be drawn at 50° (Matyushkin et al. 1980). South of this border, tigers occurred nearly everywhere in the forested regions of Amur Oblast, Khabarovsk Krai, and Primorye Krai, down to the Chinese and Korean borders.

Beginning with the last two decades of the 19th century, and continuing until the middle of the 20th, tigers in Russia were heavily harvested: tiger hunting was a popular sport (Matyushkin et al. 1980).. Before that time, Maak (1861) mentions that tigers were seldom shot, but by the turn of the century, the annual kill reached 120-150 individuals (Silantjev 1898). In addition to the hunting pressure, during the 20th century many cubs were being removed from the wild population for the worlds zoos and circuses. In fact, during the 1930s and 1940s the number of tiger cubs removed from the wild exceeded the number of adults killed (Kaplanov 1948). The combination of hunting and capture of cubs had a major impact on population size and reproductive output through the during this critical time period. The process of capturing cubs, using dogs to corner the cubs, and forked sticks to pin the animals to the ground, also resulted in an unknown percentage of deaths to cubs before delivery, and to tigresses trying to defend young from capture.

Changes in the distribution and size of the Russian Amur tiger population were also taking place due to habitat destruction. Towards the end of the 19th and first decades of the 20th century, settlement of the Khanka lowlands and the Ussurri River Valley (associated with construction of the Khabarovsk-Vladivostok railroad link beginning in 1891), and settlement of the region from Vladivostok to Ussurisk, eliminated some of the best quality habitat, began the process of habitat fragmentation, and led to the development of barriers to dispersal. Lowland and riverine habitats are usually the most productive of a region, and it is likely that the areas most suitable for agriculture were also the areas with the highest concentrations of ungulates and tigers. Indeed, Maak (1861) mentions that the moist lowlands (the first lands converted to agricultural fields), were the tigers' main habitat.

By the 1920s the remaining tiger population had already been fragmented into at least 4-5 sub-populations: a healthy population was centred on the Chinese side in Jilan Province on the Changbaishan plateau (Baikov 1925); a second population was found in the Mali Hingan region on the Russian (what is now Amur Oblast) and Chinese side of the Amur River; the third population occupied the Sikhote-Alin ecosystem, and a 4th (and perhaps 5th) occupied the Chinese-Russian border south of Lake Khanka. These last two small border populations were probably already isolated from the Changbaishan and Sikhote-Alin populations by the end of this decade.

This combination of fragmentation, habitat destruction, hunting, and removal of cubs brought the population precipitously close to extinction. By 1940 in the Sikhote-Alin population, tigers had been eliminated from much of their northern range: no tigers remained in the Bikin (northern Primorye) and Khor (southern Khabarovsk) Basins (Kaplanov 1948), traditional strongholds of the northern segment of the population. In 1940, Kaplanov (1948) initiated the first effort to census tigers in the Russian Far East, and reported that only 20-30 individuals remained in a fragmented distribution.

Several conservation measures implemented in the 1930s-1940s rescued the Amur tiger from extinction in Russia. Two key reserves, Lasovski (created in 1935), and Sikhote-Alinski (created in 1936) set aside 116,000 and 1,000,000 ha of prime tiger habitat, respectively (size of these reserves has fluctuated many times since creation). A ban on hunting was put into effect in 1947 (Matyushkin et al. 1980), although even today 2-3 specimens are killed a year under special conditions (usually livestock depredations or instances of mankilling). Although the process continues today, capture of cubs came under strict control in 1947.

By 1959, the Sikhote-Alin population apparently showed signs of recovery: Abramov (1959) estimated 90-100 for the entire Soviet Far East, including approximately 60 in Primorye. Another, more detailed census in 1969-1970 by Yudakov and Nikolaev (1973) reported a minimum of 150 tigers, with 130 in Primorye. Contrary to the positive growth of the Sikhote-Alin population, the Mali Hingan slowly continued to decrease. From 1958-1962 tiger tracks were present, but by the end of the 1960s tracks had become very rare (Kucherenko 1970). Sometime during the 1970s or 1980s, this sub-population went extinct.

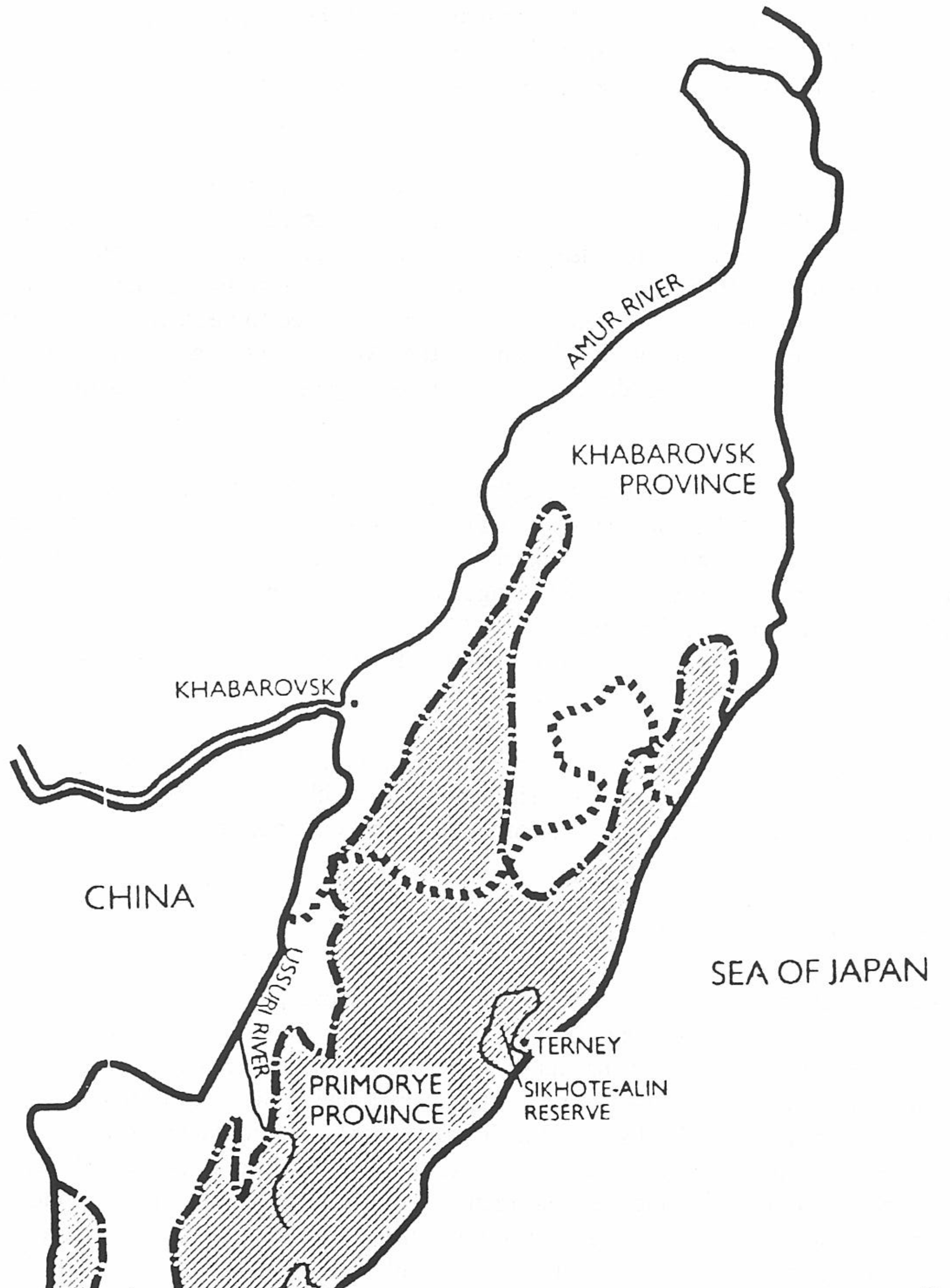
In 1984-1985, Pikunov (1988) estimated the Primorye population to be 285-293. Using the same data and a slightly different analysis, Bragin (1989) suggested that there have been as many as 370 individuals. Estimates from Khabarovsk indicate there were approximately 50 animals residing there (Dunishenko 1993). Together, these surveys suggest that at the end of the 1980s and early 1990s, there were 330-420 tigers surviving in the Russian Far East. Estimates from the most recent survey, conducted in the winter of 1995-1996, are not yet available.

Sludski (1973) estimated that approximately 60% of all original habitat of the Amur tiger throughout its entire range has been lost. However, Matyushkin et al. (1980) believed that in Russia, tigers remain in about two-thirds of their original distribution.

Present range and habitat of Amur tigers

The present range of Amur tigers extends from approximately 430 to 480 N within Primorye and Khabarovsk Provinces (Krais). The dominant geographical features of this region are the Sikhote-Alin Mountains and the Amur River and its tributaries. The Sikhote-Alin Mountains are low (most peaks below 1,000 m), paralleling the Sea of Japan coastline. The Ussuri River drains the inland side of the divide, and acts as a boundary between Russia and China before emptying into the Amur River (Fig. 1). Only two reserves in the region are large enough to provide adequate protection for segments of the tiger population: Sikhote-Alin Biosphere Reserve, located in the northernmost district of Primorye Krai, is 4,000 km2; and Lazovsky Reserve, located in the south-east portion of Primorye, is 1,160 km2. In Russia Amur tigers are presently found within only Khabarovsk and Primorye Provinces. With the Mali Hingan sub-population now extinct, the majority of individuals appear to be part of a metapopulation extending from the southern Sikhote-Alin Mountains into the southern regions of Khabarovsk Province through a continuous forest belt (Fig. 1). One or two very small populations in the south-west corner of Primorye Province are separated from the primary population by farmlands, cities, and roads associated with

FIG. 1. DISTRIBUTION OF AMUR TIGERS IN RUSSIAN FAR EAST



human development between the cities of Vladivostok and Ussurisk. This south-west population is probably augmented by individuals travelling between Russia and China, but the amount of interchange is unknown. The viability of this south-west population is questionable. Primorye Province is the interface of the northern Boreal and Asian life zones. Its biogeographic position, along with the fact that the region was not recently glaciated, results in a surprisingly high diversity and endemism in plant and animal species for a temperate region. More than 150 species of trees and shrubs exist in Primorye (Berg 1950). The northern and inland regions of the Amur tiger's range are dominated by components of boreal and temperate conifer forests, while forests toward the south and along the coast are primarily Asian and deciduous. Four general forest types are found over much of this region. Oak forests, dominated by Manchurian oak (*Quercus mongolica*) are common along the coastline and in the south. Inland, especially along the Sikhote-Alin Range, pine forests, characterised by Korean pine (*Pinus koraiensis*), are common. These mixed forests include a variety of coniferous and deciduous species, including larch (*Larix komarovii*), fir (*Abies nephrolepis*), spruce (*Picea ajanensis*), birch (*Betula costata, B. anata,* and others), basswood (*Tilia amurensis*) and maple (*Acer tegmentosum, A. ukurunduense*). Farther north, and on the inland side of the Sikhote-Alin Range, spruce-fir boreal forests are characteristic. Riverine forests found throughout the region are perhaps the most diverse, including such tree species as willows (*Salix schwerinii, S. viminalis, S. rorida*), poplar (*Populus maximoviezii*), ash (*Fraxinus mandshurica*), and elms (*Ulmus laciniata, U. propinqna*).

Present threats to the Amur tiger population

Poaching. Once legal hunting was outlawed in 1947, poaching of tigers was a relatively rare event in the Soviet Far East. Tigers were killed for a number of reasons, including depredations (of livestock or hunting dogs), perceived competition for ungulates (common for hunters), or simply fear. However, tiger carcasses were usually burned and/or buried because discovery could lead to severe punishment. In short, there was little interest or motivation to hunt tigers. Closed borders, tight control on firearms, the difficulty of transporting tiger parts, especially abroad, no economic value of tigers within Russia, and potentially severe repercussions if caught, combined to provide little incentive.

The political changes occurring since 1992 have radically changed the situation. The loosening of political control and the opening of borders have provided knowledge of and access to the traditional Chinese medicinal market. Tiger bones and other body parts have been an important and highly sought element in many Asiatic medicines and treatments (Nowell 1993, Mills and Jackson 1994), but until the 1990s this was not general knowledge in the Soviet Far East, and for those that did know about it, there was no way to profit from that knowledge. This new-found knowledge, proximity to the major market (China), the relative ease of acquiring firearms, and the increase in number of people illegally hunting for game meat (thereby increasing chance encounters and killing of tigers), led to a dramatic increase in poaching of tigers. In addition to these internal pressures, there also appeared to be an escalating demand from source countries (Russia and India in particular) resulting from depletion of tigers in the wild and long-standing stockpiles of tiger bone from range countries (especially China) consuming tiger products (Mills and Jackson, 1994).

Although tiger hunting is outlawed in Russia, the penalties are minimal (Traffic International 1994), and local authorities have traditionally not considered poaching a serious offence. Additionally, enforcement has been hampered due to serious under-funding and lack of equipment. As a result, poaching activities became organised very quickly, and now the Russian "Mafia" has become involved in trafficking of tiger parts (Galster et al. 1996).

Habitat degradation/fragmentation. Infringement into tiger habitat has taken many forms. Clearing of land for settlement, for farmlands, and for development has been very important in China, and to a lesser extent, in the Russian Far East. Some of the best habitat in the Ussuri River Basin, and on the Khanka lowlands had been lost to settlements and development by the 1920s. However, throughout most of remaining tiger habitat in Russia, forests remain, and the way those forests have been exploited in the past, and how they will be managed in the future will largely determine the fate of the Amur tiger.

Logging has by far the largest impact on tiger habitat. Fifty-nine percent of the world's softwood inventory is found in Siberia and the Russian Far East. There are 214 million ha of commercial forest land in the Russian Far East alone. The conifer inventory of the Russian Far East is estimated at 18.1 billion m^3, of which 3,868 million m^3 is found in Khabarovsk Krai, and 715 million m^3 lies within Primorye (Marshall, S. pers. comm.). However, these numbers are misleading when considering the area presently inhabited by tigers. Although in Khabarovsk Province biological potential to expand harvest may be as much as 38%, harvest capacity has already been overreached in Primorye (Marshall, S., unpubl.), where most of the tiger population is found.

Nonetheless, logging is an important component of both the local and national economy. At the local level, logging provides firewood for heat and cooking, and timber for building supplies. Timber extraction has traditionally been an important component of the regional economy and a major source of jobs. The need for foreign currency has forced Russia to seek co-operative ventures with international conglomerates that can invest the capital for large projects. Presently, several such large ventures are situated in Primorye and Khabarovsk. Other foreign companies are keenly interested in this general region, largely because the Sea of Japan provides easy access to mills and markets.

The impact of logging is in this region is subtle because the predominant form of logging is not clearcutting, but selective cuts. Clearcutting is practised in Khabarovsk Krai, along the northern border of tiger range, but throughout most of tiger habitat selective cuts have been employed to extract the highest quality timber from mixed forests. From the end of the Second World War until the 1980s, the local industry was focused on Korean pine, the most valuable commercial tree. However, by the mid-1980s it was clear that this species had been overharvested, and in 1990 the Primorye Krai government outlawed cutting of pine except under very explicit conditions. Nonetheless, export of Korean pine continues, largely uncontrolled. However, because most of the merchantable pine has already been removed, currently most logging emphasises softwoods, such as larch, spruce, and fir, and a few hardwoods (mostly ash and oak).

The effect of the logging industry on tigers is multi-faceted. Changes to habitat structure and vegetation composition of forests probably do not affect tigers directly, but do affect the prey upon which tigers depend. Tiger distribution appears to be closely tied to the distribution of wild boar and elk (Zhivotchenko 1976, Dunishenko 1993, Miquelle et al. in press). Korean pine acted as a "keystone" species in the mixed forests of Primorye. The mast from the pine cones was a key source of food for everything from chipmunks to bears to wild boars, who relied on the mast as a overwinter food source. Boar can also use acorns, but both pine and oak have large variations in mast crop production over space and time. Therefore, large tracts of mature forests of both oak and pine are necessary to reduce the probability of crop failures. Many specialists have suggested that the loss of the extensive pine forests is responsible for a dramatic decrease in the wild boar population (Smirnov, E. N. pers. comm.).

Habitat requirements of elk vary from those of wild boar. The elimination of Korean pine probably had minimal detrimental impact on elk. On the contrary, removal of the canopy through selective cutting may stimulate growth of the understory, thereby providing more nutritious forage for elk, which may flourish where a range of successional forests provide forage, shelter, and cover.

Secondary, more insidious effects may have a greater impact on tigers and their prey than logging itself. In contrast to clearcutting, selective logging requires work to be conducted over vast areas. Consequently, an extensive road network provides access for hunters, thereby increasing harvest pressure (both legal and illegal) on prey densities, and increasing the probability of tiger poaching.

Lack of Public Support. Despite the difficulties in providing concrete evidence, the local populace is at best complacent about the status of the Amur tiger. Although it has powerful symbolic imagery for indigenous peoples (local Udege called the tiger "Amba", or "great sovereign" of the forest) and for Russians alike (the tiger is the centrepiece of the city seal for Vladivostok), people in the local cities are unaware of the endangered status of the tiger, and people in the villages are too close to see the looming dangers. Relatively few people see the need for tiger conservation.

Responses to threats

Only a few years ago, there was little to report in terms of concrete conservation actions implemented to save the Siberian tiger (Miquelle et al. 1994). Although there is still much work that needs to be done to secure this population, some important steps have been taken.

Governmental Support. The federal government has taken an active role in promoting conservation of the Amur tiger. Partly in response to the international interest in the Amur tiger, Prime Minister Chernomyrdin issued National Decree number 795 "On saving the Amur tiger" on August 7, 1995. That decree calls for development of a national strategy for tiger conservation, which is being developed by the Ministry of Environmental Protection and Natural Resources. Included in the strategy are many of the key points delineated.

Although money has not come forward in the expected amounts for tiger conservation, the fact that a federal program exists lends essential support to all efforts, whether local, federal, or international, to conserve the Amur tiger.

Anti-Poaching Teams. In 1994, new anti-poaching teams were formed with financial support from international conservation organisations. Many of these teams are under the umbrella of the Ministry of Environment's "Operation Amba", others are supported by Zapovedniks or State Hunting Departments (Galster et al. 1996). These anti-poaching teams deal not only with tiger poaching, but a whole host of illegal activities in the Ussuriski taiga, including ungulate poaching, which undermines the critical food base for tigers. In contrast to the estimated 50-60 tigers poached in 1992-1993, the estimate for 1995 and 1996 is approximately 10-15. In addition to the impact of the anti-poaching campaign, world opinion and economics have also played a part. World-wide publicity of tiger poaching apparently has caused some governments to tighten up security at customs checkpoints, making smuggling of tiger products more difficult. In 1995 and 1996 there are many reports of Russian hunters who could not find buyers for their poached tiger skins and bones. Lack of demand and the inability to move products will have a great impact on future hunter interest in tiger poaching.

Habitat Protection. A habitat protection plan developed by the Hornocker Wildlife Institute in association with Russian colleagues establishes as a goal no further loss of tiger habitat (Miquelle et al. 1995). The plan proposes a network of protected areas linked with corridors that will secure a continuous web of habitat from the northernmost to southernmost limits of present-day tiger distribution. In addition to this network, the plan proposes, for all remaining habitat, development of management regimes that vary in level of stringency, dependent on the importance of the area as tiger habitat. This plan would set minimum standards for maintaining the habitat necessary for a viable population of Amur tigers. Key components of this plan have been incorporated into the national strategy.

Environmental Education. A host of local and international organisations are developing environmental education programs in the Russian Far East. These programs are taking many different shapes and forms: some using the formal education system to reach school children, while some are focused on the adult segment of the population. There have been numerous training workshops hosted by the USAID Environment, Policy, and Technology (EPT) Project to teach educators how to introduce environmental education to the classroom. Perhaps most importantly, international organisations are providing support for local groups and individuals to get organised and develop the capacity to implement institutional change and to change peoples perceptions of their relations to the natural world, including the tiger. Less successful to date have been the attempts to reach that segment of the population now impacting the tiger, i.e., the hunters and local people who directly interact with the tiger in its own environment. This segment of the populace is perhaps the hardest to reach, but is of immediate importance.

Sustainable Economic Development. Ultimately, the welfare of the tiger, and of all wildlife, is inextricably linked to the welfare of the people. During these very stressful and chaotic times in Russia, people in the small villages are perhaps the hardest hit economically. Their response, predictably, is to rely to a greater extent on local resources, and to extract more resources from the surrounding forests. To convince these people of the need to limit utilisation at a level that is sustainable, they must be able see the benefit to themselves. The concept of sustainable development has been gathering force in the Russian Far East as a consequence of two large international programs, and the environmental education movement. An international team, headed by Environmental Sustainable Development, has developed a land-use plan for the entire Ussuri Basin (on both the Chinese and Russian side) whose principle aim is the sustainable use of natural resources. The USAID EPT Project presently being implemented goes one step further by developing detailed land-use plans that will be used at the local level, and by assisting local individuals to increase market value of their forest products (whether it be timber or non-timber) by seeking local and international markets for finished products. For instance, rather than selling round logs, local businesses should produce and sell finished furniture, thereby ensuring a greater profit earned from each unit of resource, and a greater percent of the profit that stays in the local economy. In this way, more income is derived from each unit of resource, and fewer of those resources need to be exploited to have a positive impact on the local economy. Finally a biodiversity conservation plan is being developed with support of the EPT Project that will integrate the needs of the tiger population, as well as other endangered species, into an overall plan to protect the natural resources of this region.

Summary

A comprehensive conservation plan for the tiger must protect much of the forest community upon which it depends. It must also meet the demands of the people of the region who also depend on the forest. Therefore, an integrated approach must not only respond to the specific threats faced by tigers (such as poaching and habitat destruction), but must develop ways of resolving the conflict between human and wildlife needs. Solutions must be sought at the landscape level. We believe the Amur tiger can act as an umbrella species: to protect the tiger the integrity of the ecosystem and biodiversity of this unique forest complex must also be protected. If done properly, such a conservation plan will also preserve the integrity of the human communities of the region as well. Perhaps most importantly, the charismatic tiger is a powerful symbol that can alter our perceptions of our relationship to the natural world.

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Future prospects for the Amur tiger EEP

Sarah Christie, EEP Co-ordinator for the Amur tiger

As Dr Brouwer has shown, if we wish to continue to hold rare species like Amur tigers in our zoos, species which can no longer be routinely taken from the wild, good management is necessary. Management can, of course, mean the husbandry and veterinary care of the animals as well as the genetics of the population as a whole. Here we will examine the prospects for the EEP Amur tiger population in genetic terms.

However, I must stress that it is of course impossible to separate good genetic management from good husbandry. The various factors are inextricably interlinked. Good facilities, good husbandry and good veterinary care are pre-requisites for breeding success - and without breeding success, genetic goals cannot be met.

Without forgetting this, let us take a closer look at the genetic situation in the Amur tiger EEP. We have, overall, 219 Amur tigers held by 76 institutions in 21 countries. This may be more tigers than currently exist in the wild state.

The wild population is small and far from safe. We therefore have an enormous responsibility. We must use our tigers to raise public concern about the plight of the tiger in the wild and to raise funds for tiger conservation; we must make our expertise available to field workers wherever it may help. Most of all, we must ensure that our zoo populations remain physically, behaviourally and genetically healthy in the long term, so that we can continue with these efforts, and also so that captive tigers can act as a genetic reservoir in the future, a hedge against extinction in the wild. This last function is unique to zoos; other organisations can help to educate the public and raise awareness, other organisations can raise funds, but only zoos can maintain tiger populations outside their native habitat.

So, we hope to be able to breed and manage Amur tigers in our zoos into the future, without removing further tigers from the wild unless in exceptional circumstances, and to have a healthy zoo population in, for example, one hundred years' time. This means we have to be careful to avoid inbreeding and to maximise the retention of genetic diversity. It is our responsibility to ensure we will be able to do this. So how do the prospects look? Do we need to change anything to meet our goals?

The generally accepted goal today is to try to maintain at least 90% of the genetic diversity present in a wild population for at least 100 years. Just looking at the overall, present-day genetics of the EEP population gives a very encouraging picture; see Table 1.

Table 1 is adapted from a SPARKS printout. (SPARKS is a computer programme for studbook keeping which enables one to carry out genetic and demographic analysis on a zoo population.) As you can see we have representation from a total of 65 founders in the Amur tiger EEP. Twenty-five of these are still living. The EEP population as a whole is currently retaining almost 96% of the genetic diversity you would expect to find in a wild population, with potential to increase to 99% if managed perfectly. In practice this is never possible, but an attainable level would fall somewhere between the two.

Table 1; Genetic Summary.

	Actual	Potential
Number of founders	53	65
Fraction of wild gene diversity retained	96%	99%
Mean inbreeding coefficient	0.063	

This printout also gives the mean inbreeding co-efficient of the population; it is 0.063, which is very low, though zero would be even better.

This sounds excellent, and to some extent it is; but we must remember that this is only the situation today, and we need to maintain these high levels of genetic diversity for at least 100 years. The figures are biased by the fact that many of the founders are still alive, and therefore 100% of their genome is represented. Are these founders likely to leave sufficient descendants in the EEP, in the future, to maintain genetic diversity for 100 years?

Since the establishment of the International Tiger Studbook, at least 132 wild Amur tigers have entered European zoos. More than half of these - 67 - have not left any living descendants in the EEP today, though a few have descendants in the SSP.

Is it still the case today that wild-caught tigers are often dying without contributing to the managed programmes? Yes, it is. Twelve of our living founders have not yet left any descendants in the EEP. This is why the table shows only 53 actual founders and 65 potential founders - the potential founders are the ones that have no descendants in the EEP. Some of them have in fact reproduced - and Table 2 shows what has happened to the cubs born.

Table 2; Summary of the fate of the offspring of our 25 living founders.

Still in EEP	Died	Lost	In managed programmes elsewhere
17%	60%	21%	2%

The figures are given as percentages of the total number of cubs born to our living founders. Only 17% of their cubs remain in the EEP. About 60% of them died before reaching adulthood. About 21% have been lost entirely, for example sold to circuses or dealers, and only about 2% have gone to managed programmes elsewhere.

Today, of course, it is no longer acceptable to remove Amur tigers from the wild unless the circumstances are exceptional. That means that we must improve on these figures if the EEP population is to remain healthy into the future. Clearly the biggest problem is in the high mortality rates - these figures are not *cub* mortality, which is slightly lower, but mortality in the first few years of life. The next most important problem here is that less than half of the surviving cubs born to our living founders have remained in the programme.

The author, and Dr Rietkerk of the EEP Executive Office, have visited and spoken at length with a number of the zoos holding these founders, and we know that there are many difficulties; the working group sessions of the Special Meeting of the Amur tiger EEP were intended to define the causes of these problems and begin working on some solutions.

Considered as a sub-region of the EEP, the CIS zoos are very important and could play a crucial role in achieving our population goals. Table 3 shows the relative importance of the different regions. Only meaningful divisions have been used; there is no effective difference between management of tigers in France and that in the UK, between Poland and the Czech Republic, or between the Ukraine and Russia; but there are economic and logistic factors operating to cause differences between Western and Eastern Europe and the ex-Soviet states.

Table 3; Gene Diversity retained in different parts of the EEP.

Region	**Retention of genetic diversity**	**No. of Founders**
Whole EEP	96%	65
Western Europe only	94.75%	41
Eastern and Western Europe	95.3%	50
Russia, Ukraine and Baltics	92%	22

If we run an analysis on the Western European population only, it shows 41 founders represented. Retention of genetic diversity in such a situation fal's to 94.7%. Including Eastern Europe improves this slightly; 50 founders are represented, and the retention of gene diversity goes up to 95.3%. Combining all regions of the EEP gives 96% retention of genetic diversity, as we saw earlier.

Most of the living founders are in the ex-Soviet states; these are also the regions with the most problems. This is not to say that the rest of the EEP region is problem-free. Similar difficulties do occur across the region, but the richer zoos are presently better able to deal with them. These two factors - the presence of most of the founders, and the presence of the most difficult problems, are the reasons why the discussion parts of the Special Meeting, and the Action Plan it generated, dealt mainly with the geographical grouping of Russia, the Ukraine and the Baltic states. From now on this geographical group will be referred to as our target area.

If we look only at the target area, we find 22 founders represented, and retention of genetic diversity running at 92%. This high level is deceptive - it is biased by the fact that many of the founders are still alive. Let us assume that, in line with the overall historical rate mentioned earlier, half of the living founders will die without leaving descendants in the EEP, and that no new tigers come in from the wild. If we remove a random sample of half the living founders, and run the analysis again, we find that current retention of genetic diversity in the target area drops to less than 90%.

The figures also do not take into account the current high mortality rates. In order to assess how the programme might develop in the future, we need to look at rates of cub mortality and loss of tigers from reporting institutions, shown in Table 4.

Table 4; Fate of all Amur tiger cubs born in EEP Institutions in Russia, the Ukraine and the Baltic States since records began.

Known to have survived to adulthood	90 (19.5%)
Gone to non-responding institutions	121 (26.5%)
Died before adulthood	250 (54.25%)
TOTAL BORN	461

As you can see from Table 4, of 461 Amur tigers born in these countries since the International Studbook began, 250 - well over half - did not survive to adulthood. Worse, well over half of the survivors were lost not only to the EEP, but also to the International Studbook. If we look only at the last fifteen years, the situation deteriorates further, as is shown in Table 5.

Table 5; Fate of Amur tiger cubs born in EEP institutions in Russia, the Ukraine and the Baltic States since 1980.

Known to have survived to adulthood	33 (12%)
Gone to non-responding institutions	67 (25%)
Died before adulthood	172 (63%)
TOTAL BORN	272

Only 12% of the cubs born remain in reporting institutions (and some of these are not in the EEP), 63% of the cubs born have died before reaching adulthood, and the remaining 25% have been lost. Compared with the figures in Table 4 for the longer time period, loss of surviving cubs has remained about the same but there has been an increase in juvenile mortality. I suspect that this is due, essentially, to economic factors.

The overall historical mortality rate in the EEP region is also too high for comfort; 45% in the first year of life. I do not have figures for overall rate of loss of surviving cubs from the EEP as a whole, but I would expect this again to be high, though considerably less than in our target area.

In her presentation, Kathy Traylor-Holzer described the very high levels of co-operation in the Amur tiger SSP. The Americans obviously have a number of major advantages over the EEP; they all speak the same language, and in general they cannot be said to suffer from financial problems. In addition, no international borders are involved in their tiger transfers. In my two years as Co-ordinator for this EEP, and during my travel around Russia and the Ukraine this summer, I have gained a painful awareness of our difficulties. I have also come to feel immense respect for the efforts that are being made in our target area, despite the problems, and for the forward-thinking attitude I have often encountered. I hope very much that we will be able, over the next few years, to markedly improve both cub survival and the retention of genetically important surviving cubs in the programme, so that this EEP can make a significant contribution to the survival of the Amur tiger. Implementation of our Action Plan will go a long way towards these goals.

Conservation Breeding Specialist Group Activities and Workshops: 1994-1995

Professor Ulysses S Seal, Chair, Conservation Breeding Specialist Group

SSC MISSION: To preserve biological diversity by developing and executing programs to save, restore and wisely manage species and their habitats.

CBSG MISSION: To assist development and application of scientifically-based biological and social tools and processes to expedite species management and to train a global network of managers in their application.

These tools, based on small population, conservation biology, sociology, and management science, are used in intensive, problem-solving workshops to produce realistic and achievable recommendations for both *in-situ* and *ex-situ* populations. CBSG is an information and knowledge based organisation with 6 full time employees. We organise, assemble information, conduct and produce reports for about 40 workshops and meetings each year in 12-15 countries. We receive and respond to about 3,500 pieces of correspondence annually. We produce about 80 referable publications each year. We manage membership information on our 675 plus members. We have an institutional donor base of 125 institutions from whom annual contributions are received.

CAMP OVERVIEW WITH FOCUS ON THE ASIAN WILD CATTLE CAMP

Introduction

The exponential rise in human population size around the world has resulted in extensive fragmentation and destruction of wildlife habitat. As habitat is lost, wildlife populations face threats, some known and some unknown, that combine to increase the likelihood of diminished genetic variation and even extinction. Increasingly, wildlife managers recognise that global, integrated, multi-dimensional strategies must be developed to respond to the escalating crisis facing the world's biodiversity. It is obvious that resources available for the preserving the world's biodiversity are limited and must be apportioned to the highest priority needs. Concomitantly, if current and projected extinction rates are to be slowed, global cooperation, co-ordination, and improved networking are essential.

In response to the above challenge, the Conservation Breeding Specialist Group (CBSG) of IUCN's Species Survival Commission (SSC) has assisted developing and applying a series of scientifically-based tools and processes to expedite species management. These tools, based on small population and conservation biology, are used in intensive, problem-solving workshops to produce realistic and achievable recommendations for both *in-situ* and *ex-situ* populations.

The CAMP Process

One of these workshop processes is the Conservation Assessment and Management Plan or CAMP. The CAMP process provides an objective workshop environment and a neutral facilitation process that supports sharing of available information, reaching agreement on the issues and available information, and then making useful and practical management recommendations for the taxon or region under consideration. Its proven heuristic value and constant refinement and expansion have made it one of the most imaginative and productive organising forces for species conservation today (Conway, 1995).

The CAMP process is a tool for bringing together stakeholders in the future of a taxon or region and for assembling information and setting conservation action priorities. The goals of the CAMP are: 1) to assess threat using the new IUCN red list criteria; 2) to make broad-based management recommendations; and 3) to recommend specific conservation-oriented research. As Bill Conway stated in a recent publication in Biodiversity and Conservation, the CAMP process is one of the most imaginative and productive organising forces for species conservation today.

Thirty-nine CAMPs have been conducted since its inception in 1991. Three hundred and nineteen institutions from 39 countries participated in these workshops. Nine CAMPs have been conducted this year.

The CAMP Report is not the final word for the evaluated species. The process and the information, as well as the documents, are constantly evolving. There have been many changes in the process since its inception. One of these changes is the use of the new definitions for IUCN Red List Categories of Threat. When the CAMP Workshops began we used the Mace-Lande categories of threat described in 1991. These categories were especially relevant for large vertebrates. The Mace-Lande categories were revised and expanded resulting in the adoption in December 1994 of the final revision of the New IUCN Red List Categories which we now use in all CAMP Workshops. These New Categories provide a way of making comparisons across a wide range of taxa encompassing vertebrates, plats and invertebrates, based both on trends, population, and distribution criteria. These categories can be applied to any taxonomic unit at or below the species level.

Another recent change is the focus on the taxon data sheet to collect data instead of the summary spreadsheet. This enables the gathering of more complete information for each individual taxon considered during the workshop. This includes a record of the sources of the information and the compilers of that particular data sheet. All of this information from the taxon data sheet will be incorporated into REGASP, a computer program for institutional, regional, and global collection planning, developed by the Australian Species Management Program. The program and this information will be distributed by ISIS beginning in early 1996. This will allow us to get the CAMP information and recommendations out to ISIS institutions 3-4 times each year with the ISIS database.

An addition to the CAMP process is the Global Captive Action Recommendations or GCAR. The GCAR is designed to serve as a guide for threatened species selection priorities for captive programs for institutions and regions that are involved in collection planning. When appropriate, we hold the GCAR at the same time as the CAMP in order to take advantage of the expertise of the participants. For taxa recommended for captive management a global captive target population is determined based upon (1) the status and founders currently in captivity, or (2) with the addition of new founder stock, and (3) with the use of genome resource banking to store sperm. Information is gathered on the current populations held in captivity. GCAR data is included in some of the most recent CAMP reports.

In spite of all the changes made to the CAMP process over the years, the role of CBSG has remained the same. CBSG serves as a neutral facilitator of the process with all recommendations made by the workshop participants.

Asian Wild Cattle and Storks, Spoonbills, Ibises CAMPS

Two of our most recent CAMPs were the Asian Wild Cattle CAMP and The Storks, Spoonbills, and Ibis CAMP held in Chonburi, Thailand in July 1995. These workshops were sponsored by 4 AZA institutions and the Japanese Association of Zoos and were hosted by the Khao Kheow Open Zoo and the Thailand Zoological Parks Organisation. The meetings were organised by CBSG, the Asian Wild Cattle Specialist Group, the Stork, Ibis ana Spoonbill Specialist Group, the Thailand Royal Forestry Department and the Zoological Parks Organisation of Thailand.

Both were truly global workshops with 14 countries represented. One of the most valuable functions of CBSG is to bring together people who have similar concerns for the survival of a particular species or group of species but who have never met. People from several Southeast Asian countries gathered at this workshop and formed friendships and collaborations that they hope will be long-lasting and productive.

The goals of the workshops were:

1. To review population status and demographic trends, assign New IUCN Red List categories of threat to each taxon and identify needed management options.

2. To provide recommendations for in situ and ex situ management, research and information-gathering.

3. To produce draft Conservation Assessment and Management Plan Reports.

The participants broke into working groups. Each working group had a Thai facilitator and the reports were given in both Thai and English.

The results from the Wild Cattle workshop have been summarised and a draft report circulated. Seventeen of the 25 (68%) of the Asian wild cattle taxa examined were classified as threatened (either critical, endangered or vulnerable).

Table 1. **List of Asian Wild Cattle taxa in the IUCN categories.**

Category & List #	TAXON	Country
Critical		
4	*Bubalus bubalis*	Central India
2	*Bubalus bubalis*	Thailand
3	*Bubalus bubalis*	Nepal
7	*Bubalus bubalis*	Vietnam?
6	*Bubalus bubalis*	Cambodia?
10	*Bubalus bubalis*	Laos? (Ex?)
16	*Bos gaurus lasosiensis*	Myanmar to China
17	*Bos gaurus hubbacki*	Thailand, Malaysia
22	*Bos javanicus birmanicus*	Myanmar to Vietnam
25	*Bos sauveli*	Cambodia
Endangered		
5	*Bubalus bubalis*	Assam
11	*Bubalus depressicornis*	Sulawesi
13	*Bubalus mindorensis*	Philippines
23	*Bos javanicus lowi*	Borneo
Vulnerable		
12	*Bubalus quarlesi*	Sulawesi
21	*Bos javanicus javanicus*	Java
24	*Bos muticus*	China, India
Data Deficient		
9	*Bubalus bubalis*	Sri Lanka
8		Borneo
Least Risk		
15	*Bos gaurus gaurus*	India, Nepal

When the results of all CAMP workshops are combined, it can be seen that 40% of the over 4,000 taxa considered in CAMP workshops to date are classified as threatened, indicating the need for some degree of timely conservation attention. Of 4,971 taxa reviewed during CAMP processes, approximately 39 percent (1,954) have been assigned to categories of Extinct (45 taxa), Extinct in the Wild (15 taxa), and to threatened categories of Critical (395 taxa), Endangered (567 taxa), Vulnerable (930 taxa), or Conservation Dependent (5 taxa).

Determining the type of conservation attention needed is another goal of the CAMP. Based upon the information gathered and the status of the taxon, decisions must be made regarding the need for taxonomic and genetic studies, surveys, population monitoring, habitat management, management of factors limiting the population or research to determine what the limiting factors are, life history studies or translocation. Another recommendation to be considered during the CAMP is whether or not a PHVA workshop should be held for a taxon. The PHVA is designed to evaluate the factors affecting the population's risk of extinction and to develop a management strategy for minimising that risk.

One of the valuable results that can come from a CAMP workshop is the focusing of our understanding not just of what we know but what we don't know. In the Asian wild cattle CAMP, 56% of all research recommendations made were for information gathering research: survey, monitoring and taxonomic studies. This is also true when we look at the cumulative data. Nearly half of all recommendations are for survey, monitoring and taxonomic studies.

Another category of recommendation to be considered in the CAMP process is that of captive management. The CBSG approach is that captive propagation be considered a support, not a substitute, for wild populations, and that programs should be developed in the country of origin of the taxa.

There are three levels of captive programs. Level 1 is the most intensive program with a goal of retaining 90% heterozygosity for 100 years and to be implemented immediately. Level 2 is similar to Level 1 but includes periodic supplementation of genetic material from the wild. Level 3 is used for taxa that are not recommended for captive programs for conservation purposes but for other important reasons such as education and research. If there is not enough information available at the time of the CAMP to determine if a captive program is required, a recommendation of Pending is assigned. Alternatively, no captive program may be needed.

All the captive recommendations made in the Asian wild cattle CAMP were made for threatened species. In total 7 recommendations were made for captive programs and 4 taxa were given a recommendation of pending. But the majority, fully 50% of the taxa, were not recommended for captive programs.

Similarly, for over half of the taxa considered in the CAMP process to date, no captive program has been recommended. It is important to note, however, that recommendations have been made for many taxa not currently held in captivity. Obviously, the mission of

CBSG is not to promote captive breeding at the exclusion of other options. You can see that changing our name from Captive to Conservation was a very appropriate move.

In every CAMP workshop issues important to a particular species or a group a species are discussed and short reports of the discussions are included in the documents produced from the workshop. Recommendations resulting form discussions at the Asian Wild Cattle CAMP included:

* Stop breeding gaur subspecies hybrids.
* Develop a survey, census, and monitoring training program.
* Conduct disease surveys and outbreak investigations.
* Establish a wild cattle Genome Resource Bank.

One of the goals of the CAMP is to produce the draft workshop report at the meeting. The value of the report is greatly enhanced if it is published soon after the workshop has been conducted. We now add a day or two onto each workshop to give us time to complete the draft report. The draft report from the Asian Wild cattle CAMP was completed before we left Thailand and is now being reviewed. The working document will be completed by mid-October.

GLOBAL CAPTIVE ACTION RECOMMENDATIONS (GCAR)

Introduction

As wildlife populations diminish in their natural habitat, wildlife managers realise that management strategies must be adopted that will reduce the risk of extinction. These strategies will be global in nature and will include habitat preservation, intensified information gathering, and in some cases, scientifically managed captive populations that can interact genetically and demographically with wild populations.

Within the Species Survival Commission (SSC) of IUCN-The World Conservation Union, the primary goal of the Captive Breeding Specialist Group (CBSG) is to contribute to the development of holistic and viable conservation strategies and management action plans. Toward this goal, CBSG is collaborating with agencies and other Specialist Groups world-wide in the development of scientifically-based processes, on both a global and regional basis, with the goal of facilitating an integrated approach to species management for conservation.

In addition to managing the natural habitat, conservation programs leading to viable populations may sometimes require a captive component. In general, captive populations and programs, or the use of captive technologies, can serve several roles in holistic conservation: 1) as genetic and demographic reservoirs that can be used to reinforce wild populations either by revitalising populations that are languishing in natural habitats or by re-establishing by translocation populations that have become depleted or extinct; 2) providing scientific resources for information and technology that can be used to protect and manage wild populations; and 3) as living ambassadors that can educate the public as well as generate funds for *in-situ* conservation.

Captive breeding programs have limited resources. Priorities must be developed co-operatively among all regions of the world for program development and resource allocation, the purpose of the Global Captive Action Planning process. Once global priorities are known, regional captive propagation programs can be developed to assist in practical conservation.

Global Captive Action Recommendations (GCARs)

GCARs are derived from the CAMP process. The CAMP recommends which species / subspecies deserve attention, and the GCAR determines the target number of animals necessary to sustain a healthy captive global population. This system assumes that captive populations be treated as an integral part of the metapopulations being managed by conservation strategies and action plans. Viable metapopulations may need to include captive components. The IUCN Policy Statement on Captive Breeding recommends, in general, that captive propagation programs be a component of conservation strategies for taxa in which the wild population is below 1,000 individuals. Captive and wild populations should and can be intensively and interactively managed with interchanges of animals occurring as needed and as feasible, after appropriate analysis. There may be problems with interchanges including epidemiological risks, logistic difficulties, and financial limitations. However, limited but growing experience suggests that these problems can be resolved. Strategies and priorities should maximise options while minimising regrets for species conservation.

Captive populations are a support and a reservoir, not a substitute, for wild populations. A primary focus of the GCAR is on captive propagation programs that can serve as genetic and demographic reservoirs to support survival and recovery of wild populations in the future. The purpose of the GCAR workshop is to provide strategic guidance for captive programs at both the global and regional level in terms of captive breeding. GCAR workshop activities include considering how the various regional programs for each group of taxa might interact and combine to catalyse a truly effective global effort. An important aspect is establishing global target population size goals (i.e., how many individuals ultimately to maintain). More specifically, GCARs recommend which taxa are most in need of captive propagation and thus:

1) which taxa in captivity should remain there,
2) which taxa not yet in captivity should be there, and
3) which taxa currently in captivity should no longer be maintained there.

There are multiple genetic and demographic objectives affecting the captive population target: some taxa require large population sizes for a long time, where others need small nuclei or reduced gene pools that can be expanded later, if needed. One result of the GCAR will be an ability to logically adjust current captive population sizes in various regions, hopefully to better sustain threatened taxa as well as to identify new space available for conserving other species/subspecies receiving insufficient attention.

In summary, the GCAR provides the strategic framework for establishing global priorities that, in turn, can be used by all regional taxon advisory groups to formulate, co-ordinate, and implement effective Regional Collection Plans that together will have a true global conservation impact.

GCAR Workshop Goals

The goals of the GCAR are:

1) to review CAMP data and discuss required changes;
2) to prioritise taxa in need of captive management and to identify global target population sizes; and
3) to evaluate the direction of regional collection plans on the basis of global conservation priorities identified by the GCAR process.

The GCAR Process

The GCAR process begins by compiling as much background information as possible on the status of taxa in the wild and in captivity. For this purpose, CBSG utilises information from

Action Plans that may have been formulated by taxonomic Specialist Groups of the SSC or BirdLife International. When such plans do not exist, CBSG collaborates with Specialist Groups to produce the necessary data that will allow the GCAR process to proceed. The priorities and program goals determined by the CAMP process, as well as the number of individuals in captivity and the degree of experience and difficulty of captive management for each taxon, are available in the CAMP document. GCAR spreadsheets, and information briefing books also contain this information. A current census of captive animals found in ISIS abstracts and TAG reports, studbooks, and regional inventories also is useful.

The GCAR workshop process entails considering all relevant data in intensive and interactive discussion involving experts representing the various organised world regions of the zoo and aquarium world. The objectives are systematic decision-making, captive program prioritisation, initial selection of global species target population sizes, and identification of regional distribution of each taxon. Second, a determination needs to be made about which species/subspecies and how many individual animals should be included in this global captive program. Target population sizes can be computed by three methods based upon availability of founder stock. The first uses only the available captive population, the second considers the need and effects of the addition of new founder stock, and the third includes the use of genome banking.

GCAR Report Preparation

Using ISIS information, CAMP spreadsheets, the International Zoo Yearbook, selected regional surveys and collection data, studbooks and SSC Action Plans, preparation of the GCAR report can begin. This phase of the process involves review of CAMP workshop data on taxon status and captive program recommendations, initial selection of global species targets, determination of GCAR population priorities and target population numbers, tabulation of GCAR information, and preparation of review draft of the report.

The GCAR spreadsheet (see page 15) is set up with the name of each taxon that was considered in the CAMP process listed on the left side of the table. Next is a summary of the CAMP determinations; an estimate of the number of individuals remaining in the wild, the Mace/Lande category of threat assigned to that taxon, and the level of captive recommendation. The first step of this phase of the process is to revisit this CAMP Workshop information and note any necessary changes in these columns of the GCAR spreadsheet. This includes review of the status of each taxon's category of threat and the level of captive program recommendation. In some cases, these determinations may have changed since CAMP workshops were conducted. Also, participants in the GCARs may have information unavailable at the time of the CAMP.

The current ISIS data are entered in the column labelled N in the WORLD section of the GCAR spreadsheets before the Workshop begins. Any changes in this information should be noted for each region in the appropriate column on the spreadsheet. For a particular region, including data from non-ISIS institutions may provide more accurate figures. This information may be accessible from sources available at the Workshop.

On the basis of the information compiled to this point, global species and population targets must be set. A determination needs to be made about which species require inclusion in this global captive program and, in turn, the number of individuals required to successfully establish and maintain the recommended program. Target population size depends on a number of factors and can be computed using Ballou's CAPACITY 3 program described above.

Secondly, to assist in regional collection planning, there is a section of the spreadsheet labelled "Distribution of Captive Population". In this section, each region or country holding a particular taxon, and the number of individuals currently in captivity in that location, can be entered into the appropriate columns. Depending on the current captive population distribution and the global recommendations for the taxon, regional target populations can be determined by taxon advisory groups of the various organised regions of the world.

Ultimately, the GCARs will serve to guide decisions regarding how responsibilities for captive programs might best be distributed among organised Regions of the global captive community and will assist in preventing duplication of efforts between zoo regions. Once the captive program target species and populations have been determined, the very important step of distributing among the regions the responsibility for carrying out the recommendations must be undertaken at the regional level. These decisions involve prioritisation of target species within each region and will be made, in part, on the basis of captive husbandry expertise and existing captive populations, and the goals of regional collection plans.

The data collected during the GCAR process will then be tabulated and specific global recommendations made. This information will be compiled by each working group and a review draft of the GCAR report will be prepared before the participants leave the meeting.

Implementation

The final phase of the GCAR workshop is what happens after the workshop ends. CBSG staff will carry back to Minnesota the review drafts of each report. In collaboration with the GCAR leaders, a participant's first draft of the report will be prepared. This draft will be distributed to members of the GCAR working group and to TAG chairs and Conservation Co-ordinators for their review. Once the participants have had an opportunity to make comments and we have made revisions of the reports, they will be distributed for regional and national review.

The Regional TAGs then consider this first draft of the GCAR within a regional context to develop and implement a Regional Collection Plan (RCP). GCARs provide very general, global recommendations and are, in essence, a first-cut in outlining taxa priorities, target populations and space/resource allocation. The GCAR documents can then be used as a guideline in the development of RCPs. These documents are especially helpful in providing a comprehensive list of which taxa, globally, are in need of captive programs for conservation reasons. The GCAR working groups will facilitate interaction and co-ordination among Regional TAGs as they develop their RCPs in an attempt to optimise use of captive space and resources for conservation on an international basis. In this way Collection Plans of the various Regions will not develop in isolation from one another and captive resources can be allocated efficiently and effectively to taxa in need.

Another responsibility of the regional TAGs and Collection Plans should be to encourage institutions to develop their own Collection Masterplans in the context of both the RCPs and ultimately the GCARs. It is through these activities that the recommendations of the GCARs will be realised. Both the Global and the Regional Plans will need to be interactively and iteratively re-assessed and revised as new information becomes available or as circumstances change.

To maximise the effective use of captive resources, Regional Programs may need to be integrated and co-ordinated to form global programs or Global Animal Survival Plans (GASPs) for individual species of concern. Programs and masterplans for propagation and management now exceed 200 in the various regions of the zoo/aquarium world and development is in progress to form GASPs for at least a dozen taxa.

Principles and Concepts of PHVA Workshop Process

The CBSG PHVA Workshop process is based upon biological and sociological science. Effective conservation action is best built upon a synthesis of available biological information, but is dependent on actions of humans living within the range of the threatened species as well as established international interests. There are characteristic patterns of human behaviour that appear cross-cultural: 1) in the acquisition, sharing, and analysis of information; 2) in the perception and analysis of risk; 3) in the development of trust among individuals; and, 4) in 'territoriality' (personal, institutional, local, national). Each of these has strong emotional components that shape our interactions. Recognition of these patterns has been essential in the development of processes to assist people in working groups to reach consensus on needed conservation actions.

The motivation for organising and participating in a PHVA workshop comes from a fear of loss as well as a hope for recovery for a particular species, subspecies, or population. Inherently we abhor species going extinct on our 'watch'. A commitment to the species is made by individuals who provide needed leadership. Effective and persistent action depends upon a bottom-up approach, sometimes by participants who have rarely been a part of species conservation action planning. Usually a single person is key to initiating the workshop process. This person is essential for bringing other stakeholders to a workshop which includes outsiders.

At the onset of the workshop, there is a consensus among the players on a general desired outcome to prevent extinction and achieve species recovery. A collaborative process with power equalisation of participants either is recognised as essential to achieve the recovery or needs to be achieved. Successful outcome depends on formulating a potential win - win strategy as a basis for developing management scenarios for participants and stakeholders whose interests and agendas usually differ. There is a need for an agreement to willingly pool resources, including new or unpublished information despite traditions of personal ownership.

The biological problems and threats to a particular species usually are complex and interactive with a need for diverse specialists. No agency or country encompasses all of the useful expert knowledge. Thus, there is a need to perceive outsiders as acceptable and useful as resources and analysts. This is a major difficulty in some regions (especially developed countries). It is important that the invited experts have reputations for expertise, objectivity, initial lack of local stake, and for active transfer of wanted skills. Local solutions (both people and political) are focus solutions. Workshop reports and outcomes are the property of locals and participants. Therefore, significant commitment for the workshop process must be derived from local resources.

A corollary problem is the extraction of expert knowledge, the assumptions on which it is based, and its use in the face of incomplete knowledge and uncertainty about its application. In our experience, perhaps 80% of useful information for species risk assessment and management planning is in the head of experts, is not published, and is not likely to be available in printed (or electronic form) for problem solving. Modelling and simulations provide a neutral externalisation focus for assembly of information, identifying assumptions, projecting possible outcomes (risks), and examining for internal consistency.

Timely reports from the workshop are necessary to have impact on stakeholders and decision makers. Therefore, the workshop reports need to be completed and distributed quickly.

The PHVA Process

The Population and Habitat Viability Assessment (PHVA) workshop is a key component of CBSG s toolkit of scientifically-based conservation processes. A brief overview of the basic premises and characteristics of the PHVA workshop are illustrated by a discussion of the eight PHVA workshops conducted by CBSG during from September 1994 - September 1995). Three of these workshops will be discussed in the context of a central feature of the PHVA process - the broad-based individual and institutional participation and support.

The PHVA workshop is designed to assist in the development of comprehensive adaptive management plans of a single species or population, as well as its corresponding habitat. From the narrow perspective of population biology, the PHVA is the estimation of extinction probabilities by analyses that incorporate identifiable threats to population survival into models of the extinction process. Information on the life history, population dynamics, ecology, and distribution of the focal species or population is assembled and analysed at the workshop and serves as input to the simulation models that assess both current persistence as well as the consequences of alternative management strategies proposed at the workshop.

An important feature of these workshops is the extraction, assembly, and assessment of information from the experts present at the workshop. Much of this information, perhaps 75-80%, is not readily available in published form but may be of decisive importance in understanding the population dynamics of the species in the wild. Moreover, the social structure of the PHVA workshop provides a neutral environment within which individual participants agendas are set aside and mutual problem-solving is fostered in the development of species management programs.

Of special interest are the gharial workshop was organised, funded, conducted, and facilitated solely by people within India - the range country, and the Workshop for the European bison, which is the first PHVA for a land mammal in mainland Europe. The workshops in Mexico and Panama were the first of their kind in these countries. We at CBSG are confident that these firsts will serve as precedents for further expansion and development of this process in these and other countries.

PHVA workshops scheduled for the remainder of 1995 include the clouded leopard in Taiwan, the Komodo monitor and sea turtle species in Indonesia, and the Orinoco crocodile in Venezuela. PHVA workshops scheduled for 1996 include the volcano rabbit in Mexico, cheetah in Namibia, African wild dog in South Africa, tamaraw in the Philippines, Iberian lynx in Spain, babirusa in Sulawesi, muriqui in Brazil, tapir in Columbia, tiger in Malaysia, and a langur in Vietnam.

Broad and Diverse Participation: A Cornerstone of the PHVA Process

A defining characteristic of the PHVA process is the broad base of individual and institutional participation at each and every workshop. All people with a stake in conservation of the target species are invited to actively participate in the workshop. For example, a total of more than 200 people from nearly 110 institutions participated in the eight PHVA workshops conducted between September 1994 and August 1995 and listed above. This social environment facilitates the discussion of difficult topics related to species management, and ultimately results in a strong sense of participant ownership of the workshop product. This sense of personal ownership in a proposed conservation strategy is essential for the subsequent implementation of that strategy.

Several PHVA workshops illustrate this phenomenon of participation.

1. The PHVA for the peninsular pronghorn, conducted in La Paz, Mexico in November 1994 was our first PHVA workshop in Mexico. It brought together 30 scientists, governmental representatives, and members of non-governmental organisations. These participants were from 18 institutions, representing academic, scientific, governmental, and commercial interests. This workshop was the first time that all those individuals in Mexico concerned with pronghorn conservation had met together to discuss the important issues related to management of this acutely threatened subspecies. Distribution of this subspecies has been reduced by more than 90% during this century. Specific management recommendations made at the workshop included:

The establishment of a detailed environmental education campaign from the local to the international level;

> The prioritisation of detailed research needs directed towards pronghorn biology;
>
> Efforts directed towards predator (coyote) control;
>
> An intensive study of the utility and the nature of any future captive breeding program.

2. The recent PHVA workshop for the European bison, held in Poland in June 1995, further illustrates the participation phenomenon. Twenty-one institutions were represented by 29 participants from 10 countries including Russia, Belarussia and Poland. Among the recommendations made at the workshop were the establishment of an EEP captive breeding program and the establishment of a genome resource bank or GRB.

Two major issues, one disease and the other taxonomic, critical to successful bison management were identified at the workshop but are as of yet unresolved:

The etiology and epidemiology of a urogenital disease in males, which leads to their sterilisation and ultimate elimination from an affected herd (as many as 20% of all males in a given herd are removed in this way), needs to be determined and its effect on the demography, genetics, and risk of extinction of affected herds assessed. Risks from other domestic livestock near the bison herds also needs to be systematically evaluated.

Two lines of European bison are currently being managed separately: the pure Lowland line (Bison bonasus bonasus) and a line of hybrids between B. b. bonasus and the Caucasian subspecies B. b. caucasicus, now extinct. The Lowland line resides primarily in Poland, while the majority of Lowland-Caucasian bison reside in Russia and the Ukraine. The degree of genetic distance between these two lines needs to be addressed within the context of proposed admixture between lines, thereby greatly increasing overall population size.

The continued evolution of VORTEX

This past year has seen an important advance in the evolution of VORTEX with the added capability of modelling species with hermaphroditic breeding systems and real time graphing capabilities. This new feature will greatly expand CBSG's capability to apply the PHVA process to a wide variety of species, now including plants. We plan to do PHVAs for more plant species.

PHVA Facilitators' Training Workshops

There is a projected need for thousands of species and habitat adaptive management plans which can be developed with PHVA process workshops conducted globally over the next decade. One of the primary areas of emphasis for CBSG for the next 2-3 years is training additional workshop facilitators and population biologists to meet this need.

One of the primary products to come out of the first workshop in Minnesota in 1994 was the Conservation and Management Planning Process Design Manual. This manual provides a detailed guide to the steps necessary to successful organisation and implementation of a PHVA workshop. The authors of the manual also address many of the difficult issues, both biological and social process that commonly arise during the course of a workshop.

Prologue

The concept and potential of genome resource banks (GRBs) (the organised collection, storage and use of biomaterials) for wildlife species has been debated for more than two decades. The challenge has been in converting the concept into reality having an actual impact on conservation.

Beginning in 1991, the Conservation (Captive) Breeding Specialist Group (CBSG) under the umbrella of the World Conservation Union's Species Survival Commission began seriously considering how to systematically develop the GRB concept. The issue was first debated in both a plenary session and in a working group at the Annual CBSG Meeting in Singapore. It was determined that GRBs could have tremendous potential for both in situ and ex situ conservation programs, especially as a method for ensuring maintenance of genetic variation as well as moving genetic variation among isolated populations. One primary recommendation of the 1991 meeting was that GRBs should be considered as an ancillary conservation tool to be developed in the form of individual action plans, written documents that would ensure that biomaterials would be collected, stored and used in a systematic and scientific fashion and only for the purpose of real conservation. The topic was re-visited at the annual CBSG meeting in 1992 (Vancouver) where the working group developed a written set of guidelines precisely identifying all the factors that must be addressed in writing the Action Plan (these guidelines are appended to this document).

The next high priority was actually testing the guidelines by preparing a 'prototype' Action Plan. Because of (1) its precarious status in the wild, (2) a world-wide masterplan for the captive population and (3) a substantial database on reproduction, the tiger was chosen as the model species for developing a GRB Action Plan. During the formulation of the Plan, a number of population biology-type questions arose that (to our knowledge) had never been addressed in a systematic fashion by the scientific community. These unknowns were sufficiently important to dictate not only how the GRB should be developed, but also its potential and ultimate impact on the conservation of the species. It was for this reason that the CBSG in cooperation with the American Zoo and Aquariums Association held a 2-day workshop to discuss the population biology aspects of genome resource banking. The following are the resulting recommendations from these discussions.

Introduction

Genome banking offers the opportunity to expand the scope, time span, scale, security, and economy of programs for conservation of species and of within species genetic diversity. As populations of wild cattle species are fragmented in distribution and reduced in numbers, genetic diversity is lost and the populations become increasingly vulnerable to extinction. Some of the species are vulnerable to hybridisation with domestic cattle or domesticated stock of wild species. Cryopreservation of representative samples of genomic materials from wild and captive populations will allow indefinite preservation of presently available diversity and protection against extinction. Additionally, cryobanking will assist in the genetic management of living wild and captive populations.

Formulation of goals and objectives for a genome banking program are necessary for development of sampling and utilisation strategies to guide : (1) selection of an optimal representation of the genetic diversity, (2) collection and storage of an adequate amount of material, and (3) distribution and use of the appropriate materials. These materials may then be used to assist restoration of extinct wild populations, genetically supplement small living wild populations, assist in the exchange of genetic material between previously connected wild populations, and support smaller captive populations with indefinite retention of presently available genetic diversity.

The utilisation of genome banks as part of an integrated program of management of living wild and captive populations may allow retention of a larger fraction of the present genetic diversity in the wild populations with smaller living captive populations. It also may be possible to distribute semen/embryos to other sites without removing animals from threatened populations. These might then be inseminated/transferred to surrogate hosts to produce living populations as a basis for further expansion of the genome bank, introductions to other sites, or supplementation of wild population. The living population could receive periodic infusions from the genome bank to replace diversity lost by drift or to maintain a closer correspondence to the genetic composition of the wild population. The cryopreserved materials will allow indefinite (thousands of years) retention of the present day genetic diversity which will significantly modify current goals for captive conservation programs based upon 90% retention of genetic diversity for 100 or 200 years in the captive populations.

This capability to retain more diversity with smaller living captive populations should allow a dramatic (4-10 fold) expansion of the number of species or evolutionary significant units that might be supported with living captive populations and genome banks. This expansion in the number of species to be managed will greatly increase our need for systemic data collection, analysis, and distribution and for simpler development of species management plans. The addition of another mode for protection of species against loss should further secure them from extinction from catastrophic events and the impacts of continuing loss of habitat quantity and quality.

**issues of cryobanking strategies emphasising importation, system management and storage considerations have been previously detailed (Armstrong et al., 1991; Schiewe et al., 1995) and should be used as reference material.

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Evaluation of the AZA Tiger SSP and its relation to the Global Siberian Tiger Program

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Historical Overview of the Tiger SSP

The Tiger Species Survival Plan (SSP) was the first co-operative management program developed for captive populations in North America and has served as a model for subsequent management programs for other species co-ordinated by the American Zoo and Aquarium Association (AZA). The Tiger SSP was initially developed in 1982 by Dr. Ulysses Seal, who served as the Species Coordinator for ten years. Dr. Ronald Tilson took on responsibility for managing the Siberian (Amur) tiger population in 1987, and has served as the Tiger SSP Coordinator since 1992.

Today, the AZA Tiger SSP manages three tiger subspecies in North America as recommended by the Conservation Breeding Specialist Group's Tiger Global Animal Survival Plan (GASP): 154 Siberian tigers *Panthera tigris altaica* (co-ordinated by Ronald Tilson, Minnesota Zoo); 60 Sumatran tigers *P.t. sumatrae* (co-ordinated by Gerald Brady, Potter Park Zoo); and 10 Indochinese tigers *P.t. corbetti* (co-ordinated by Edward Maruska, Cincinnati Zoo).

There are currently 91 zoological institutions in North America which are official participating members of the Tiger SSP. These institutions are distributed throughout the United States and southern Canada over an area greater than that from London to Moscow, Gibraltar to St. Petersburg, and across a wide variety of climates. The Canadian tiger population is managed as a subset of the larger SSP population; transfers across the international border are minimised to avoid to lengthy permit process involved. Each SSP institution signs a Memorandum of Participation and appoints a representative to the Tiger SSP. An annual election is held among these representatives to elect three members to the nine-member management committee, each of which serve three-year terms. This management group works with the co-ordinators and studbook keeper to make breeding and management recommendations for the captive tiger population.

Since 1982 the Siberian tiger SSP population has been managed to produce a gradual decline in the population from about 200 to 150 animals in order to produce cage spaces for the expansion of the Sumatran and Indochinese tiger programs. In addition, no breeding has been recommended for "generic" tigers (those of unknown origin with no designated studbook number), and additional cage space for tigers has been created as these animals gradually die due to old age.

As of October 1995 there are 154 Siberian tigers maintained at SSP institutions, 100 of which comprise the managed population and the remaining 54 being designated as surplus. Historically, 15-35% of the Siberian tiger SSP population have been surplus animals. An individual is declared "surplus" if it is anticipated that it will never breed and contribute genetically to the population in the future. Selection criteria include: low genetic value (the genetic line is overrepresented and therefore the animal has a high mean kinship value); age (the animal is post-reproductive or is aging and is of low genetic value); and sterility or other condition whereby the animal is unable to reproduce. By excluding these individuals from the managed breeding population and from the genetic analysis, it is possible to get a more accurate genetic profile of the managed population. For instance, by including a genetically valuable but post-reproductive female in the genetic analysis, her offspring may not appear as particularly valuable for breeding until after her death. Also, designating an animal as surplus allows an institution more freedom in the management of the animal; for instance, zoos may neuter surplus animals or transfer them to non-SSP institutions without prior approval from the SSP.

The current age structure of the Siberian tiger population suggests a gradually declining population, with surplus animals primarily concentrated in the older age classes. Age-specific fecundity over the past 14 years is an artefact of captive management rather than a biological measure, and indicates that under SSP management conditions, females are most prolific between 5-8 years of age, while males show relatively high fecundity from 5-12 years of age. Mean litter size is 2.45 cubs per litter; most litters contain 2 or 3 cubs, but litters range from 1 to 5 cubs. Neonatal mortality is 34%. For animals surviving to one year of age, mean lifespan is about 13 years. The major causes of mortality in adults based upon necropsy reports are various forms of cancer (especially mammary adenocarcinoma in females) and degenerative joint diseases in older males.

Although the managed population has been down-sized from 200 to 100 tigers over the past 14 years, genetic population measures have improved, suggesting more efficient management. Founder representation for most of the 45 founders is approaching target levels. Recent imports of wild-caught tigers occurred in 1991 and 1993. Each time, a pair of young animals (siblings) was imported after being found orphaned in the wild. The number of founders has increased from 29 to 45 since 1982, with a corresponding increase in the number of founder genome equivalents from 6.961 to 12.664. There has also been a gradual increase in gene diversity retained from 92.8% to 96.1%, with the SSP program goal being the retention of 90% gene diversity over 100 years. Descendant mean kinship, a measure of how related an animal and its descendants are to all other animals in the population, has decreased from 0.0722 to 0.0394, indicating that animals are relatively less related to each other. Finally, the mean inbreeding coefficient has decreased substantially from 0.102 to 0.020, meaning that there have been fewer breedings between close relatives.

Management Processes and Issues

Several processes and lines of communication are used to ensure the effective operation of the Tiger SSP. Annual inventory updates are sent to each institution; these are used not only to verify the current inventory and to request missing information, but also to update any institutional requests on file. These annual updates are meant to serve as back-up confirmation of information continually communicated between zoos and the SSP. Institutions are requested to submit any births, deaths or transfers to the SSP as they occur, so that a current database can be maintained. Copies of all necropsy reports are sent to the SSP as part of an analysis of the causes of mortality in the population. All institutional requests, such as requests for replacement animals, transfers of animals out of the zoo due to lack of sufficient space, and future breeding recommendations, must be made in writing as a form of documentation. Each year after the current inventory has been verified, a new genetic analysis is performed. The SSP management committee then produces a list of breeding recommendations for the next year, a list of recommended transfers to accommodate breedings and institutional needs, and a list of animals that are newly designated as surplus. Modifications to these recommendations are made as needed throughout the rest of the year.

Compliance with SSP recommendations is very good. Institutions rarely breed tigers without an SSP breeding recommendation despite the fact that there is a waiting list and zoos generally wait several years after their request before receiving a breeding recommendation. Institutions do not transfer animals that are part of the managed population to non-SSP institutions, and do not transfer them to other SSP zoos without prior SSP approval. Generally the SSP makes about 15-20 or more transfer recommendations each year, many of which are associated with breeding recommendations. The majority of these transfers are accomplished, but many are delayed due to weather conditions (extreme cold in the north or heat in the south) or because an institution needs to transfer another animal in or out first.

When determining breeding recommendations, the Tiger SSP takes the following factors into consideration in order of importance:

1) Mean Kinship Ranking: An effort is made to breed those animals of reproductive age at or near the top of the mean kinship list, with priority given to those with the lowest mean kinship value (i.e. highest ranked and most genetically valuable). Generally, only animals within the top third of the mean kinship list are given breeding recommendations.

2) Location: Zoos are requested to breed only if they have sufficient facilities and space to have the ability to separate animals if needed. Breeding institutions are required to hold resulting offspring for up to three years before being placed by the SSP. When pairing animals at different facilities, consideration is also given to minimise transfer distance and changes in climate. For example, if genetic factors are roughly equal, it would be preferable to transfer an animal only 90 miles from Milwaukee to Chicago (both cold climates) rather than 1,700 miles from Los Angeles (hot) to Chicago (cold).

3) Institutional Requests: When possible, priority is given to institutions highest on the waiting list for breeding recommendations. Consideration is also given to requests to move out or retain specific individuals at the zoo.

4) Inbreeding Coefficient: When a potential breeding pair has been selected, the inbreeding coefficient of the resulting offspring is determined. An effort is made to minimise inbreeding and avoid inbreeding coefficients greater than 0.100.

Compliance rate is good in that there are very few unwanted litters, and most zoos attempt to transfer and breed animals according to the recommendations; however, not all recommendations result in litters being produced. About 50-70% of the breeding recommendations involve the transfer of one or more animals. As mentioned earlier, this is not always accomplished or may be delayed due to weather conditions (animals often can only be shipped in the spring and fall) or due to other reasons. Breedings are not always successful even if both animals are at the same institution. Various factors may be responsible for this: the pair may not be introduced to each other, they may not be compatible, they may breed with no resulting pregnancy, or one of the animals may be sterile, in poor health, or die before breeding. In the Tiger SSP about 42% of breeding recommendations lead to litters being produced. Often those recommendations that are unsuccessful are carried over to the next year. Over the past six years 60 breeding recommendations have been made, resulting in 62 cubs. Although results are variable from year to year, on average one cub is produced for each breeding recommendation made.

Regional and Global Tiger Populations

Table 1 provides a brief comparison of the current status of the North American SSP and European EEP Siberian tiger populations. A third large captive population of Siberian tigers is held by zoos in Japan but this population is not included in this analysis. The EEP tiger population is larger, with 219 tigers compared with 100 tigers in the SSP managed population.

The EEP population is also based upon more founders (53, with a potential of 65). However, the percent of gene diversity retained and the number of founder genome equivalents is essentially the same between the two populations. The average inbreeding coefficient is higher in the EEP but is relatively low for both populations. Overall the SSP is able to manage a smaller population as effectively as the larger EEP population, but has the distinct advantage of few international borders and a common language.

The North American captive population has 17 founders that are not represented in Europe and Europe has 36 founders not represented in North America. If these two populations are combined and managed as a single population, one might intuitively expect a noticeable genetic benefit. In reality, there is only a relative small increase in founder genome equivalents and percent of gene diversity retained. The addition of new founders has the greatest impact on a population when the total number of founders is low, but a much smaller impact as the number of founders increase. However, the potential of each of the two populations managed individually, as well as the potential when they are managed as one population, is quite high; the percent of gene diversity retained has the potential to be as high as 99.1%. To reach this potential would require "perfect" management based upon genetics without practical or political considerations and therefore is probably not achievable.

The bottom line is that overall both the SSP and EEP Siberian tiger populations are currently in relatively good shape. Complete integration of the two programs is unnecessary and impractical. If, however, animal exchanges are considered between the two regions, there are a few animals in North America that represent founders close to their target representation in North America but are not represented in Europe; likewise, there are well-represented animals in Europe that are unrepresented in North America. These animals are young or are of breeding age and would make good candidates if an exchange was made between the regional programs. Such exchanges would provide the most benefit with the least effort. It is most important, however, that both the SSP and EEP continue to manage their Siberian tigers as effectively as possible to achieve their program goals. By doing so, we can strive to maintain the relatively high quality of the global captive population of Siberian tigers.

Table 1. Comparison of the SSP and EEP managed Siberian tiger populations.

	SSP	EEP	Both	Potential
Total population size	154	219	373	
Managed population	100	219	319	
% gene diversity	96.1	96.0	96.8	99.1
# of founders	45	53	70	81
# of F.G.E.	12.658	12.203	15.799	58.608
# unique founders	17	36		
Desc. mean kinship	0.0398	0.0412	0.0317	
Mean inbreeding coeff	0.020	0.063	0.046	

The Tiger Global Animal Survival Plan: Russia and the EEP

Dr Ronald L Tilson, Tiger SSP Co-ordinator

The Tiger Global Animal Survival Plan (GASP) represents the first version of a strategy for the co-ordinated international management of captive and wild tiger populations under the aegis of the Conservation Breeding Specialist Group (CBSG) of the Species Survival Commission (SSC) of the World Conservation Union (IUCN). It was generated during an international workshop on tigers in July 1992 at the Edinburgh Zoo, Scotland, and was revised at the Annual Meeting of the IUCN/SSC CBSG in Antwerp, Belgium in September 1993. The Tiger GASP is a management strategy for tigers at the international level that links *in-situ* (in the habitat) and *ex-situ* (captive management) conservation activities for the recovery and long-term maintenance of wild and captive populations.

Some elements of the Tiger GASP that address global responsibilities include:

- Adopting global goals for tigers, in part by considering recommendations from the IUCN Cat Specialist Group and from CBSG Conservation Assessment Management Plans (CAMPs) and Global Captive Action Recommendations (GCARs);

- Dividing responsibility for achieving minimum target population sizes of captive tigers among the regional programs, centred in tiger range countries;

- Arranging tiger or genome exchanges among regional management programs to achieve global and regional goals;

- Linking captive regional programs with the conservation of wild tigers; and developing a global masterplan to guide the management of tigers at the international level.

A primary focus of the Tiger GASP is development of captive management programs that will provide genetic and demographic reservoirs to support the survival and recovery of wild populations in the future. To accomplish this, a global captive conservation program for tigers is being initiated by providing a strategic framework for the most efficient application and economic allocation of zoo resources for tigers. Another emphasis is on ways the world zoo community can share its technical information and expertise with those who work with wild tiger populations.

The Tiger GASP is managed through recommendations made by the Tiger GASP Committee comprised of members representing regional zoo organisations in the tiger range countries, the Cat Specialist Group and CBSG, the International Tiger Studbook Keeper, and tiger co-ordinators from North America, Europe, India, China, Thailand, Malaysia, Indonesia, Japan, and Australasia.

The Tiger GASP recommends a global minimal target population size of 250 tigers in captivity for each of the five subspecies. It also suggests how this number can be most satisfactorily distributed among various regional programs. A population size of 250 tigers for each subspecies will be sufficient to preserve 90% of the genetic diversity of each population for 100 years. As a first priority, a captive management program for each subspecies should be developed in its country of origin. Ideally, at least one additional captive management program should be developed by another region to prevent loss of a subspecies due to biological, economical or political catastrophes.

For the North American captive management program (the American Zoo and Aquarium Association's Species Survival Plan, or SSP), the Tiger GASP recommends that the currently available 290 spaces for tigers in zoos be dedicated to captive programs for Siberian, Sumatran and Indochinese tigers. In working toward this goal, the Tiger SSP is eliminating any remaining generic tigers from our zoos through attrition and gradually decreasing our Siberian tiger population to allow for the expansion of our Sumatran and Indochinese tiger programs. For the European EEP tiger management program, the Tiger GASP recommends concentration on captive programs for Siberian and Sumatran tigers, and possibly developing a program for Bengal tigers as well. Again, elimination of tigers of unknown origin and reduction in the number of Siberian tigers would allow for the gradual growth of a third subspecies program in Europe.

A goal of the Tiger GASP is to link captive tiger programs with the conservation of wild tiger populations. The Tiger GASP recognises the value of Population and Habitat Viability Assessment (PHVA) Workshops, which focus primarily on distribution, threats and status of wild tiger populations. It also recognises the value of genome resource banking (GRB) and assisted reproductive techniques for enhancing populations of tigers both in captivity and in the wild.

The Tiger GASP has been recognised as a strategic document by the world zoo community managing tigers. These regional programs are: Australasian Regional Association of Zoological Parks and Aquariums (ARAZPA), Perhimpunan Kebun Binatang se Indonesia (PKBSI), Southeast Asian Zoo Association (SEAZA), Zoological Parks Organisation of Thailand (ZPO), Indian Zoo Association (IZA), Chinese Association of Zoological Gardens (CAZG), Japanese Association of Zoological Gardens and Aquariums (JAZGA), American Zoo and Aquarium Association (AZA), and the European Association of Zoos and Aquaria (EAZA).

Implementation of the Tiger GASP has already begun. The following is a summary of some of its programs for captive and wild tigers in Southeast Asia.

Siberian Tiger Program

With only 150-250 Siberian tigers left in the wild, the status of this subspecies is critical. This special meeting of the EEP will further the development and integration of the global captive management program for Siberian tigers, particularly the increased incorporation of zoos in Russia. The wild Siberian tiger population has been the focus of a four-year Russian-U.S. field study in Sikhote-Alin Biosphere Reserve in the Russian Far East by the Hornocker Wildlife Research Institute. Thirteen tigers have now been radiocollared to collect information regarding tiger natural history parameters. Additionally, anti-poaching patrols have been established in the area to dissuade illegal taking of tigers.

South China Tiger Program

The South China tiger is the most critically endangered of the five remaining tiger subspecies. Perhaps fewer than 20 remain in the wild, and the possibility of conducting a field census and Population and Habitat Viability Assessment for the wild population is being pursued. Only 50 South China tigers are in captivity, all in Chinese zoos. Several tiger specialists met in China last April to assist in the development of an accurate South China Tiger Studbook and to initiate a masterplan for the subspecies. This team will return to China in November 1995 following this meeting to evaluate animals, facilities, and management procedures at four of the major China zoos and to train Chinese zoo staff in tiger management.

Indochinese Tiger Program

The 1,000 - 1,750 wild Indochinese tigers are spread across several political boundaries, including the countries of Vietnam, Lao, Cambodia, Malaysia, Thailand and Myanmar. Many of these populations are fragmented and are still subjected to pressure from poaching. An assessment of wild tiger populations in Thailand is now underway, including Geographic Information System (GIS) analysis. In July 1995 an Indochinese Tiger masterplan workshop was held in Thailand to establish a captive management program in Thai zoos. A strong captive program for Indochinese tigers is already established in Malaysia, and Southeast Asian zoos holding this subspecies need to be integrated further into a co-operative management program.

Bengal Tiger Program

Project Tiger has been operating in India for the past 25 years to protect wild Bengal tiger populations and their habitat. With 3,250 - 4,700 tigers in the wild, the Bengal tiger is more secure than the other four tiger subspecies, but is still under threat from fragmentation and poaching. Recently the Indian zoo captive tiger program has been strengthened with the development of a regional studbook for Bengal tigers.

Sumatran Tiger Program

The Sumatran tiger has been the focus of the most extensive projects initiated through the Tiger GASP. Over the past three years a team of tiger specialists has made several trips to Indonesia to establish a regional Sumatran tiger studbook, evaluate all of the tigers in the captive program, train Indonesian zoo staff, and initiate the development of an Indonesian masterplan for Sumatran tigers. Genetic samples obtained through this project are currently being analysed to guide the management of tiger regional programs. In 1992, a CBSG Population and Habitat Viability Analysis (PHVA) was held in Padang, Sumatra, which estimated the wild populations to be about 400 - 500 animals. This led to the development of the Sumatran Tiger Conservation Strategy by the Indonesian Department of Forest Protection and Nature Conservation. In June 1995 a four year field study was initiated in Way Kambas National Park in South Sumatra. This study will use remote camera censusing and radiotelemetry to monitor and collect information on wild tiger populations, and also includes a community education component.

Although the Tiger GASP was only developed three years ago, we have come a long way already toward its implementation. The further development and integration of a global management program for captive Siberian tigers by the participants of this conference is an important component of the Tiger GASP management strategy.