台灣黑熊族群與棲地存續分析保育研習會

ASIATIC BLACK BEAR

Ursus thibetanus formosanus

POPULATION AND HABITAT VIABILITY ASSESSMENT WORKSHOP

中華民國八十三年六月十四一十六日

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台北市立動物園

Taipei Zoo
Taipei, Taiwan

REPORT

Ying Wang, See-wu Chu, and Ulysses S. Seal (Editors)

行政院農業委會
台北市動物園之友協會
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PREFACE

「族群與棲地存續分析技術應用於本土野生動物—以台灣黑熊爲例—的保育研究」研習會報告序言

首先代表台北市立動物園由衷的感謝大家來到本園，參加「族群與棲地存續分析技術應用於本土野生動物—以台灣黑熊爲例—的保育研究」研習會。在爲期三天的研習過程中，應用族群與棲地存續率分析（Population and Habitat Viability Assessment，PHVA）技術爲基礎，整合包括台灣黑熊在內的亞洲黑熊現況資料，然後研判其在台灣本島所受棲地減少及瀕臨絕種的危急程度，並仔細評估其未來發展的可能性，提供未來對拯救台灣黑熊採取保育措施的建議。

選擇台灣黑熊做爲研習主題的原因，在於台灣黑熊是比較危急的瀕臨絕種野生動物，而且全世界的黑熊保育工作正積極的進行中。以本園立場而言，選擇黑熊爲對象，是考慮園內黑熊一直未曾繁殖成功，希望藉由圈養繁殖專家群的專家及其提供的技術，協助本園解決圈養繁殖問題。然而此一改善野生動物圈養繁殖只是此次研習會目標的一小部分，其整體目標則是配合全球黑熊的保育工作。集合專家學者、執行保育工作的政府人員、及社會上關心動物保育的機構及人士，在研習期間從行政、學術、管理、執行等有關野生動物保育的工作進行多面的探討。研習範圍包括棲地、族群、貿易、藥政、未來保育策略、教育推廣等等，是一個全方位的研習工作。這是運用科學理性的方法，匯整以前收集的資料，進而提供日後保育工作努力的方向。

我們知道圈養繁殖專家群（Captive Breeding Specialist Group，CBSG）是國際自然保育聯盟（International Union of Nature and Natural Resources，IUCN）之下，針對圈養繁殖事務所組成的專家小組，成立至今已有十五年歷史，二千多位專家參與，並在全球各地舉辦過七十多場的族群與棲地存續分析研習會。很榮幸的首度在台舉行的族群與棲地存續分析研習會由我們動物園主辦，誠摯的感謝行政院農業委員會的經費補助和台北市動物園之友協會的贊助，而所有會務人員的辛勞努力，使本會得以如期舉行，在此敬致最大的感謝！

此次研習會是中外保育工作專家學者相互學習的活動。研習人員的與會情形如下：國外方面由圈養繁殖專家群主席Seal博士率領其專家群中對全世界熊有專門研究的Garshelis博士以及有豐富經營動物園經驗美國奧勒岡州波特蘭市華盛頓動物園園長盛佑中女士參加，國

内則爲各大學相關科系教授及研究生、政府各保育及其相關單位之先進和民間保育團體的有識之士，並聘請師大教授王穎博士做分組研習的協調人。研習内容則包括野生族群模型建立、動物遺傳、疾病、繁殖生物學、保育計畫及策略擬定、保育教育等。研習過程中並將與會討論小組分爲：政策與法律、黑熊利用的管理、物種保存飼育技術、保育生物學研究、保育教育策略、PHVA技術之運用等六方面。經過三天的腦力激盪，提出確切的問題並討論尋求解答，然後將這些問題與解答綜合討論，最後再將討論結果融合成此一完整具體並具有建設性的報告。如此繁重的工作是在短短三天研習期間，所有研習人員秉持著無比的熱誠與耐力日以繼夜完成。這是一個既艱鉅又具高度專業性的研習會。

最後本人對參加此次研習會所有人員致上萬分敬意及謝意，不論是分組研習人員、協調人員及幕後工作人員，此研習會之順利完成，實由各位群策群力盡心盡力的結果。本園對於野生動物保育工作向來是不遺餘力，期盼各位除了致力於研習的課程外，也能對本園的飼養管理、景觀規劃、教育服務等多方賜教，促使本園邁向國際化的保育重鎮。

台北市立動物園園長
暨研習會主持人
朱錫五

ASIATIC BLACK BEAR

Ursus thibetanus formosanus

POPULATION AND HABITAT VIABILITY ASSESSMENT WORKSHOP

REPORT

Section 1

Executive Summary and Recommendations

摘要報告

由於棲地的破壞及過度的獵捕，台灣黑熊族群減少，分佈變小，其族群面臨滅絕危機，由過去5年內的調查資料顯示，其在野外的族群估計可能尚有百隻以上，主要（約90％）分佈在中央山脈兩側海拔1000公尺以上人煙較少之山區中。由北部之插天山往南至南部大武山區，此外在花東之海岸山脈亦曾有紀錄，有關本科詳細之資料則不清楚。

台灣黑熊由於具有相當的經濟價值，其爲原住民傳統上獵捕的對象，由於常有侵入農地、破壞農作之例，被視之爲危害性生物，加以體形壯碩，令人畏懼膽顫，此外，其膽及掌等在東方傳統醫學及食用上的利用價值很高，亦造成各個不同階層及種族之人們對本種在價值觀的有很大的歧異，此爭議間接影響到政府至公眾間對本種保育及研究工作的支持及所應採用策略之分歧。

爲有效保護本種使其免於在野外絕種，台北市立動物園乃於民國83年6月14～17日以4天時間在園方舉行台灣黑熊拯救計劃之研討會，邀請聯合國IUCN物種保存計畫CBSG的專家Dr.Seal, Dr.Garshelis,及Ms. Sheng蒞臨現場指導，分享世界黑熊的保育現況、並提供小族群生物學理論的技術指導，包括利用先進之物種群評估分析模式(VORTEX)，針對現有的台灣黑熊資料及輔以相關物種的資料進行模擬分析，以明瞭目前各種存在之威脅因子對本種未來生存之可能影響程度。大會的程序由Dr. Seal負責推動，師大生物所王穎教授擔任協同主持人。

四天的會議中第一天由大會委請國內之生物學者、中醫學者、民間團體代表、政府官員、原住民代表及國外專家針對黑熊現存概況及研究成果做一背景資料之介紹，並於會後晚間組成以下六個小組：

一、法律、政策與國際合作小組
二、台灣黑熊利用管理小組
三、野外族群之保育管理小組
四、圈養族群之保育管理小組
五、保育教育計劃小組及
六、VORTEX分析小組

每個小組分由國內相關的學者擔任小組聯絡人，由與會者自行選擇組別參加，第一次的會議的工作係成員相互認識並針對相關議題，提出討論題綱：

第二天上午國外專家針對VORTAX之分析進行詳細介紹，後於下午開始進行第二之分組討論，各組於二個半天的討論後，於第二天下午提出各組的近、中、長程行動建議的中英文稿，以供CBSG小組二位外賓了解。各小組的討論結果，請參考本報告的各章節，不再贅述。

爲了有效的提出更整合性的台灣黑熊之保育行動計畫，大會又針對黑熊目前所遭受的問題將討論主題重新組合成5個問題，分別爲：

一、根據現有的資料，利用VORTEX程式來預測台灣黑熊在各種不同程度之威脅下未來的命運。
二、如何有效管制現存之偷獵活動。
三、如何防止現在棲地之破壞，並進一步增加未來可用之棲地以提供永續族群生存量(Evolutionary viable population size)之生存空間。
四、如何綜合各種不同價值觀（如文化、傳統……），達成對台灣黑熊利用哲學的共識。
五、如何增進對台灣黑熊族群現況及危機之了解，結合現有資源掌握其脈動並發展出適當的方式，有效地收集並監測未來台灣黑熊族群的概況。

在大會討論中，由全體與會人員針對以上問題提供各組對該問題之看法及意見，並包括短、中、長程之建議及計劃。第二階段的討論結果在第4天由小組聯絡人綜合整理成以下摘要建議。

一、VORTEX預測

根據現有台灣黑熊的資料配合中國大陸飼養熊及美洲黑熊野外資料，我們預測台灣黑熊若受到較好的保護，其偷獵小於5%時族群會顯著的增加，視其原始的族群數量而異(100～400)，其在80年至100年以上會達到其環境之負荷量，若偷獵之比例在7.5%則族群持平微揚，偷獵之比例在10%則族群在未來的百年內會減少至極易滅絕的數量（不論原始數量爲何，其皆在50隻以下），若偷獵比例在15%，則族群在六十年至八十年間全部滅絕。若考慮族群在不同地區所受到不同程度的保護時，則受到較保護的地區（<5%的獵捕率）族群會增加至其環境之負荷量，而保護區外之族群（10～15%的獵捕率）其族群則持續下降或滅絕。在此情況下，無法維持一個永續生存之族群量，由於目前資料有限，使用的數據仍然有待校正，爲有效預測及保護其族群及對其族群動態之掌握，國內學者應積極進行獵捕率之估算，族群分布與棲地調查，及個體生物學之研究，並廣泛收集本種的生態背景資料。

二、如何防止現有的偷獵活動

爲降低或消除目前野生族群下降之趨勢，在減少盜獵方面，需積極促使政府健全法規體制，設置保育警察，森林警察，同時設立獎勵、升遷辦法以鼓勵非獵人之居民或警察報告遭誤捕之黑熊及取締偷獵事宜，並對當地居民對黑熊的保育成果予以獎勵。就長期而言，擬定結合當地居民參與的資源經營管理計畫，將更有助於黑熊的保護。另外，加強現有國內相關熊及其產製品市場的管理，現階段應禁止中醫藥外之所有的消耗性使用方式。建議必要時以合法方式進口美洲黑熊熊膽滿足國內傳統中藥市場需求，國內也應配合熊膽替代品持續的研發及宣導，有效的減少本地野生族群遭盜獵的誘因。

三、如何執行棲地之保護

在棲地保護方面，應依現有的法規嚴加管制海拔1000公尺以上高山地區的超限利用，海拔2500公尺以上地區因爲涉及國土保安及水源保護應禁止開發，

必要時透過環境影響評估之審查，減輕其影響。在現有高山保護區間，宜設立緩衝地帶管制與棲地消失及干擾有關的各種開發及土地及資源利用，以保護隔離族群間個體交流之走廊與未來族群數成長所需之空間。至於其他現有各小型隔離族群外圍，應增加其族群存活機率。另建議由現行保育主管機關召集黑熊棲地主管機關行政人員、學者專家、及民間團體組成任務小組，負責研議加強我國自然保護區體系縱向及橫向的聯繫，並規劃新的自然保留區，以及增設野生動物遷移走廊，以加強各保護區管理單位間的協調及研究站的設立，並減少橫貫中央山脈之開發計畫。

四、黑熊價值觀之共識

在教育宣導方面，應由教育機關、國家公園、動物園等或民間團體舉辦活動，說明黑熊爲生態系之旗艦種，保護黑熊即保護生態環境。增加民眾對黑熊的認識以降低恐懼感。與傳統醫藥團體業者溝通協調合作，停止使用稀有或瀕臨絕種之黑熊，對民眾傳達正確的中醫藥觀念降低熊膽及其他產製品之使用。鼓吹非消耗性之使用如生態旅遊等。

五、掌握黑熊的現況及未來

爲掌握台灣黑熊復育計畫之進度及執行狀況，宜成立台灣黑熊工作小組，針對各種黑熊面臨之問題定期檢討，擬定因應策略，並修正各項復育措施。該小組應規劃行動方案，整合野生及飼養族群資料，以對本物種之復育做出最大的貢獻。另外也建議成立台灣黑熊保育基金會向民間及企業籌募款項，長期支持黑熊保育工作及調查、並教育當地居民、社會大眾對黑熊的保育認知。

EXECUTIVE SUMMARY

As a result of habitat destruction and over-exploitation, the bear population in Taiwan has decreased both in numbers and in distribution. The Formosan bear was proclaimed an endangered species under the Cultural and Natural Heritage Act in 1986. Results from a few preliminary surveys within the past 5 years indicated that probably over 100 bears still exist. Over 90% of the sightings were recorded along the central mountain range at over 1000m in elevation, where there is little human inhabitation. The distribution stretches from Chatien Mountain in the north to Tawu Mountain in the south (Fig. 1). Some sightings also were recorded in the eastern coastal mountain range. Aside from this sighting information, the general biology and other information pertinent to conservation of this species is completely lacking.

There are many threats against the Formosan black bear. Because of its high economic value, it has been targeted by aboriginal hunters. Bears also raid agricultural fields and thus are sometimes considered a pest. Being the largest carnivore on Taiwan, the bear can create fear among the public. Additionally, the gall bladder is considered a valuable medicine in traditional oriental culture and bear paw is considered a delicacy. As a consequence of differing attitudes among people towards the use of this species, a diverse spectrum of viewpoints exist regarding approaches necessary for its conservation, leading in turn to varied policies among governmental agencies.

As a first step in developing a unified approach for protecting this species from extirpation in Taiwan, the Taipei Municipal Zoo held a Population Habitat Viability Analysis workshop, during June 14-17, 1994. Dr. Ulysses Seal, chairman of the IUCN Captive Breeding Specialist Group, Dr. David Garshelis, Bear Specialist with the Minnesota Department of Natural Resources, and Y. Sherry Sheng, Director of the Portland Zoo, were asked to participate in the workshop, providing lectures about small population viability and current status of Asiatic black bears in the world. The primary function of these specialists was to demonstrate and assist in the application of a population modeling technique (VORTEX), integrating available data on Asiatic and American black bears to generate risk analyses for the Formosan bears. The workshop was facilitated by Dr. Seal and Dr. Ying Wang, professor of wildlife biology, Taiwan Normal University.

Attendants of the 4-day meeting were composed of scholars, specialists in bear biology and Chinese medicine, NGO representatives, governmental officials, aboriginal representatives, and international experts. During the first day, the current status of the Formosan bear and other related research were presented to provide the background for subsequent discussion.

Six working groups were formed after the daytime session to deal with the following issues:

1. Law, policies, and international cooperation.
2. Utilization and management of the Formosan bear.
3. Conservation and management of wild populations.
4. Captive breeding and management.
5. Conservation education.
6. VORTEX simulation modeling of risk analysis.

Each working group was led by a specialist coordinator to facilitate the group discussion. Attendants were free to join any of the groups. After a brief introduction of the participants of each group, an outline was developed for the subsequent day's discussion. During the morning session of the second day, the VORTEX model was presented in a plenary session; bear data were then incorporated in the model to make preliminary runs of risk analysis. During the afternoon session, individual group discussions resumed. After two half-day discussions, a plenary session was convened in the afternoon of the third day, and each group presented the results of their discussions related to short and long-term conservation goals for the Formosan black bear. A synopsis of those results is presented in the chapters of this report.

In order to effectively incorporate each groups recommendations in an action plan for the conservation of the Formosan black bear, the plenary session reorganized results to highlight 5 major themes most pertinent to the threats impinging on this species, posed as the following questions:

1. What are the greatest risks facing this population? Although few data specific to this population are presently available, VORTEX analyses were used to assess the risks of poaching and consequent population fragmentation on population viability.

2. How can we most effectively control poaching?

3. How can further habitat deterioration be prevented; moreover, how can habitat be increased to ensure a viable population size?

4. How can various viewpoints and values, stemming from different cultural traditions and ethnic groups, be integrated to reach a consensus about utilization of Formosan black bears?

5. How can we improve our degree of knowledge regarding the population status, and what are the best ways of dealing with the apparent population crisis?

During the plenary discussion, participants provided comments related to these points from the point of view of their group discussion. These responses were synthesized by each group coordinator and are summarized as follows:

1. Assessing Risks:

The VORTEX analysis combined available data for the Formosan bear, captive bears in mainland China, and wild American black bears. The model predicted that under reasonably good protection (poaching rate <5%), the population would increase, and could possibly reach carrying capacity (assumed to be about 2,000 bears) in about 80-100 years, depending on the present population size (estimated at 100-400 bears). If the poaching rate is 7.5% the population would remain stable or could slightly increase. If the poaching rate is 10%, the model indicates that the population will decrease to a critical number which is highly subject to extinction sometime over the next 100 years, regardless of the present population size (the population size after 100 years would be reduced to <50). If the poaching rate is 15%, the population would be extirpated within 50-80 years. If we consider protected areas as having lower levels of poaching (i.e., 5%) than elsewhere, the population in the protected areas could increase (to some carrying capacity) while populations outside these protected areas would continue to decrease and eventually become extirpated (in the sense that there would be no reproductive females); in the long run, the total island-wide population would become so fragmented that it would likely not be viable. These model runs were only preliminary assessments, based mainly upon data extracted from other sources. To accurately assess and effectively protect this particular population, a field study investigating the effects of poaching would be of paramount importance. Additionally, in the course of such a study, valuable information would be obtained on other aspects of the distribution and biology of this little-known bear, which could be used to refine the inputs of this model.

2. Controlling Poaching:

To reduce the level of poaching, the government must be urged to modify laws and enforcement strategies. For example, the government should consider developing a force of forest rangers and conservation police. In the meantime, a system should be established whereby local people are rewarded for reporting bears incidentally captured in traps set for other species, and police could be rewarded for assisting in the release of incidentally captured bears and for apprehending poachers. Rewards also should be established for achievements by local people in the conservation of black bears. For successful conservation in the long-term, we should invite local people to develop and participate in resource management plans. There also must be greater control of the commercial use of bear parts. At the present time, all types of consumptive use of bears must be stopped, excepting traditional medicinal use. If necessary, it is suggested that the legal importation of gall bladders from North American bears might fulfill the need of local markets. In the meantime, people should be educated to use substitute products and more research should be directed at finding effective substitutes for bear gall in traditional Chinese medicine.

3. Protecting Habitat:

Under existing law, the government needs to strictly enforce restrictions against the overuse of the land above 1000m, because this area contains the only remaining range of the black bear. Further development should be prohibited on lands over 2500m, due to its additional value in soil and water conservation. If necessary, development could be prohibited or mollified in specific cases through the process of environmental impact assessment. Buffer zones and corridors should be established around and between parks in the high mountain region to avoid habitat fragmentation and ensuing risks associated with small population size. Where lands pertinent to bear survival are owned by a variety of agencies, a commission should be formed by all representatives, organized by the primary conservation agency in charge. This commissions's responsibility would be to ensure that the various landowners act in a consistent way to protect land from development, establish new protected zones or corridors, or set up research stations.

4. Developing a Consensus about the Value of Bears:

Various groups responsible for public education, including national parks, zoos, schools, and NGOs should stress the relationship between the bear and its environment, and the bear's position as a flagship species for conserving entire ecosystems. The public also should be educated to reduce unnecessary fear of the bear. The community involved in traditional Chinese medicine should be educated regarding the risks that their use of bear parts impose on the viability of the bear population. This community should also be given a broader concept of the use of traditional medicinal practices and the potential for substitutes for bear products. Nonconsumptive use of bears also should be promoted in the framework of ecotourism, but concurrently, tourists and others should be encouraged to avoid activities that might adversely affect the environment of bears.

5. Implementing Strategies:

A working group on Formosan bears should be formed to monitor the progress of the recovery of this population. This group should meet regularly to review the problems facing this population and revise, if necessary, strategies to most effectively provide solutions. An action plan for recovery should be established by this group using an integrated database from wild and captive studies. Monies should be obtained from both public funds and private enterprise for the establishment of a Formosan black bear foundation which could support long-term research, conservation efforts, and educational campaigns aimed at fostering a healthy view towards conservation of Formosan black bears.

ASIATIC BLACK BEAR

Ursus thibetanus formosanus

POPULATION AND HABITAT VIABILITY ASSESSMENT WORKSHOP

REPORT

Section 2

Distribution and Population Status of the Asiatic Black Bear on Taiwan and Globally

台灣黑熊之分佈與現況

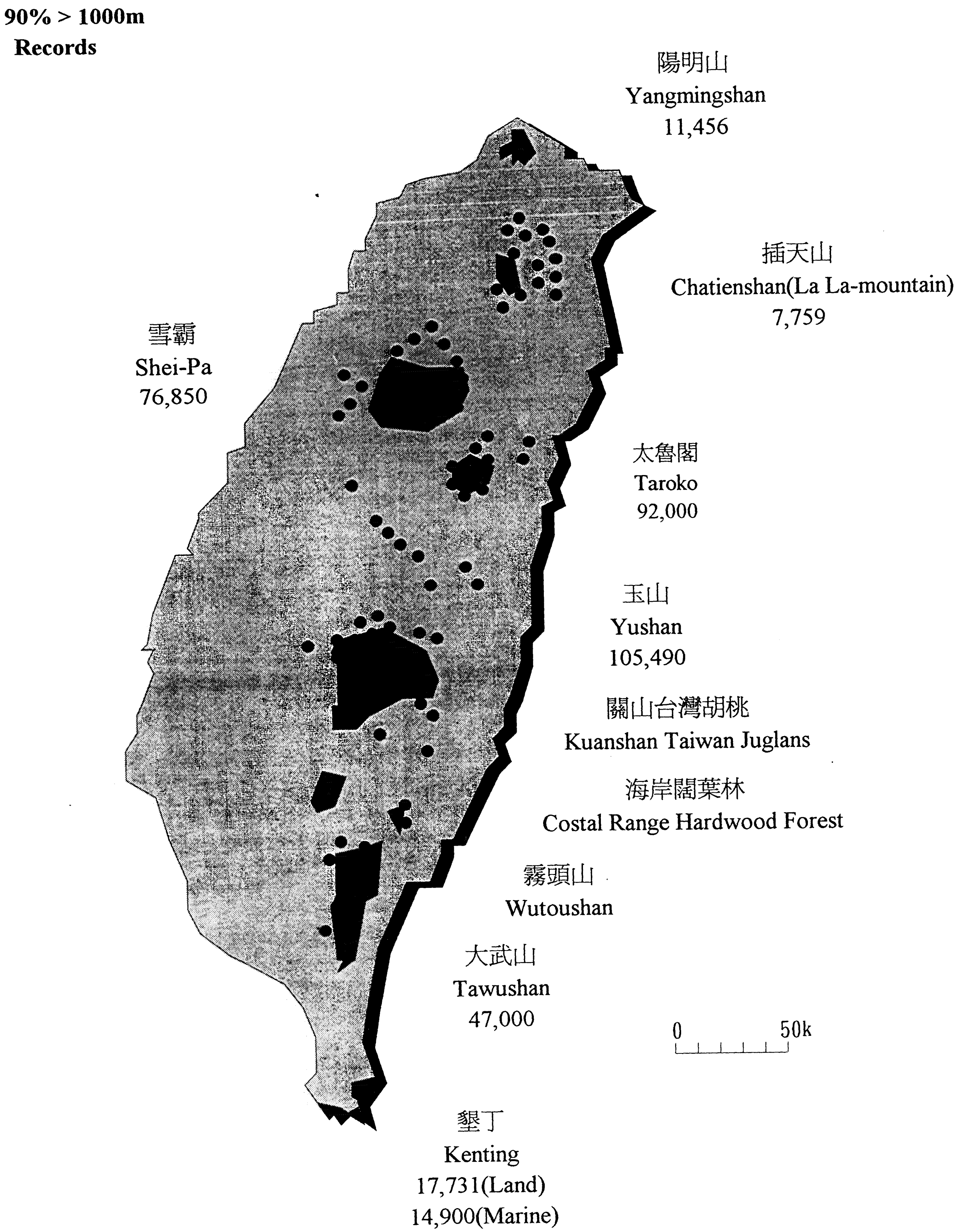
台灣黑熊爲台灣特有亞種，早期之記錄由低海拔至高海拔皆有分布（鹿野，1930；掘川，1936），近年來由於棲地遭到破壞，範圍有口漸減縮的趨勢(McCullough, 1974; 林，1985;　王等，1989;王及王，1990;王及陳，1991)。由其發現地點之海拔分布來看，王及王(1990)記錄其垂直分佈在200～3500公尺以上，而其中95％之出現地點皆在1000公尺以上。又據王及陳(1991)之1000公尺以上。由於本種係山地獵人傳統之狩獵對象(McCullough, 1974;顏，1979)，1980年來更由於山產店的興起，野生動物的需要量大增，益加重其獵捕壓力（王，1986;1988;王及林，1987;王等，1989）。在1989年野生動物保育法通過後，商業上公開的需求受到法律的管制，但黑市的交易所造成之盜獵現象仍然持續。根據研究者1993年7月至1994年6月初部之記錄，共累積熊蹤或熊跡14筆的資料中顯示，其由北往南熊分佈於中央山脈兩側，其中至少有10筆是在國家公園或是保護區內被發現者，若綜合目前與以往5年中所見之報告及參考林務局的森林資源調查報告，將1988年以來至今所見熊之地點初步歸納顯示，熊之分佈由北邊之哈盆（插天山之北）到南部之大武山（圖一）沿中央山脈兩測皆有其零星之分佈。此外，雪山山脈（雪霸國家公園）及海岸山脈亦有記錄，其中幾個集中之地點由北往南分別爲插天山（拉拉山）及其附近地區，雪霸及太魯閣國家公園及其周遭地區、玉山國家公園及其附近、大武山自然保護區等。此外，在太魯閣及玉山國家公園之中間亦有相當之記錄。若將此些區域連接當做黑熊的棲地及發展空間，則面積約有一百萬公，頃而就目前熊出現在各國家公園及保護區內的面積，初步估計約爲33萬公頃，大部分之熊分佈的記錄多集中在這些保護區及其附近，顯示熊目前在台灣分佈的概況，保護區扮演了相當的角色。

THE STATUS AND DISTRIBUTION OF THE BLACK BEAR ON TAIWAN

Ying Wang, Institute of Biological Science, National Taiwan Normal University, Taipei, 117, Taiwan

The Formosan black bear, an endemic subspecies of Taiwan, was, according to early records, distributed both in low and high elevations. However, due to habitat destruction in recent years, its distribution, gleaned from sightings, has decreased (McCullough 1974, Lin 1985, Wang et al. 1989, Wang and Wang 1990, Wang and Chen 1991). These sightings indicate that the bear's distribution is presently limited to 200-3600m elevations; nearly 90% of the sighting records were at elevations >1000m. This species is a traditional target of aboriginal hunters (McCullough 1974, Yen 1979), and the commercial marketing of game meat and the medicinal use of parts from this species increases hunting pressure (Wang 1986, 1988; Wang and Lin 1987; Wang et al, 1989) In 1989, after the passage of the wildlife conservation law, bear meat and parts could not legally be sold, but an illegal market persists.

During recent surveys (July 1993-June 1994), bear sign could still be found along both sides of the central mountain range from north to south. About 40% of these sightings were found within the boundaries of national parks or other protected areas. Combining sighting reports from field surveys during the past 5 years with information obtained by the Forest Bureau during the past 3 years, we found that bears were distributed along the Central Mountain Range from the Hapan area (north of Chatien Mountain) south to Tawu Mountain (Fig. 1). Additional sightings also were recorded in the Snow Mountain area and the Coastal Mountain Range. Several concentrated sites of bear activities could be identified, especially areas in and in the vicinity of 3 national parks and 2 reserves, which included (from north to south): Chatienshan Reserve (La La Mountain), Shei-Pa National Park, Taroko National Park, Yushan National Park, and Tawushan Reserve, as well as the area between Taroko and Yushan. Connecting this broad area where bears or bear sign have been sighted, and considering this the principal remaining bear habitat on the island, bear habitat totals roughly 1 million hectares. Of this, about 330,000 ha are within protected areas. The fact that most sightings occur within or in the vicinity of national parks or reserves indicates that protected areas play a key role in maintaining the present bear population.



1988/9~1994/6 (Ying Wang)

GLOBAL STATUS OF THE ASIATIC BLACK BEAR

David L. Garshelis, Minnesota Department of Natural Resources, 1201 E. Hwy. 2, Grand Rapids, MN, 55744 USA

Asiatic black bears (*Ursus thibetanus*) share a common ancestor with the American black bear (*Ursus americanus*). That ancestor, thought to be the so-called Etruscan bear (*Ursus etruscus*), apparently lived throughout Europe and as far east as China. The modern distribution of the Asiatic black bear includes only Asia, with the western-most limit in Afghanistan, but there is some evidence that the original distribution extended as far west as Germany (Kurten 1976).

The present distribution of the species is broadly disjunct, with a large gap in central China that separates the span across southern and southeast Asia from the range in northern China, Korea, Russia, and Japan (Fig. 1). Certainly this range was at one time continuous (and some old range maps show it to be, although possibly in error [Lekagul and McNeely 1977]). In reality, the present distribution is far more fragmented than can be shown on a global range map, as the species has been relegated mainly to protected areas that not only preserve forests but limit hunting and poaching.

The status of the Asiatic black bear is strikingly different than that of the American black bear. The range of the American black bear, which includes Canada, the U.S. and Mexico, is also highly fragmented in some areas (e.g., southeastern U.S.), but there are also broad expanses of continuous habitat supporting large populations. Continent-wide, American black bears probably number >600,000 (TRAFFIC USA, unpubl. rep., 1994; D. Garshelis, unpubl. data); although no substantiated estimates exist for the total population of the Asiatic species, it is likely about an order of magnitude less. Also, whereas the North American black bear is classified as a game animal in most parts of its range, supporting a sustained annual harvest of >40,000 (Servheen 1990; TRAFFIC USA, unpubl. rep., 1994; D. Garshelis, unpubl. data), legal hunting of the Asiatic black bear persists in only a few countries, and the total worldwide harvest is rather insignificant. Despite high annual harvests of American black bears, populations in most areas are reportedly stable or increasing (Garshelis 1991; TRAFFIC USA, unpubl. rep., 1994); conversely, most populations of Asiatic black bears appear to be decreasing, and in many areas are facing threats of extirpation.

Because the American black bear is an important game species, much work has been done to monitor population sizes, trends, reproductive rates, and rates and sources of mortality. In contrast, demographic information for the Asiatic black bear is virtually nonexistent. This report reviews available information related to the status of this species throughout its range, and discusses protective measures as well as continuing threats to population viability in the countries that it currently inhabits. This paper is not meant to be an exhaustive treatise on this subject, but rather a general overview. Much of the information presented here is incomplete, indicating either an absence of data, or data that were not available to me. Unfortunately, much of what is known is likely contained in country-specific reports, rather than in widely-distributed publications. Thus, although not an excuse for possible misinformation contained herein, these limitations clearly restrict the depth of this report.

DISTRIBUTION AND STATUS

Black bears may have once occupied Iran, but it seems doubtful that they still exist there. Similarly, they may have been recently extirpated from Afghanistan, although during the Russian occupation in the early 1980s bears were still occasionally sighted (and captured) near the eastern border with Pakistan (J. Fournot, pers. commun., 1994); it is unclear, however, whether these were black bears or brown bears (*Ursus arctos*), which historically occupied the same general area.

Black bears once ranged from Afghanistan across a broad, continuous region of Pakistan, but as much as 20 years ago their distribution had been reduced to small, disjunct populations (Roberts 1977)(Fig. 2). In some parts of Pakistan, game species, like bears, were protected in private hunting reserves, but when these reserves were eliminated, bear populations declined rapidly due to increased poaching (Cowan 1972). One population in the subtropical pine forests of the Murree Hills in Punjab Province (central Pakistan)

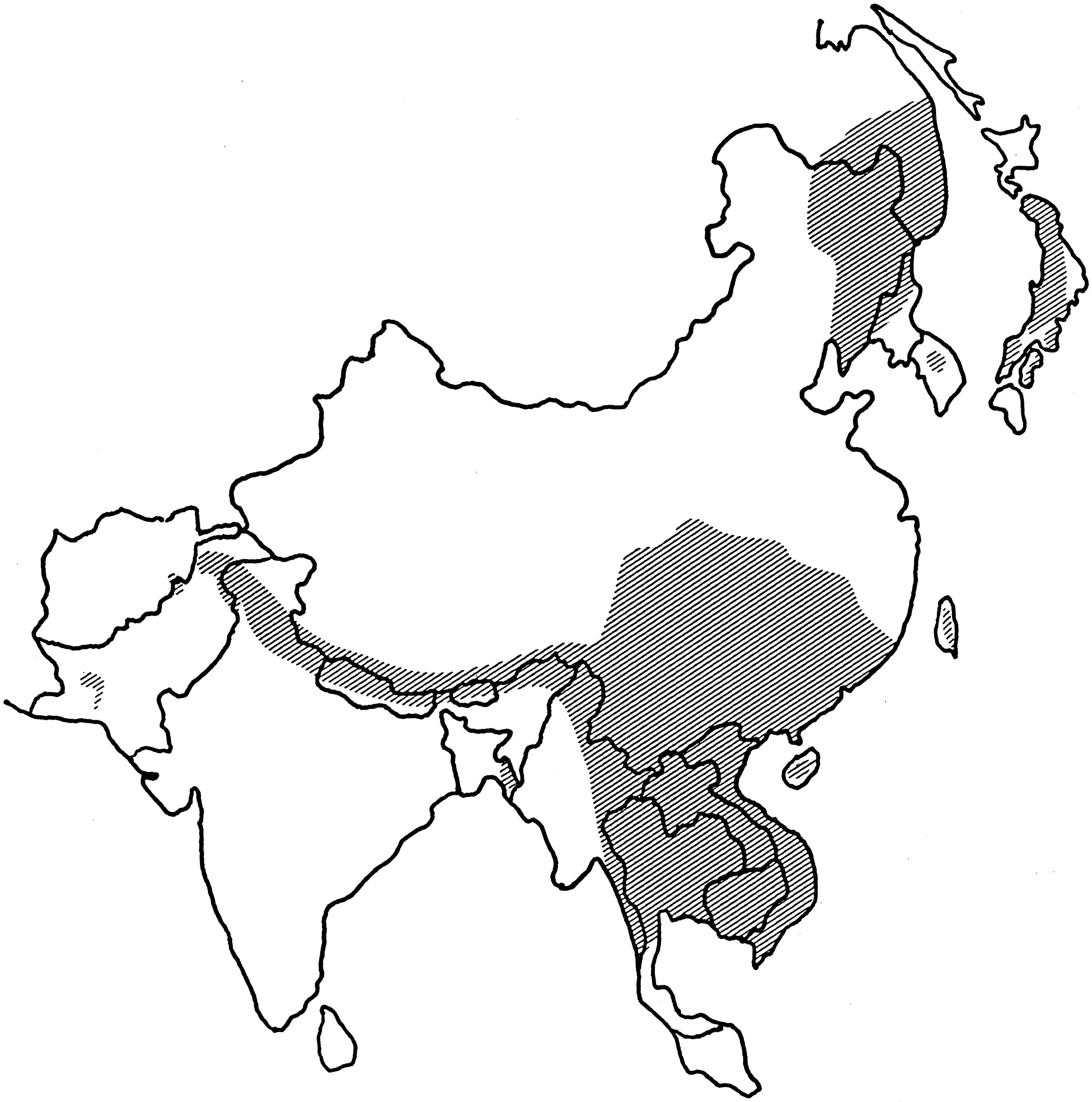


Fig. 1. Generalized range map of the Asiatic black bear (adapted from Servheen 1990).

was extirpated in the 1970s, coincident with dramatically increasing human populations (Table 1). A survey of present residents of the area indicated widespread disinterest in the bear's reintroduction (Chaudhry 1994). The isolated population of black bears in southern Pakistan, a small-sized bear that is designated as a separate subspecies (*U. t. gedrosianus*), inhabits the arid, mainly treeless region of Baluchistan; now it is also on the verge of being (or has already been) extirpated. The largest population of black bears in Pakistan, estimated at 230-350, remains in the moist temperate forests of the Northwestern Frontier Province (Chaudhry 1994). Brown bears also live in this region, although generally are found at higher elevations than the black bear (Roberts 1977).

Fig. 2. Distribution of Asiatic black bears and brown bears in Pakistan in the late 1970s (from Roberts 1977).

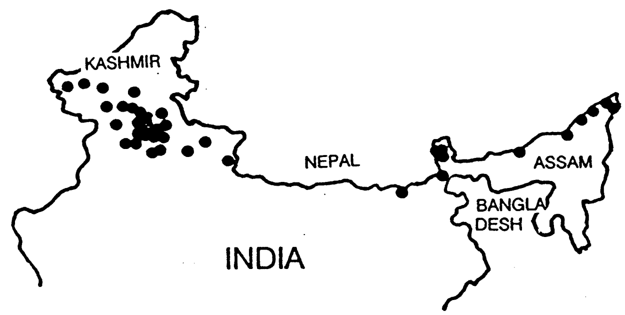


Fig. 3. Protected areas in India occupied by Asiatic black bears, based on confirmed reports indicated in the Wildlife Institute of India's national wildlife database as well as less-substantiated listings of species presence documented in Saharia (1982).

Table 1. Fate of black bears in the Murree Hills, Pakistan (data from Chaudhry 1994).

Year	Estimated bear population	Human population	Hectares of forest remaining
1901	220	5,000	88,000
1951	75	90,000	46,000
1970s	0		
1992	0	290,000	30,000

Both black bears and brown bears range from Pakistan into northern India, and although there is some ecological separation, several parks and reserves in India contain both species. The presence of black bears has been noted in at least 38 protected areas in India, principally within the band of states that border China/Tibet (Fig. 3). Black bears also exist in some forested areas outside these parks and reserves, as well as into Nepal and Bhutan; however, their distribution outside protected areas is basically undocumented. Based on the distribution of remaining forested areas, these populations must be quite fragmented.

Sloth bears (*Melursus ursinus*) also live in India, Nepal, and Bhutan; however, this species, which eats mainly ants and termites and lives primarily in lowland habitats, has very little ecological or geographical overlap with the black bear. In Nepal, black bears occupy the central middle hills, whereas sloth bears inhabit a separate, more southern range of lower hills and the adjacent low flat area (known as the terai) bordering India (D. Garshelis, A, Joshi, and J. D. L. Smith, unpubl. data). Another unidentified species or variety of bear has been reported by local villagers to live sympatrically with black bears at high elevations (up to 3500m) in the northern part of Nepal, but the presence of some other type of bear has never been documented through scientific investigation.

Black bears were known to once stretch southward through Assam, India, and into northern and eastern Bangladesh (Prater 1971, Roberts 1977, Khan 1984). Sloth bears and sun bears (*Helarctos malayanus*) also apparently occupied Bangladesh. All of these species are presently rare in this country (Khan 1984, Servheen 1990), and have been for a number of years (Cowan 1972); it is possible that some have been completely extirpated.

Black bears have not been extirpated from any entire country of southeast Asia. They remain in forested tracts of Myanmar (Burma), Thailand, Laos, Kampuchea (Cambodia), and Vietnam. In these countries there is extensive overlap between the black

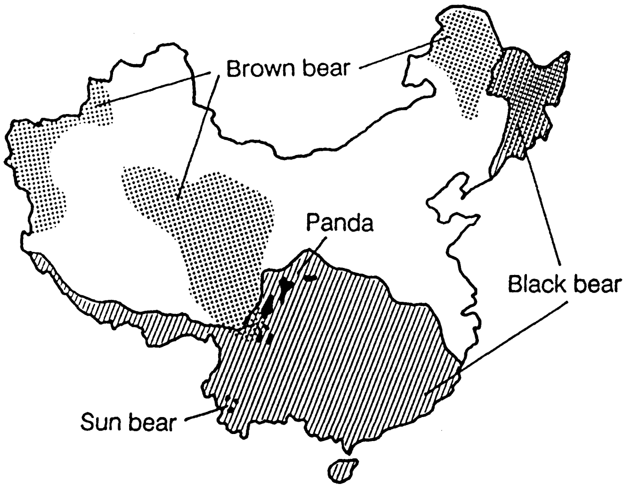


Fig. 4. Distribution of black bears (striped area), brown bears (stippled), sun bears (dark dots)(all from Ma 1983) and pandas (dark blotches)(from Schaller et al. 1989) in China.

Fig. 5. Distribution of black bears (solid shading) in Japan (from Hazumi 1994, pers. commun.).

bear and sun bear (Servheen 1990). The status of black bears in southeast Asia has not been documented, although none of these countries reports them as rare, and Laos, for one, indicates that they are still quite widespread (letter reference in Mills and Servheen 1991).

The total population of black bears in China has been estimated at about 20,000 (Gui 1991), although other sources indicate this same population for Sichuan Province alone (Peoples Republic of China 1994). Historically, black bears ranged across much of central China, where they are now absent (Cao 1991, Sun and Li 1991). Presently they occupy two broad geographic regions in China, which overlap the ranges of the brown bear, sun bear, and panda (*Ailuropoda melanoleuca*)(Ma 1983)(Fig. 4). However, both sun bears and pandas have very restricted ranges. Sun bears, which although rare, may still exist in southern China (Ma 1991, 1992; Xu 1991). Pandas survive in 6 isolated populations, remnants of a range that was once much more expansive (see maps in Schaller 1993:62-63), and which greatly overlapped that of the black bear; pandas and black bears, however, are ecologically quite distinct (Schaller et al. 1989).

Black bears still occupy the islands of Hainan (China) and Formosa (Taiwan). Ma (1983) and Xu (1991) indicate that these populations are the same subspecies (*U. t. formosanus*), although the two islands are a considerable distance apart. Both of these populations are small, totaling an estimated 30-40 individuals on Hainan (Xu 1991) and about 100-400 on Formosa (Y. Wang, pers. commun., 1994). Sighting records on Formosa indicate that bears are restricted to rugged terrain mainly in the Central Mountains at elevations above 1000m, both within and outside a series of five protected areas (Wang 1990, 1994). No other species of bears live on either of these islands.

Similarly, only black bears inhabit the Japanese islands of Honshu, Shikoku, and Kyushu (subspecies *U. t. japonicus*), whereas only brown bears live on Hokkaido. Fossil evidence indicates that brown bears once occupied the other major Japanese islands, but may have been displaced by black bears, which arrived via the Korean land bridge (Kawamura 1982; T. Mano, pers. commun.). The Japanese Environmental Agency estimates a current total population of 10,000-15,000 black bears in Japan (T. Hazumi, pers. commun., 1994). Although seemingly abundant, black bears on Honshu occur in a series of distinctly separated populations (Watanabe 1980, Shibata 1985, Wada et al. 1991, Hazumi 1994)(Fig. 5). Bear numbers on Shikoku are now very small, possibly <100 (letter cited in Servheen 1990), and bears may have been virtually extirpated from Kyushu by the late 1940s or early 1950s (Hanai 1985, Yokohata et al. 1990). Over a 30-year period, only 4 sightings were reported on Kyushu, all in a high-elevational narrow belt (Eguchi, cited in Azuma and Torii 1980). One bear was shot on Kyushu in 1987, but the possibility exists that it was an escaped captive animal rather than a representative of a remaining wild population (Yokohata et al. 1990).

The black bear is the only native bear of South Korea, whereas both black bears and brown bears inhabit North Korea. The South Korean and North Korean black bear populations are no longer contiguous. An estimated 50-80 individuals survived in South Korea in the early 1980s, divided among 5 separate populations (Milliken 1985, Lim et al. 1991, Han 1991); the present wild population may be as low as 10-20 (Mills and Servheen 1991). The status of bears in North Korea is unknown.

Black bears extend from North Korea and northeastern China into eastern Siberia (Fig. 1), where they are still reportedly common. The current Russian population is estimated at about 4,000 (Pikunov 1991). Both black bears and brown bears are sympatric in this part of Russia (H. and K. Quigley, pers. commun., 1994).

Table 2. Status and protection of Asiatic black bears. Countries are listed from west to east, in order discussed in text. Population sizes are crude estimates (references in text).

Country	Black bear population	CITES party
Afghanistan	unknown	Y
Pakistan	350	Y
India	present	Y
Nepal	present	Y
Bhutan	present	N
Bangladesh	rare	Y
Myanmar	present	N
Thailand	present	Y
Laos	common	N
Kampuchea	present	N
Vietnam	present	Y
Taiwan	100-400	N
China	20,000	Y
Japan	10,000	Y
S. Korea	10-20	Y
N. Korea	unknown	N
Russia	4,000	Y

INTERNATIONAL PROTECTION

Black bears are listed in Appendix I of the CITES agreement, which prohibits international trade except under special circumstances (i.e.: specimens were obtained legally, removal of the specimen was deemed non-detrimental to the survival of the species, and the trade was not for primarily commercial purposes). All trade among CITES parties (and from non-parties to parties of CITES) requires both export and import permits from specified management authorities. Among the 17 countries that are presently inhabited by Asiatic black bears, 11 are CITES members (Table 2).

CITES restrictions are a principal means of controlling international trade in bear parts, especially gall bladders and paws, the former being an entrenched component of traditional Chinese medicine for some 3,000 years, and the latter an expensive delicacy. Unfortunately, several of the countries involved in the trade of these parts are not CITES members (Myanmar, Laos, North Korea, Taiwan) or have exclusions that allow continued trade (Japan, Thailand). South Korea and Vietnam are recent signatories of CITES (1993 and 1994), the former having been a major player in the trade in bear parts; it is as yet unclear how South Korea's new membership in CITES will affect this trade.

Since 1982 South Korea has considered black bears a National Monument, thereby forbidding all killing or trade of their native bears; however, they have allowed bear products to be imported (Mills and Servheen 1991). Similarly, although Taiwan has not been permitted to join CITES, they listed black bears as an endangered species and prohibited any take of native bears. They have also been pressured to adopt CITES regulations, but continued availability of gall bladders in traditional Chinese medicine shops in Taiwan indicates persistent poaching and/or importation. Taiwan's continued illegal trade in tiger bone and rhino horn prompted the U.S. to impose a 1994 embargo against the import of legally obtained wildlife products from that country.

TRADE IN BEAR PARTS

The demand for bear parts is great, as they are used for medicine and/or food in many Asian countries (Table 3). Much of the trade in bear parts is covert, and illegal exportation has been documented for nearly every country with an indigenous population of black bears, often involving other intermediary countries, like Hong Kong and Singapore, as well (Mills and Servheen 1991). A confounding factor in this trade is that although Asiatic black bears are apparently the most sought-after species, as its gall bladder is believed to have the greatest medicinal effects (Hsien-cheh Chang, China Medical College, Taiwan, pers. commun., 1994), parts from sun bears, sloth bears, brown bears, and American black bears also have been involved in the trade, and these are indistinguishable from gall bladders of Asiatic black bears. With the recent (1992) addition of American black bears to Appendix II, however, trade in all species of bears is now regulated by CITES. There has been a lag, though, among individual countries adopting the Appendix II listing of American black bears, so some gall bladders, possibly from Asiatic black bears, are still sold without restriction as American black bear galls.

Apparently, some or many gall bladder products in Asian markets today are either not from bears or are from farmed bears. Recent investigations indicated that 65-80% of the gall bladder samples sold on the streets of Hong Kong and Taiwan are from animals other than bears, and moreover, most of the real bear material appears, based on color and chemical composition, to have been from captive animals (Lau et al. 1994; H. Chang, pers. commun., 1994).

China, South Korea, North Korea, and Vietnam (Saigon zoo) raise bears in captivity with the explicit purpose of draining ("milking") bile from catheters surgically inserted in the gall bladder. There are at least 8,000 bile-producing bears on farms in China (Peoples Republic of China 1994), of which 5,000-7,000 are black bears (Gao 1991, 1992); the government has indicated an eventual target of 40,000 bears on farms (Mills and Servheen 1991). It has been argued that each such bear in captivity provides an annual production of bile equivalent to (i.e., potentially "saves") 45-50 wild bears (Gui 1991); from 1986, when bile draining was initiated, to 1993, over 89,000 bear-equivalents of farmed bile have been produced (Peoples Republic of China 1994). The Chinese have petitioned CITES for a resolution to permit the commercial export of this bile.

Table 3. Human uses of Asiatic black bears. Countries are listed in same order as in Table 2; countries with no available data are omitted (data taken mainly from Mills and Servheen [1991]; other references in text).

Country	Medicine	Food	Pets/ farms or displays
Pakistan	N	N	Y
India	Y	N	Y
Nepal	Y	N	N
Bhutan	N	N	N
Bangladesh	N	N	N
Myanmar	Y	N	N
Thailand	Y	N	Y
Laos	Y	N	Y
Taiwan	Y	Y	Y
China	Y	Y	Y
Japan	Y	Y	Y
S. Korea	Y	Y	Y
N. Korea	Y	Y	Y
Russia	N	N	N

CAPTIVE HOLDING

The Japanese do not as yet pursue bile milking like the Chinese and Koreans, but they do have large, captive populations of bears, totaling over 1,000 animals (both black and brown bears) which are held in so-called bear parks, ostensibly developed exclusively for tourism. However, bears that die in these parks, often from seemingly inadequate care, also become part of the gall bladder market (Mills and Servheen 1991).

The Japanese bear parks and Chinese and Korean bear farms all practice captive propagation, although some bear parks are apparently still stocked with wild cubs, mainly those orphaned during Japan's legal hunt (discussed below)(Mills and Servheen 1991). Black bear (and especially sun bear) cubs are also routinely taken from the wild in countries like Thailand, Laos, and Taiwan to supply a pet industry that deals largely in wild animals (Mills and Servheen 1991)(Table 2). This industry poses threats to wild populations not only as a consequence of direct removal of animals from the wild, but also because of the potential release back to the wild of these captive held animals, which are often unhealthy and may spread disease.

Pakistan hosts one of the most deplorable captive bear industries. As many as 100 black bear and brown bear cubs have been removed annually from the remaining wild population in the northern corner of the country (Fig. 2) to supply a 200-year old spectacle referred to as bear baiting (Chaudhry and Farooq 1993). These bears are kept in captivity on a rope leash attached to a ring pierced through their nose, and their canines and claws are often removed. They are trained to fight bull terriers or other aggressive crossbreeds of dogs; generally two dogs are pitted against one bear in a 3-minute duel in which the dogs are declared the winners if they are able to pin the bear's nose to the ground. Although Pakistan has long banned both the capture of bears as well as this specific activity, special permits to maintain these fights have been regularly issued. Various groups advocating conservation of wildlife and the prevention of cruelty to animals have, however, recently persuaded the government of Pakistan to direct its provincial governments to amend and enforce their laws to prohibit this practice; it is suspected that this activity will likely continue underground, however. Additionally, it is unclear how the government will deal with the 1,800 or more bears currently held in captivity (Chaudhry and Farooq 1993).

HUNTING AND PEST CONTROL

Hunting Asiatic black bears remains legal in a few countries, but in most, harvests tend to be very limited. Russia harvests bears, and since the collapse of the Russian economy, Russian hunting agencies have looked toward attracting foreign hunters, especially from the U.S. and Canada. These hunters pay high prices to partake in what has been described as brown bear "slaughters" on Kamchatka (Bear News, Spring/Summer 1994). No black bears live in this area, and the existing black bear range is much more remote, but if the Kamchatka brown bear population is overexploited, Russians could start luring hunters toward the coastal brown bear population across the Sea of Okhotsk, where they would have the chance to harvest black bears as well.

Table 4. Number of Asiatic black bears killed by hunters and in nuisance control operations in Japan during 1986-1990. Data were not available for 1991-1993. (Data from Japanese Environmental Agency, obtained by T. Hazumi, 1994).

Year	Hunter kill	Nuisance kill
1986	953	1,625
1987	1,140	828
1988	972	1,148
1989	761	1,266
1990	869	658
mean	940	1,105

Japan is presently the only country that still treats black bears as a major game species. During 1986-1990, the average annual hunter kill in Japan exceeded 900 black bears (Table 4). There is no limitation on the number of hunters or the number of bears that each hunter can kill, but a declining interest toward hunting and voluntary limitations set by hunting groups (who were threatened by mandatory restrictions from the government) may reduce future harvests (T. Hazumi, pers. commun.).

Pest control results in the taking of even more Japanese black bears than hunting (Table 4). Most pest control on Japan involves bears that strip the bark from commercially valuable trees. Many of the natural forests of Japan have been replaced by man-made commercial forests, which apparently provide less natural food, prompting bears to strip bark and eat the cambium (Azuma and Torii 1980, Furubayashi et al. 1980). Such bark stripping by American black bears in the western U.S. has likewise been linked to human manipulation of the forest (Giusti 1988, 1990). Significant tree damage by bears in the U.S. dates to the early 1950s (Glover 1955), and was the impetus for one of the first intensive studies of American black bears (Poelker and Hartwell 1973). Over a period of several decades, various schemes to reduce bear numbers have been implemented in an effort to control tree damage in the U.S. (Poelker and Parsons 1977), but with limited success; in Japan, excessive harvest and pest control have, on occasion, directly led to local extirpations and increased fragmentation of bear populations (Azuma and Torii 1980). In the U.S., there is evidence that tree damage can be reduced by providing artificial food for bears (Flowers 1987).

Like its American counterpart, the Asiatic black bear is also attracted to corn and other agricultural crops, and in many countries, including especially China, Japan, Myanmar, Pakistan, India, Nepal and Bhutan, a significant but unknown number of crop depredating black bears are killed each year. Local governments in China have even attempted to cull bears to protect crops (Peoples Republic of China 1994). In the U.S., there have been extensive efforts to trap and move bears out of cornfields, and some jurisdictions compensate farmers for damage, but these measures do not really remedy the problem, and moreover, are exceedingly expensive (e.g., Vaughan et al. 1989, Stowell and Willging 1992). In most Asian countries, translocation of nuisance bears from cornfields and compensation to farmers for the damage caused by bears would be neither affordable nor logistically feasible.

CONCLUSIONS

Asiatic black bears are threatened on many fronts: across much of their range they are poached for gall bladders and paws; they are removed from the wild for sale to the pet industry, bear-baiting exhibitions, parks or farms; and they are excessively hunted in at least one country and indiscriminately killed as pests in several others. These threats are compounded by a steadily shrinking and splintering habitat. Habitat fragmentation directly reduces population viability by exacerbating the effects of rare but devastating events (e.g., complete food failures, storms, fires, diseases, etc.) and increasing the risks of human contact. It is no wonder that this species has lost much of its former range, and many of the small remaining populations are so isolated that they face seemingly certain extirpation. Even populations in national parks and sanctuaries are apparently not safe from poachers, who are spurred by the lucrative rewards of the gall bladder trade.

It is not within the scope of this paper to attempt to judge the relative merits of better enforcement, greater habitat acquisition, or the provision of alternate sources of bile as conservation strategies for this species; clearly, all would be highly beneficial. It is also beyond my intentions to weigh possible options for alternate supplies of bile, those being, in particular: synthetic compounds, milked bile from farmed bears, and gall bladders from harvested black bears in North America. Arguments could be posed for and against each of these sources on grounds of medicinal potency, ethics, logistics, and ultimate effects on the market. There is, however, no appropriate forum to judge these arguments and, moreover, not enough available data to enable any sort of objective decision-making process. In fact, aside from a few studies of basic ecology (e.g., Schaller 1970; Nozaki et al. 1983; Maita 1985; Nozaki and Mizuno 1985; Hazumi and Maruyama 1986, 1987; Schaller et al. 1989; Reid et al. 1991), information on this species is woefully lacking. Assessments of population size, including those presented in this paper, are crude estimates at best, and in most places little or nothing is known of reproductive rates, or rates and sources of mortality. What is clear, however, despite this tremendous lack of information, is that this species, like its range-mates the sun bear and sloth bear, is at a point in its history where some sort of intervention will be necessary to maintain long-term viability.

LITERATURE CITED

Azuma, S., and H. Torii. 1980. Impact of human activities on survival of the Japanese black bear. Int. Conf. Bear Res. and Manage. 4:71-79.

Cao, K. 1991. An outline of the Ursidae fossils in China. Proc. East Asiatic Bear Conf. (abstract only) 2:203.

Chaudhry, I. 1994. Black bear in moist temperate and subtropical pine forests of western Himalayas. Proc. Int. Union Game Biol. 21: in press.

______, and T. Farooq. 1993. Bear baiting. Natura: World Wide Fund for Nature, Pakistan, Newsletter. 19(2): 2-5.

Cowan, I. M. 1972. The status and conservation of bears (Ursidae) of the world - 1970. Int. Conf. Bear Res. and Manage. 2:343-367.

Flowers, R. H. 1987. Supplemental feeding of black bear in tree damaged areas of western Washington. Pages 147-149 *in* D. M. Baumgartner, R. L. Mahoney, J. Evans, J. Caslick, and D. W. Breauer, eds. Animal Damage Management in Pacific Northwest Forests. Washington State Univ., Pullman.

Furubayashi, K, K. Hirai, K. Ikeda, and T. Mizuguchi. 1980. Relationships between occurrence of bear damage and clearcutting in central Honshu, Japan. Int. Conf. Bear Res. and Manage. 4:81-84.

Gao, Y. 1991. From hunting, capturing, to breeding the black bear (*Selenarctos thibetanus*). Proc. East Asiatic Bear Conf. (abstract only) 2:120.

______. 1992. From hunting, capturing, to breeding the black bear (*Selenarctos thibetanus*). Int. Conf. Bear Res. and Manage. 9 (abstract only).

Garshelis, D. L. 1991. Monitoring effects of harvest on black bear populations in North America: a review and evaluation of techniques. East. Workshop on Black Bear Res. and Manage. 10:120-144.

Giusti, G. A. 1988. Recognizing black bear damage to second growth redwoods. Proc. Vertebrate Pest Conf. 13:188-189.

______. 1990. Black bear feeding on second growth redwoods: a critical assessment. Proc. Vertebrate Pest Conf. 14: 214-217.

Glover, F. A. 1955. Black bear damage to redwood reproduction. J. Wildl. Manage. 19: 437-443.

Gui, X. 1991. Conservation and management for Asiatic black bear: challenge and strategy. Proc. East Asiatic Bear Conf. (abstract only) 2:126.

Han, Y. 1991. Current description and countermeasure related to dichotomy busted bear in Korea. Proc. East Asiatic Bear Conf. (abstract only) 2:131-132.

Hanai, M. 1985. The status of Japanese black bear and few problems of its management. Asiatic Bear Conf. 1: abstract no. 11.

Hazumi, T. 1994. Status of the Asian black bear in Japan. Int. Conf. Bear Res. and Manage. 9:in press.

______, and N. Maruyama. 1986. Movements and home ranges of Japanese black bears in Nikko. Int. Conf. Bear Res. and Manage. 6:99-101.

______, and ______. 1987. Movements and habitat use of Japanese black bears in Nikko. Int. Conf. Bear Res. and Manage. 7:275-279.

Kawamura, Y. 1982. Fossils of bears in Japan. Higuma (Hokkaida brown bear) 13:24-27.

Khan, M. A. R. 1984. Endangered mammals of Bangladesh. Oryx 18:152-156.

Kurten, B. 1976. The cave bear story: life and death of a vanished animal. Columbia Univ. Press, New York. 163 pp.

Lau, A., C. Ngai, and D. S. Melville. 1994. Study on bear gall bladders for sale in Hong Kong. TRAFFIC Bull. 14(2): 59-62.

Lekagul, B., and J. A. McNeely. 1977. Mammals of Thailand. Sahakarnbhat Co., Bangkok. 758pp.

Lim, C. et al. 1991. Wild bear preservation efforts in Korea. Proc. East Asiatic Bear Conf. (abstract only) 2:121

Ma, Y. 1983. The status of bears in China. Acta Zool. Fennica 174:165-166.

______. 1991. Protection and utilization of bear resources in China. Proc. East Asiatic Bear Conf. (abstract only) 2:129.

______. 1992. The conservation and utilization of bear resources in China. Int. Conf. Bear Res. and Manage. 9: (abtract only).

Maita, K. 1985. Movements of Japanese black bears (*Selenarctos thibetanus japonicus*) in Taiheizan Mountain region, Akita Prefecture. Asiatic Bear Conf. 1: abstract no. 5.

Milliken, T. 1985. Concern over Japanese bear trade. TRAFFIC Bull. 7(1):5-8.

Mills, J. A., and C. Servheen. 1991. The Asian trade in bears and bear parts. World Wildlife Fund, Baltimore. 113 pp.

Nozaki, E., and A. Mizuno. 1985. Black bears in Hakusan. Proc. Asiatic Bear Conf. 1: abstract no. 12.

______, S. Azuma, T. Aoi, H. Torii, T. Ito, and K. Maeda. 1983. Food habits of Japanese black bear. Int. Conf. Bear Res. and Manage. 5:106-109.

Peoples Republic of China. 1994. Proposal to register breeding Asiatic black bear in captivity and bile drainage for commercial trade. Submitted to CITES.

Pikunov, D. G. 1991. Description of the population of *Selenarctos thibetanus* and *Ursus arctos* of the southern far east, USSR. Proc. East Asiatic Bear Conf. (abstract only) 2:137.

Poelker, R. J., and H. D. Hartwell. 1973. Black bear of Washington. Wash. State Game Dept., Biological Bull. No. 14. 180pp.

______, and L. D. Parsons. 1977. Black bear hunting to reduce forest damage. Int. Conf. Bear Res. and Manage. 3:191-193.

Prater, S. H. 1971. The book of Indian animals. Bombay Nat. Hist. Soc., Bombay. Third ed. 324 pp.

Reid, D., M. Jiang, Q. Teng, Z. Qin, and J. Hu. 1991. Ecology of the asiatic black bear (*Ursus thibetanus*) in Sichuan, China. Mammalia 55:221-237.

Roberts, T. J. 1977. The mammals of Pakistan. Ernest Benn Ltd., London. 361pp.

Saharia, V. B. 1982. Wildlife in India. Natraj Publ., Dehra Dun, India.

Schaller, G. B. 1970. Food habits of the Himalayan black bear (*Selenarctos thibetanus*) in the Dachigam Sanctuary, Kashmir. J. Bombay Nat. Hist. Soc. 66:156-159.

______. 1993. The last panda. Univ. Chicago Press, Chicago. 291 pp.

______, Teng Qitao, K. G. Johnson, Wang Xiaoming, Shen Heming, and Hu Jinchu. 1989. The feeding ecology of giant panda and Asiatic black bears in the Tangjiahe Reserve, China. Pages 212-241 *in* J. L. Gittleman, ed., Carnivore behavior, ecology, and evolution. Cornell Univ. Press, Ithaca, New York.

Servheen, C. 1990. The status and conservation of bears of the world. Int. Conf. Bear Res. and Manage Monogr. Ser. 2: 1-32.

Shibata, E. 1985. The Japanese black bear in the Kii peninsula, Japan. Asiatic Bear Conf. 1: abstract no. 14.

Stowell, L., and R. C. Willging. 1992. Bear damage to agriculture in Wisconsin. Proc. East. Wildl. Damage Control Conf. 5:96-104.

Sun, G., and X. Li. 1991. Distribution of bears in ancient China. Proc. East Asiatic Bear Conf. (abstract only) 2:133.

Vaughan, M. R., P. F. Scanlon, S. E. P. Mersmann, and D. D. Martin. 1989. Black bear damage in Virginia. Proc. East Wildl. Damage Control Conf. 4:147-154.

Wada, H., M. Okano, and S. Azuma. 1991. The Japanese black bear of the Shimokita peninsula. Proc. East Asiatic Bear Conf. (abstract only) 2:136.

Wang, Y. 1990. The current status of the Formosan black bear in Taiwan. Int. Conf. Bear Res. and Manage. 8:1-4.

______. 1994. The status and distribution of the black bear on Taiwan. This volume.

Watanabe, H. 1980. Damage to conifers by the Japanese black bear. Int. Conf. Bear Res. and Manage. 4:67-70.

Xu, L. 1991. The bears in southern China. Proc. East Asiatic Bear Conf. (abstract only) 2:143.

Yokohata, Y., O. Fujita, M. Kamiya, T. Fujita, K. Kaneko, and M. Ohbayashi. 1990. Parasites from the Asiatic black bear (*Ursus thibetanus*) on Kyushu Island, Japan. J. Wildl. Dis. 26:137-138.

ASIATIC BLACK BEAR

Ursus thibetanus formosanus

POPULATION AND HABITAT VIABILITY ASSESSMENT WORKSHOP

REPORT

Section 3

Population Biology and Modelling

族群生物學與族群模式

台灣黑熊（Selenarctos thibetanus formosanus）的活動範圍大約是在一百萬公頃的岐嶇森林棲地面，這個活動範圍區域約佔全台灣面積的三分之一。這些殘存的棲地中有三分之一（約三十三萬公頃）是屬於三個國家公園與兩個野生動物保留區。這些區域內黑熊的分佈情形是由一些非常零碎的野外目擊報告所收集而成的，報告中顯示保護區內有較密集的野生黑熊族群存在。雖然這樣會令人產生一種直覺，也就是在保護區外台灣黑熊族群所受的盜獵壓力理所當然高於族群較集中的國家公園的保護區內，但由觀察者所造成肉眼觀察的分布偏差亦不能忽略。全島野生黑熊的相對密度還未能確知，確切的數量也就無法計算。然而根據野生動物學者們的估計，台灣本島的野生黑熊數量雖然可能少於五百隻，但至少有一百隻以上仍存活於島上，並且可能有半數是在保護區範圍內活動。無可否認，這些數字的是一個相當粗略的估計，但是這估計至少提供了一個未來管理策略起始點，以檢測台灣黑熊族群繼續存活的可能性。

首先，密集管理的需求及效果如能夠被模式化（modeling），接下來就能很有效的逐步提出保存此族群的實行方法。VORTEX 是一個由 Robert Lacy 與 Kim Hughes所寫成的一套電腦模擬軟體，它過去是用來當成一種研究隨機性（stochastically）處理多變數交互作用（interaction of multiple variables）的工具。

現在的 VORTEX 程式是一種稱爲 Monte Carlo 模擬。這是一種測定野生動物族群在測定力量、統計、環境、與遺傳推測事件等各項因素影響的電腦模擬程式。VORTEX 建立族群動力學模式成爲一些不連續（discrete）、有順序（sequential）的事件（events）（例如出生、死亡、重大災害等），這些事件的發生則由機率決定。這些事件的發生機率被模式化成爲一些固定（constant）或是隨機（random）的變數（variables），這些變數是隨特定的統計分佈而形成。此程式模擬一個族群的方法是輸入各種來自於能行有性生殖複製生物體（sexually reproducing， diploid organisms）典型生活史之相關事件等一系列的步驟。

此電腦模擬程式結果並不能給一個絕對的答案，因爲此模擬設計是先將參數（parameters）輸入程式內模擬它們的交互作用，然後產生具有推測性的結果。模擬過程中也考慮存在於自然界中的隨機過程（random processes）。對於模擬結果的解釋則要依賴我們已瞭解的黑熊生物學知識、影響黑熊族群的種種狀況、以及未來可能的變化等資訊而加以推論。

程式模擬的結果是受限於輸入資料的質與量。實際上，過去並沒有台灣黑熊野生族群的生物學資料，所以我們先採用美洲黑熊（Ursus americanus）野生族群及圈養的亞洲黑熊資料來進行模擬。以生態學的觀點而論，美洲黑熊與亞洲黑熊極爲相似，其中包括覓食習性（food habits）、行爲動作（movements）、活動模式（activity patterns）、築巢行爲（denning behavior）等方面。這些相似點可以從過去對許多北美黑熊族群與一些在日本、中國大陸及蘇聯的亞洲黑熊等相關研究資料中得知。然而，生態學上的相似處並不是導出族群統計上（demographic）相同點的必要條件。例如，有許多文件清楚的說明在西部的北美黑熊比在東部北美黑熊通常生殖率較低，而東部與西部之間並沒有顯著可測的生態區別。事實上，在這兩個廣大區域中，熊的許多外表特性並沒有眞正的不同。

從野外及圈養的黑熊個體顯示，亞洲黑熊在生殖能力方面比較類似西部的北美洲黑熊而較不像東部的北美洲黑熊。所以，在資料不足的狀況下爲了要建立台灣黑熊的族群統計模型，我們利用以北美洲西部黑熊族群研究爲主的相關數據資料來做這次的程式模擬。

模擬參數資料的輸入：

第一次繁殖年齡（Age of First Reproduction）：

VORTEX 對繁殖（breeding）的定義是指幼獸出生的時間，而非性成熟的年齡。因此，成熊在夏天交配，若當時爲4.5歲的年齡，而其第一胎幼獸在冬天出生，則第一次繁殖年齡的資料輸入爲5歲。此模擬程式也可使用生殖年齡的平均數（mean）或中數（median），並估算其變異（variation），來取代產生幼獸的最早年齡。雖然一些雌黑熊在4歲大時就生產，但是在西部的北美洲黑熊10個族群中雌熊第一胎產子平均的年齡爲5歲，所以我們就將此數值輸入模擬程式。相同的，雄獸能於在3歲大時達到繁殖年齡（小獸可在父獸4歲時產下）。社會的複雜度亦可能對年紀較大的雄獸繁殖狀況有所限制。然而，社會複雜的程度隨著族群密度及年齡結構而變化，台灣黑熊族群這方面的資料也是一個未知數。這次的模擬，我們選擇6歲的雄熊做父獸。因爲黑熊的交配体系（mating system）爲一夫多妻（polygynous）制，而爲了選擇這個雄性繁殖年齡以便獲得一個顯著的族群統計結果，這些族群必須變得相當小。

生產小熊（Cub Production）：

VORTEX 將每胎產子數（number of cubs per litter）、胎次（litter interval）、以及生產第一胎成熟母熊的比例結合成爲一個變數，稱爲每胎產子數（litter size）。在中國大陸所收集的圈養黑熊資料顯示，大約80% 的熊爲每胎產子兩隻，每胎產子一隻者大約佔20% ，至於每胎產子三隻佔或三隻以上者則非常稀少。兩胎次間的時間最短間隔約爲兩年，不過平均間隔則稍長。我們採用西部的北美洲黑熊之平均繁殖間隔爲2.4年，估計每年無繁殖成熊的比例（1-【1/2.4】=58% ，大約等於60% ）。此值輸入模擬做爲無胎次之比例數據，剩餘40% 的雌獸有生產紀錄（其中8% 爲每胎次一隻，32% 爲每胎次二隻）。

經由輸入無繁殖成熟黑熊之比例的標準偏差（standard deviation），繁殖上的變異（variation）就能在VORTEX程式中執行模擬。但因缺乏數據，我們假設此變異爲平均數的25% ，變異原因爲食物產量的波動加上雌熊達到性成熟年齡的變異。VORTEX決定模擬每年的繁殖百分比，此數據取樣是從一個平均數爲60% ，標準偏差爲12.5% 的二項式分布（binomial distribution）中獲得。每胎次一隻與二隻的相對比例仍不變。

因爲沒有資料顯示亞洲黑熊的出生性比率爲1：1，我們就用相等的性比率（50:50）當成電腦自動設定值（default value）。

老化（無生殖能力）年齡（Age of Senescence）：

VORTEX 假設此動物在正常的繁殖速率上，一輩子都有繁殖能力。美洲黑熊的例子顯示它們能繁殖年齡可以達到近30歲。我們在模擬中選擇30歲爲亞洲黑熊繁殖小熊的極限年齡。

死亡率（Mortality）：

此資料能以三種方式輸入VORTEX程式：（1）每一性別年齡層中，預估每年可能死亡的百分比及這些百分比的變異數（variance），（2）每個性別年齡層中去除一固定數值（例如打獵捕獲的數目），（3）因重大的自然災變，族群總數中降低至一定數量，存活率因而降低。

在北美黑熊族群當中，幼熊存活的變化相當大。然而，影響這些變異的因素尚未能瞭解。最後，我們從23個研究案例當中的相關數據，取得幼熊的平均死亡率，做爲

我們對台灣黑熊幼獸死亡率的最佳估計（35％）。在大部分的研究當中，雄幼熊比雌幼熊有顯著較高的死亡率，所以我們假設雄幼熊的死亡率爲40％而雌幼熊的死亡率爲30％。

年齡較大黑熊的存活與否，深受人類行爲的影響。這些人類行爲包括了狩獵、盜獵及屠殺等。美洲黑熊能夠在保護區內持續的保持高存活率，除非這些熊越過邊界區域時遭到人爲因素迫害死亡而降低存活率。我們用這些經過觀察研究，未受狩獵影響之北美洲黑熊族群，設計發展出未受盜獵且在棲地負荷量以內的台灣黑熊之死亡率。由環境因變異所產生的標準偏差（SD）被考慮定爲平均值的25％，如下所列：

半成熟雌性黑熊— 5％（SD = 1.25％）
成熟雌性黑熊— 5％（SD = 1.25％）
半成熟雄性黑熊— 10％（SD = 2.5％）
成熟雄性黑熊— 5％（SD = 1.25％）

狩獵台灣黑熊是違法的，而濫殺（nuisance killing）的情形是幾乎不存在。所以，造成人爲黑熊死亡的原因主要爲盜獵。當然，盜獵的程度如何我們目前是不了解，但是它確實是影響這些黑熊族群未來消長的主要變數。因此，用不同盜獵程度做模擬，可以了解未來族群大小的可能趨勢。我們做了一個假設：盜獵者對熊的性別及年齡層不會有特別的選擇。再者，因爲無法對每個性別年齡層的相對減少量做合理的預測，我們考慮盜獵對每一性別年齡層的影響都一樣大。我們也假設偷獵者會偷獵此族群至一個相當固定的比例，而不是偷獵一定數目的隻數。這就是說，假如這個族群消失時，盜獵者會覺得愈來愈難發現熊隻，雖然盜獵的比例大致不變，然而盜獵到的熊隻數量確愈來愈少。

我們發現將盜獵當成是一個每年發生的自然大災難（catastrophe）
，此災難使每一性別年齡層黑熊隻數造成等量的減少，於是電腦模擬操作方式會變得更方便；然後我們能夠經由存活數量的減少修改盜獵的程度。我們以5%，10%，15%的不同盜獵程度來模擬可能的結果（在模擬中則是分別鍵入95%，90%，及85%的影響存活率的因子）。利用這種與盜獵相同的方式輸入資料，而不直接將盜獵資料鍵入死亡率的計畫程式中，將導致一個使族群消失的可能結果。這結果可舉例如下，因爲這死亡率是將動物限制於分佈比例，而這個比例是在非自然死亡的狀況下產生。

例如：比較兩種模擬10%盜獵率的方法。

一.10%的盜獵及5%的死亡率=15%的死亡率。

二.95%存活率因盜獵再減少至此存活率的90%,也就剩85.5%的存活率=14.5%的死亡率。
在模擬中我們用方法二。

我們加上黑熊果實（山毛櫸等）食物欠收當成第二種重大自然災害的影響結果。在美洲黑熊的食物欠收已經被觀察認爲是一項對繁殖有顯著影響的因子（有時候會導致全體無法繁殖）。雖然此因子可能會因狩獵或濫殺而造成人爲因素對族群的影響，但這並不是一種自然的死亡率。我們假設顯著的黑熊食物欠收在臺灣是每10年發生一次（在模擬中爲10%機率的隨機事件），此因子減少了正常生殖率25%，但並不影響到存活率。

棲地負荷量（Carrying Capacity）：

K值決定此族群數量大小的上限，超過此值時就會產生死亡率增加的壓力而使族群數量大小回歸到K值。對於依族群密度大小而改變的存活率，VORTEX使用K值來設定此值的範圍。K值也能夠控制一些與族群密度有關的效應，當族群逐漸趨向K值時，這些效應將隨著做連續性的改變，但因爲這些效應對在北美洲黑熊的研究尚未整理清楚，我們就不選擇將他們輸入我們的模擬程式中。

我們選擇2000隻熊作爲全島的棲地負荷量，或等於選擇大約每平方公里有1/5隻熊。然而這些值是非常可議的。在北美洲一些保護區內給予較高的黑熊族群密度，比很武斷的在模擬計畫中選擇一個K值情況下，它的影響是可以忽略的，當這個族群是低於K值。假如計畫興建一個橫跨全島的的大路，並因此可能增加盜獵者更方便盜獵，而使黑熊活動範圍更零碎化（fragment），此分裂殘存的族群也將被此更小的棲地負荷量所限制，而這個估計的單一棲地負荷量只對近期的未來（約20年）有顯著的影響。

近親繁殖衰退（Inbreeding Depression）：

我們對此項資料輸入Vortex模擬程式中沒有做選擇。假如要選擇加入此項因素的資料，則必須檢查每個不同保護區的情形所造成的影響。在此項目中我們輸入一假設值=3.14，做爲兩倍體整組基因（diploid genome）的致死量值（lethal equivalents）。選擇此值是爲40種經過測量研究的哺乳動物在這方面的中數值（median value），這是因爲黑熊缺乏這方面的資料。

最初年齡分佈（Starting Age Distribution）：

在執行此程式時最初的性別年齡層之分佈情形。

最初族群個數（Starting Population Size）：

我們分別使用100、200、300、及400四個族群隻數來模擬。

總族群分析（Metapopulation Analysis）：

我們使用5% 做爲保護區內的盜獵率，保護區外的盜獵率則有較大的變異，約爲10% 至15% 之間。我們假設所有在保護區內外遷移者均爲1-3歲大的雄性黑熊，這與美洲黑熊族群的散佈情形是一致的。我們假設25% 的零星族群在保護區內外遊走（剩餘的熊則固定分佈在其出生地的區域內）。

我們沒有保護區內外棲地差別的資料，所以我們設定棲地負荷量與區域有關連性。我們考慮全部棲地負荷量大約爲2000隻熊，而佔全部區域內三分之一的保護區棲地內則約有700隻的負荷量。

計畫的重復性及年限（Iterations and Years of Projection）：
每一個模擬腳本重覆執行200次，整個計畫時間爲100年。模擬結果節錄在以十年爲一區間的曲線圖上。假如需要，每一個格式化的腳本都有相關數值做爲參考及顯現未來其他結果。我們所用的模擬程式爲 VORTEX 6.2版。

族群評量：

1至4號曲線圖分別表示4個不同的最初族群（starting population），這些族群的盜獵率分別爲5.0% ，7.5% ，10% ，及15% 。其中7.5% 盜獵率是參考其他結果，此值是表現一個穩定性族群的較佳數據。盜獵率範圍的差異如此之大是令人震驚的：例如，對於一個最初有200隻熊的族群當中，盜獵10隻熊（5% ）時，此族群能繼續成長，盜獵15（7.5% ）隻熊則此族群維持不變，盜獵20隻熊（10% ）則使此族群趨向滅絕。

5與6號曲線圖表示在10-15% 的盜獵率時，隨時間變化而表現此族群絕種的可能率。在較低的盜獵率中，沒有絕種的情形發生。即使在10-15% 的盜獵程度，不論最初族群的大小，此族群至少可以維持20年的時間而不致滅絕。然而，在15% 的盜獵率中，此族群可能無法維持超過50年。

在不同程度的盜獵（levels of poaching, Pch）及最初族群大小（starting population size, N）的可能影響中，族群成長速率（population growth rate, r），絕種機率（probability of extinction, Pe），最終族群大小（final population size, N100），基因異型合子（genetic heterozygosity, He）的留存，以及絕種的平均時間（mean time of extinction, Te）的結果都記錄在表格1。這個決定性的成長速率是用Leslie matrix algorithm計算出來的。正數r值對於族群的繼續存在是必須的，而r=0原則上是表示一個穩定不變的族群。決定性成長速率（deterministic growth rate）對於最初族群的大小並不敏感，但會隨著不同盜獵程度而有所變化（表格一）。10% 或10% 以上的盜獵程度將導致族群的負成長及不可預期的滅種結果。

隨機性的族群成長速率（stochastic population growth rate）對於族群大小較敏感，族群越大越敏感。即使如此，對於10% 或更高的盜獵率而言，最理想的估計族群（400隻）仍持續性的減少。在持續15% 的盜獵率下，族群在未來100年間滅種的機率是100% 。而預估絕種的時間是在60年內（表格一，圖六）。在10% 的盜獵率時，絕種的時間爲100年內。

假如保護區內較保護區外的盜獵率低（5% ：10-15% ），而雄性黑熊在此兩個區域內仍有明顯的遷移現象，則這整體大族群分析（metapopulation analysis）的模擬預測如下：在保護區內族群大小有成長的趨勢，而保護區外族群則爲下降趨勢(圖七、圖八、及圖九)。黑熊在10%(非15%)的盜獵率中還能保持穩定，這是因爲對於在保護區內成長中的黑熊族群，雄性黑熊可在保護區內外遷移活動, 如此對保護區外高盜獵率所產生之損失是一種補償。這些非保護的區將成爲黑熊族群的黑洞，因爲保護區外的雌熊始終沒有繁殖機會。最後這些模擬腳本顯示在黑熊族群分佈中持續性的轉移，以及黑熊族群數目的增加。

這個模擬腳本是將族群分爲保護區內及保護區外兩個族群，但事實上現有 5個保護區均被未保護的區域所分離。當盜獵行爲減少了在非保護區內黑熊密度，而此區域中能繁殖的雌熊也被逐漸被消滅(因爲雌熊很少分散)，這些非保護區域將成爲各保護區中黑熊遷移的障礙。遊走中的雄性黑熊可能不會趨近於無雌熊的地帶，除此之外，這些雄性黑熊可能也不會跨越盜獵者出現的地區。因此，由於非保護區內高度的盜獵行爲，各個保護區變得越來越孤立，於是這些區域內的黑熊族群變成數個完

全隔離的小單位(discrete units)，而不是一個整體性的大單位。爲了檢驗這種破碎(fragmentation)棲地可能產生的結果，我們選擇北部的一個保護區（拉拉山）來模擬。此棲地內大約存有全部保護區內台灣黑熊總數的10％ 。一個最理想的模擬腳本中，假如全部的台灣黑熊族群爲 400隻，其中 200隻在保護區內, 則此拉拉山保護區中約有20隻黑熊。假如盜獵率保持在 5％， 並忽略近親繁殖的影響，這個族群預計能夠成長；然而，在一個被隔離開的小族群中，近親繁殖的影響變得非常的重要，即使盜獵率很低，仍將迫使此族群面臨滅種的危機(圖10)。

摘要：

現存的資料顯示台灣黑熊的數目可能不再成長。此外，全部的黑熊族群顯得相當的小而且很明顯的在棲地負荷量之下。盜獵問題絕對是此族群繼續存活的最大威脅。在此電腦程式模擬顯示，假如盜獵率至少在10％，將導致此族群在可預見的時間內發生絕種危機 。另一方面而言，假如能維持較低的盜獵率，則全部族群就可能繼續成長；然而在非保護區中持續不斷的高盜獵率，每個保護區被隔離的程度就愈來愈高, 族群個體中基因交換的機會愈來愈缺乏， 每個破碎的族群愈而愈趨向絕種的危機， 這在圖10可以看出。這些結果凸顯了保護區大小的重要性。所以(1) 每個保護區保護一個愈大族群的黑熊個數，對於因生物小族群化所形成的隨機影響(Stochastic effects)愈有抵抗力。(2) 介於保護區之間未受保護地帶愈小，每個保護區之間的遷移障礙就愈小。

我們所用 5％的盜獵率做爲模擬腳本，事實上可能是過於樂觀，因爲在保護內實際上的族群並沒有在成長。此外，假使保護區外的盜獵率比保護區內高很多，就暗示我們用10％～15％模擬在非保護區盜獵死亡率並沒有低估。整個模擬計畫顯示這種尺度的盜獵會使台灣黑熊族群在未來100年內滅亡，甚至可能在未來50年內就絕跡。很顯然地降低盜獵率是對台灣黑熊族群保育最急切的工作。

在輸入有限的資料情況下，這些資料就必須做小心的解釋。然而，有一個很好的理由來加強努力收集有關此族群的資料，那就是我們必須做一個結論：這個黑熊族群正處在一個高度危險的狀況。根據北美黑熊的資料，我們懷疑繁殖率是明顯的高於此模擬的假設，以及這個可能少於500隻黑熊的族群命運表現不是不變的。因此，雖然研究是針對收集更多正確的繁殖數據及獲得更佳的族群估計值是有用的，但是這些研究可能轉移對族群動態最主要的因子—盜獵—的注意力。我們應該很清楚地

了解，實驗設計研究台灣黑熊族群被盜獵的程度，可能是評估此族群現在及未來狀況最實質的方法，而且也可能是對此族群在最後保育需要上表達出一個明定的目標。許多研究導出並說明盜獵問題特性，也可幫助對此族群的保育策略發展定立方向，以獲得更良好的實施方法。

從此模擬當中有證據顯示在10% 的盜獵率—相當於從200隻黑熊族群中取走20隻黑熊，並將引起族群數量持續的減少；然而若在此黑熊族群中取走10隻（5% 的盜獵率），則此族群有增長的趨勢。這個因盜獵造成動物數目微小改變的敏感性，有助於擴大保育網路，努力降低盜獵發生。

就某種意義而言，在一百萬公頃的土地上防止20隻黑熊的被盜獵似乎是一種很不值得的工作。但從另一方面來看，這些模擬結果建議在這200隻黑熊族群中，只要將每年盜獵20隻的至10隻的盜獵（10% 的盜獵率減低至5% ），就可能足以拯救這個族群免於滅絕。

圖表說明：

圖一：在盜獵率等於5% 的情形下，假設四種大小不同的現存台灣黑熊族群隻數分別爲100、200、300、及400，而其棲地負荷量爲2000隻的狀況下，在未來100年間，每個族群數量隨時間所產生的可能變化及趨勢。

圖二：在盜獵率等於7.5% 的情形下，假設四種大小不同的現存台灣黑熊族群隻數分別爲100、200、300、及400，而其棲地負荷量爲2000隻的狀況下，在未來100年間，每個族群數量隨時間所產生的可能變化及趨勢。

圖三：在盜獵率等於10% 的情形下，假設四種大小不同的現存台灣黑熊族群隻數分別爲100、200、300、及400，而其棲地負荷量爲2000隻的狀況下，在未來100年間，每個族群數量隨時間所產生的可能變化及趨勢。

圖四：在盜獵率等於15% 的情形下，假設四種大小不同的現存台灣黑熊族群隻數分別爲100、200、300、及400，而其棲地負荷量爲2000隻的狀況下，在未來100年間，每個族群數量隨時間所產生的可能變化及趨勢。

圖五：在10% 的盜獵率下，假設四種大小不同的現存台灣黑熊族群隻數分別爲100、200、300、及400，每一族群的絕種機率隨時間改變的情形。

圖六：在15% 的盜獵率下，假設四種大小不同的現存台灣黑熊族群隻數分別爲100、200、300、及400，每一族群的絕種機率隨時間改變的情形。

圖七：在保護區及非保護區台灣黑熊族群數目的變化。假設全部現有族群隻數爲100，其中有半數在保護區內；盜獵率在保護區內爲5% ，在非保護區內爲10% 或15% 。

圖八：在保護區及非保護區台灣黑熊族群數目的變化。假設全部現有族群隻數爲200，其中有半數在保護區內；盜獵率在保護區內爲5% ，在非保護區內爲10% 或15% 。

圖九：在保護區及非保護區台灣黑熊族群數目的變化。假設全部現有族群隻數爲400，其中有半數在保護區內；盜獵率在保護區內爲5% ，在非保護區內爲10% 或15% 。

圖十：台灣北部一個被隔離的保護區（拉拉山），台灣黑熊滅種機率的變化。這區域被假設爲族群統計（demographically）及遺傳上（genetically）被隔離。其他的假設還包括5% 的盜獵率、60隻黑熊的棲地負荷量、及此族群中現存有20隻熊。共做了兩個計畫，其中一個省略了近親繁殖（雜交優勢【heterosis】= 0）所造成的潛在性危害影響，而另一者則爲近親繁殖衰退的影響（輸入值爲3.14）。

POPULATION BIOLOGY AND MODELLING

The Formosan black bear occupies nearly 1 million hectares of rugged, forested habitat, comprising about a third of the total area of Taiwan. Within the remaining habitat, about a third, or 330,000 ha are in protected areas, including 3 National Parks and 2 Wildlife Preserves. The distribution of bears across the range has been gleaned from sighting reports, which indicate higher bear densities within the protected areas. Although this makes intuitive sense, in that poaching pressures are almost certainly higher outside the protected areas, sighting records are biased by the distribution of human observers, which tend to be centered in the national parks. Thus, the relative densities of bears across the island are unknown, no less the actual number of animals. However, wildlife biologists estimate that there are likely less than 500 bears, but at least 100, remaining on the island, and probably half of these are within protected areas. These numbers are admittedly a rather crude guess, but provide at least a starting point for examining the future outlook of Formosan bears under existing or proposed management strategies.

The need for and effects of intensive management strategies can be modelled to suggest which practices may be the most effective in preserving this population. VORTEX, a simulation modeling package written by Robert Lacy and Kim Hughes was used as a tool to study the interaction of multiple variables treated stochastically.

The VORTEX program is a Monte Carlo simulation of the effects of deterministic forces as well as demographic, environmental, and genetic stochastic events on wildlife populations. VORTEX models population dynamics as discrete, sequential events (e.g., births, deaths, catastrophes, etc.) that occur according to defined probabilities. The probabilities of events are modeled as constants or as random variables that follow specified distributions. VORTEX simulates a population by stepping through the series of events that describe the typical life cycle of sexually reproducing, diploid organisms.

VORTEX is not intended to give absolute answers, since it is projecting stochastically the interactions of the many parameters which enter into the model and because of the random processes involved in nature. Interpretation of the output depends upon our knowledge of the biology of the bear, the conditions affecting the population, and possible changes in the future.

The output of the model is limited by the input. Since virtually no biological information was available for the wild population of black bears in Taiwan, we employed information from wild populations of American black bears (Ursus americanus) as well as information on captive Asiatic black bears. Ecologically, American and Asiatic black bears are very similar, as indicated by food habits, movements, activity patterns, denning behavior, etc. of black bears in various populations in North America compared to the few studies of Asiatic black bears in Japan, mainland China, and Russia. However, ecological similarities do not necessarily result in demographic similarities. For example, it has been well documented that black bears in western North America have generally lower reproductive rates than those on the eastern half of the continent, with no detectable underlying ecological differences between east and west, and in fact no real differences in the sizes of bears in these two broad areas.

It appears, from both wild and captive animals, that Asiatic black bears are reproductively more similar to western North American black bears than those in eastern North America. Thus, for the purposes of modelling the Formosan black bear population, we drew upon data related to American black bears from studies conducted mainly in western North America.

Input Parameters for Simulations:

Age of First Reproduction: VORTEX defines breeding as the time when young are born, not the age of sexual maturity. Thus, although bears mate during the summer, at say 4.5 years of age, they give birth during the winter, which in this case would be input as age 5. VORTEX also uses the mean/median age of reproduction (with an estimate of variation, as discussed below) rather than the earliest age of cub production. Thus, although some female black bears may give birth at 4 years old, the average age of first cub production among 10 populations of western North American black bears was 5 years, so we used this value in the model. Similarly, whereas males are capable of breeding at 3 years old (siring cubs which would be born when the father is 4), social constraints may limit breeding to older animals. The degree of social constraint, however, varies with density and age structure, which are unknowns for the Formosan black bear. For this model, we chose 6 years old as the age of males fathering cubs. Since the mating system in bears is polygynous, populations would have to become extremely small for this choice of male reproductive age to have a significant demographic effect.

Cub Production: VORTEX combines number of cubs per litter, litter interval, and the proportion of adult-age females producing their first cubs into a single variable called litter size. Chinese data on captive black bears indicate that about 80% have litters of 2, and 20% litters of 1, with litters of 3 being very rare. The shortest interval between successfully reared litters is 2 years, although the average is likely somewhat longer. We used the average reproductive interval among western American black bear populations of 2.4 years to estimate the proportion of adult bears without cubs each year (1-[1/2.4] = 58%, rounded to 60%). This value was input in the model as the frequency of litters of 0, leaving 40% of females producing cubs (8% litters of 1, 32% litters of 2).

Variation in reproduction is modelled in VORTEX by entering a standard deviation (SD) for the percent females producing litters of 0. Lacking empirical data, we assumed that such variation (due to fluctuations in food abundance and variations in the age at which females reach sexual maturity) was 25% of the mean. VORTEX then determines the percent breeding each year of the simulation by sampling from a binomial distribution with the specified mean (60%) and SD (12.5%). The relative proportions of litters of 1 and 2 are kept constant.

As no data exist indicating other than a 50:50 sex ratio at birth for Asiatic black bears, we used an equal sex ratio as the default value.

Age of Senescence: VORTEX assumes that animals can breed (at the normal rate) throughout their adult life. This has been shown to be the case among American black bears, which continue to produce cubs through their late 20s. We chose 30 years old as the maximum age at which Formosan bears in the model produce cubs.

Mortality: Mortalities can be entered in VORTEX in 3 ways: (1) as the percentage of animals in each sex-age class expected to die each year, with a corresponding variance, (2) as a fixed number removed (e.g., harvested) in each sex-age class, and (3) as a catastrophic event that reduces the normal survival rate by some fixed amount.

Cub survival is quite variable among North American black bear populations, and, more over, the factors affecting this variability are not understood. Consequently, we used the average cub mortality rate from 23 studies for which data were available as our best estimate of cub mortality for Formosan black bears (35%). In most studies, males have a significantly higher cub mortality rate than females, so we assumed a rate of 40% for male cubs and 30% for female cubs.

Survival of older bears is strongly related to human influences, such as hunting, poaching, and nuisance kills. Survival of American black bears in protected areas is consistently very high, except where bears cross the boundaries of the area and become vulnerable to human sources of mortality. We used the average mortality rates observed among studies in unhunted North American populations to develop the following mortality schedule expected in the absence of poaching for a population of Asiatic black bears well below carrying capacity. The SD due to environmental variation was considered to be 25% of these mean values, as shown:

subadult females -	5%	(SD = 1.25%)
adult females -	5%	(SD = 1.25%)
subadult males -	10%	(SD = 2.5%)
adult males -	5%	(SD = 1.25%)

There is no legal hunting of Formosan black bears, and nuisance killing is very rare, so the only significant human source of mortality is poaching. The level of poaching is, of course, unknown, and certainly the primary variable affecting the future status of these bears. Thus, the modelling procedure was used to project future population sizes under various levels of poaching. We made the assumption that poachers would not be selective for particular sex-age classes of bears, and since we could not make a reasonable guess as to relative vulnerabilities of each sex-age class, we considered poaching to affect each to an equal extent. We also assumed that poachers would take a fairly constant proportion of the population rather than a fixed number of bears; that is, if the population diminished, poachers would find it more and more difficult to find bears, thereby taking a smaller number, although roughly an equal proportion.

We found it most convenient to manipulate the level of poaching by including it as a "catastrophe" that occurred on an annual basis which reduced the survival of each sex-age class by the same amount; we could then vary the level of poaching by simply altering the amount by which survival was reduced. We examined the effects of poaching levels of 5%, 10% and 15%, which were entered in the model as 95%, 90% and 85% factors, respectively, affecting survival. Incorporating poaching in this manner, rather than entering it directly in the mortality schedule, results in a somewhat diminished effect, as shown in the example below, because the mortality is imposed on the proportion of animals that did not die of natural mortality.

Example comparing 10% poaching applied in two different ways. In this model we used method #2.

1. 10% poaching added to 5% natural mortality = 15% mortality.
2. 95% survival reduced 90% by poaching = 85.5% survival = 14.5% mortality.

We also incorporated a second "catastrophe" to correspond with the effects of mast crop failures. In American black bears mast crop failures have been observed to significantly affect reproduction (sometimes resulting in total reproductive failures), but not natural mortality (although it may affect human-caused mortality in populations subjected to hunting or nuisance killing). We presumed that significant mast crop failures occurred about once in 10 years in Taiwan (considered a stochastic event in the model occurring with a probability of 10%), which reduced reproduction to 25% of normal but did not affect survival.

<u>Carrying Capacity</u>: K defines an upper limit for the population size, above which additional mortality is imposed in order to return the population to K. VORTEX uses K to impose density-dependence on survival rates. It also has the capability of imposing density dependent effects that change continuously as the population

approaches K, but since such effects have not been documented among the numerous studies of black bears in North America, we elected not to include them in our model.

We chose an overall K for the island of 2,000 bears, or about 1/5 km^2. Whereas this value is certainly arguable, given much higher black bear densities in some protected areas in North America, the effect of this rather arbitrary choice of a value for K on the model projection is negligible, as the population is currently well below K. The imposition of carrying capacity would only have meaningful effects in the near future (i.e., next 2 decades) if proposed cross-island road construction, and the ensuing probable increase in access for poachers, fragment the bear's range to the extent that each separate, remnant population becomes limited by its own individual carrying capacity.

Inbreeding Depression: We did not include the option for inbreeding depression included within VORTEX for most runs of the model. This option was added, however, when we sought to examine the effects of fragmentation of the various protected areas. For this option we assumed 3.14 lethal equivalents per diploid genome, which, absent specific information for bears, is the median value from 40 other mammalian species

Starting Age Distribution: We initialized all of the model runs with a stable age distribution that distributes the total population among each sex-age class in accordance with the existing mortality and reproductive schedules.

Starting Population Size: We tested 4 initial estimates of population size: 100, 200, 300 and 400 bears.

Metapopulation Analysis: After the initial model runs, we repeated the process using the same estimates of total population size, but assumed that the island-wide population was not uniform with respect to levels of poaching and hence population density. Given that poaching should be lower within protected areas than outside these areas, and poaching is likely the major influence on bear density, we assumed that although a third of the available bear habitat is within protected areas, half the bears occupied these areas. Thus, for a starting population of 200 bears, 100 were considered to be within protected areas and 100 outside.

We used poaching rates of 5% inside protected areas and varied the poaching rate outside from 10% to 15%. We assumed that all migrants between protected and unprotected areas were young (1-3 year-old) males, in accordance with data on dispersal in American black bear populations. We also assumed that 25% of dispersing animals moved from protected to unprotected areas, or vice versa (the remainder dispersed within the area that they were born).

We had no information on habitat differences between protected and unprotected areas, so we presumed carrying capacities to be relative to area. Considering a total carrying capacity of about 2,000 bears, as above, we thus considered the protective areas, with a third of the area, to have a carrying capacity of 700.

Iterations and Years of Projection:

Each scenario was iterated 200 times, and projections were made for 100 years into the future. Output results were summarized at 10 year intervals in the time series figures. Each tabulated scenario has a corresponding file number for reference and future retrieval of other results, if necessary. The simulations were run using VORTEX version 6.2.

Population Projections:

Figures 1-4 show population projections for the 4 different starting populations, assuming poaching rates of 5%, 7.5%, 10%, and 15%. The 7.5% scenario was added after viewing the other results as a demonstration of population stability. The vastly different projections for rather subtle differences in the extent of poaching, in terms of numbers of bears taken, is striking: for example, for a starting population of 200 bears, poaching 10 bears (5%) enables the population to increase, poaching 15 holds it stable, and poaching 20 drives it towards extinction.

Figures 5-6 show the probabilities of extinction over time for poaching rates of 10% and 15%; no extinctions occurred at lesser poaching rates. Even under poaching levels of 10-15%, the population will persist for at least 20 years, regardless of the initial population size. However, with a poaching rate of 15%, the population would likely not persist beyond 50 years.

Population growth rates (r), probabilities of extinction (Pe), final population size (N100), and retention of genetic heterozygosity (He) after 100 years, as well as the mean time to extinction (Te) are shown in Table 1 for the varying levels of poaching (Pch) and starting population sizes (N). The deterministic growth rate was calculated by a Leslie matrix algorithm. Positive values are necessary for a population to survive, and in principle a zero value would characterize a stable population. The deterministic growth rate is not sensitive to differences in starting population size, but varies with level of poaching (Table 1). Poaching levels of 10% or more result in negative population growth and inevitable extinction, presuming no intervention. Stochastic population growth rates were more sensitive to population size, tending to be higher with larger populations, but even the most optimistic population estimate of 400 animals declined steadily with 10% or more of the animals poached. The probability of extinction within the next 100 years was 100% for poaching rates of 15%. Expected time to extinction under this rate of poaching was <60 years (Table 1, Fig. 6). With a poaching rate of 10%, the population would be expected to persist <100 years.

If the protected areas have much lower poaching rates (5%) than unprotected areas (10-15%), but there is significant interchange (of males only) between the two, the model (metapopulation analysis) predicted growth of populations in protected areas and decline in unprotected areas (Figures 7-9). Bears persisted in unprotected areas in runs with 10% poaching (but not 15% poaching) because immigration of males from the growing protected populations compensated for poaching loss. These unprotected areas became population sinks, with virtually no reproductive females. Overall, this scenario indicated a substantial shift in bear distribution and an overall increase in bear numbers.

This scenario, however, considered the protected and unprotected areas as two populations, whereas in reality there are presently 5 discrete protected areas separated by unprotected zones. As poaching reduces bear densities in these unprotected zones and gradually eliminates reproductive females (because female bears rarely disperse), these areas may become barriers to interchange between protected areas. Dispersing males might not be attracted to areas with no available females, and more over, those that did attempt to cross the area might be intercepted by poachers. Thus, with high levels of poaching in unprotected areas, the protected areas would become more and more isolated from each other, and their populations would behave as small discrete units rather than as a single large unit, as modelled above. To examine the effects of such fragmentation we chose one protected area in the northern part of the range (La La Mountain), where an estimated 10% of the total protected area population resides. In the most optimistic scenario, where the total population is presumed to number 400 bears, 200 of which are in protected areas, this one area would contain about 20 bears. If the poaching rate is held to 5% and inbreeding effects are ignored, this population would be expected to grow; however, in a population this small, isolated from other populations, inbreeding effects could become important, imposing a risk of extinction, even with this rather low level of poaching (Fig. 10).

Summary:

Sighting data indicate that bear numbers in Taiwan are likely not growing. Furthermore, the total population appears to be quite small and must be well below carrying capacity. Poaching is certainly the greatest threat to viability. The modelling runs conducted here indicated that poaching rates of at least 10% result in an appreciable risk of extinction. If lower rates can be maintained within protected areas, the overall population would grow; however, with continued high rates of poaching in unprotected areas, the protected areas would become more and more isolated, with less and less genetic interchange, running greater and greater risks of extinction, as demonstrated in Figure 10. These results highlight the value of increasing the size of protected areas so that (1) each harbors a larger population of bears, more resistant to the stochastic effects of small population size, and (2) the intervening unprotected zones are smaller, and therefore less of a barrier to migration between protected areas.

The scenarios we modelled, with 5% poaching within protected areas, might actually be overly optimistic, given that the real populations within protected areas appear not to be growing. Furthermore, if poaching outside protected areas is higher than within protected areas, it would suggest that our modelled rates of 10-15% poaching mortality in the unprotected areas are likely not underestimates. Projections indicate that poaching of this magnitude will lead to the demise of the Formosan black bear during the next 100 years, and possibly during the next 50 years. Reducing the level of poaching is clearly the utmost imperative for the conservation of this population.

These projections must be interpreted with caution, given the limitations of the input data. However, whereas there is certainly good reason to make an effort to collect data specific to this population, we see no escaping the conclusion that this population is currently in a highly perilous situation. We doubt that reproductive rates are significantly higher than assumed herein, based on North American black bear data, and the fate of the population appears to be rather invariable with respect to the actual size of the present population, given it is likely less than 500. Thus, although studies aimed at collecting more accurate reproductive data and studies to obtain better population estimates would be useful, they could divert attention from the primary factor dictating the dynamics of this population -- poaching. It seems clear that studies designed to estimate the level of poaching would be the most productive means of evaluating the status and future of this population, and would likely be the most effective means of drawing attention to this population's apparently desperate conservation needs. Studies directed at elucidating the nature of the poaching problem also could aid in developing a strategy for better enforcement.

It was evident from this modelling endeavor that a poaching rate of about 10%, equivalent to the taking of just 20 animals in a population of 200, causes the population to decline, whereas reducing the take to 10 animals enables the population to increase. This sensitivity to small changes in the number of animals poached (a reflection of the small number of bears remaining) has sizable ramifications for efforts directed at reducing poaching. In one sense, preventing the poaching of 20 bears from an area of nearly 1 million hectares might seem too daunting a task to be worthwhile. On the other hand, these projections suggest that saving just 10 bears might be enough to rescue this population from extinction.

Figure Legends:

Figure 1. Projections of population size for Formosan black bears subjected to a poaching rate of 5%, assuming a starting population size of 100, 200, 300 or 400 bears and a carrying capacity of 2,000.

Figure 2. Projections of population size for Formosan black bears subjected to a poaching rate of 7.5%, assuming a starting population size of 100, 200, 300 or 400 bears.

Figure 3. Projections of population size for Formosan black bears subjected to a poaching rate of 10%, assuming a starting population size of 100, 200, 300 or 400 bears.

Figure 4. Projections of population size for Formosan black bears subjected to a poaching rate of 15%, assuming a present population size of 100, 200, 300 or 400 bears.

Figure 5. Probabilities of extinction through time for the Formosan black bear population subjected to an assumed poaching rate of 10% and a present population size of 100, 200, 300, or 400 bears.

Figure 6. Probabilities of extinction through time for the Formosan black bear population subjected to an assumed poaching rate of 15% and a present population size of 100, 200, 300, or 400 bears.

Figure 7. Projections of the number of bears in protected and unprotected segments of the Formosan black bear population subjected to different rates of poaching: 5% in the protected area, versus 10% or 15% in the unprotected areas. The total present population was assumed to be 100 bears, half of which reside in protected areas,

Figure 8. Projections of the number of bears in protected and unprotected segments of the Formosan black bear population subjected to different rates of poaching: 5% in the protected area, versus 10% or 15% in the unprotected areas. The present population was assumed to be 200 bears, half of which reside in protected areas,

Figure 9. Projections of the number of bears in protected and unprotected segments of the Formosan black bear population subjected to different rates of poaching: 5% in the protected area, versus 10% or 15% in the unprotected areas. The present population was assumed to be 400 bears, half of which reside in protected areas,

Figure 10. Probabilities of extirpation of a singular protected black bear population (La La Mountain) in northern Taiwan that was assumed to be demographically and genetically isolated. Other assumptions for these model runs included a poaching rate of 5%, a carrying capacity of 60 bears, and a present population size of 20. One projection ignores potential deleterious effects of inbreeding (Heterosis [H] = 0), whereas the other incorporates inbreeding depression (Heterosis option with 3.14 lethal equivalents per genome).

Figure 11. Loss of allelic diversity as a function of starting population size and poaching rate in simulated black bear populations. The simulations are initialized with 2N unique alleles. A stochastic gene drop program applied to the alleles in each individual in the population is used to select the allele passed to each offspring. A higher proportion of alleles will be retained in a growing population.

Figure 12. Loss of heterozygosity as a function of starting population size and poaching rate in simulated black bear populations. The starting level of heterozygosity is set at 1.00. This measure provides an estimate of the level and rate of inbreeding in the simulated populations. Since the generation time is about 12 years under the conditions of these simulations the 100 years represent 8-9 generations. Thus a 100 year heterozygosity value of 0.92 would represent a loss of 8% or about 1% per generation.

Table 1. Formosan Asiatic Black Bear - Poaching Rates and Extinction Risk										
File #	Variables		Results							
	N at t=0	Pch %	Population Growth		100 Years					Te
			Deter r	Stoch r	Pe	N 100	SD	Allel	He	
K=2000										
136	100	0	.080	.079	0	1990	31	111	.984	-
137	200			.079	0	1990	30	184	.990	-
138	300			.079	0	1992	29	231	.992	-
139	400			.079	0	1989	34	262	.993	-
120	100	5	.029	.027	0	1460	493	51	.964	-
121	200			.027	0	1821	288	100	.981	-
122	300			.028	0	1923	107	145	.987	-
123	400			.028	0	1923	117	184	.990	-
132	100	7.5	.002	-.0002	.005	132	101	18	.880	99
133	200			.0000	0	239	146	35	.941	-
134	300			.0007	0	379	215	54	.962	-
135	400			.001	0	512	280	73	.973	-
124	100	10	-.025	-.037	.655	17	13	5	.666	76
125	200			-.033	.325	24	17	8	.752	85
126	300			-.031	.150	25	18	10	.801	92
127	400			-.029	.085	35	25	13	.842	91
128	100	15	-.082	-.109	1.00	0	-	-	-	36
129	200			-.102	1.00	0	-	-	-	45
130	300			-.101	1.00	0	-	-	-	50
131	400			-.098	1.00	0	-	-	-	54

Table 2. Formosan Asiatic Black Bear Metapopulation and Poaching Scenarios

			Protected Populations: K=700, Poach=5%							Unprotected Populations: K = 1400						
File #	N t=0	Pch %	rd	rs	Pe	Te	N	He	Allel	rd	rs	Pe	Te	N	He	Allel
Migration Rates =0.25 of 1-3 Yr Males																
M10	50	10	.029	.024	0	-	527	.920	26	-.025	.001	.540	69	98	.724	25
M16		15		.024	.050	88	507	.903	22	-.082	-.030	.995	42	80	.922	21
M12	100	10	.029	.025	0	-	636	.960	50	-.025	-.0003	.425	25	125	.960	45
M14		15		.024	0	-	647	.953	43	-.082	-.021	.995	48	111	.958	38
M13	200	10	.029	.026	0	-	674	.978	87	-.025	-.004	.225	83	139	.976	72
M15		15		.026	0	-	669	.974	74	-.082	-.018	.995	55	107	.971	59

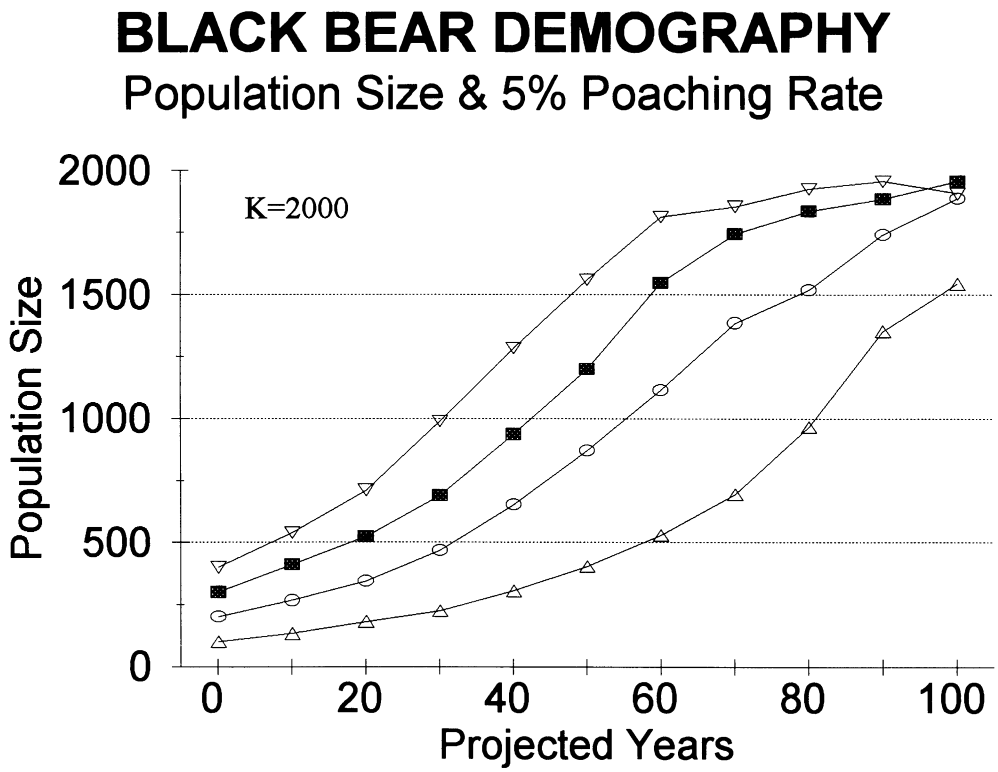
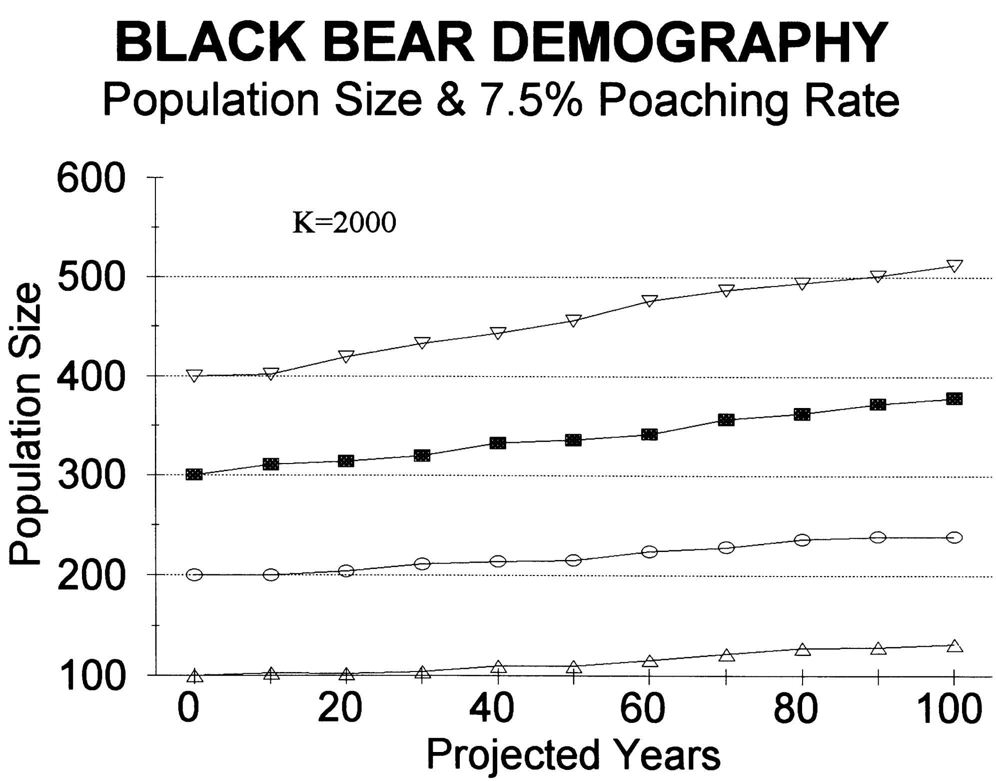


Figure 1.



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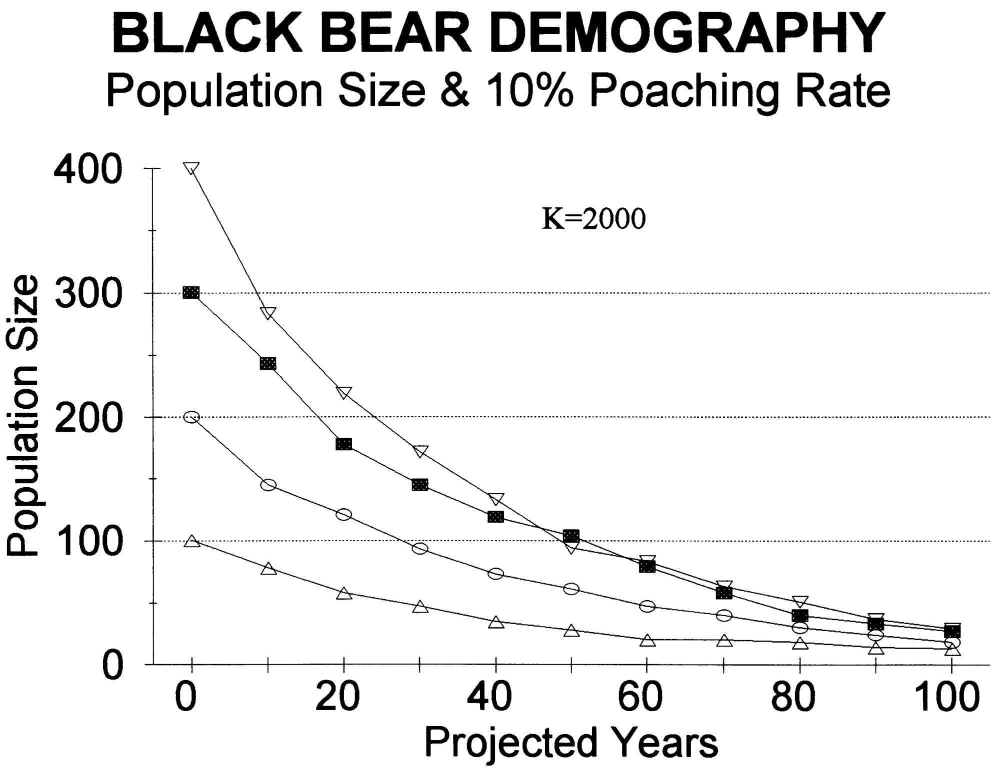

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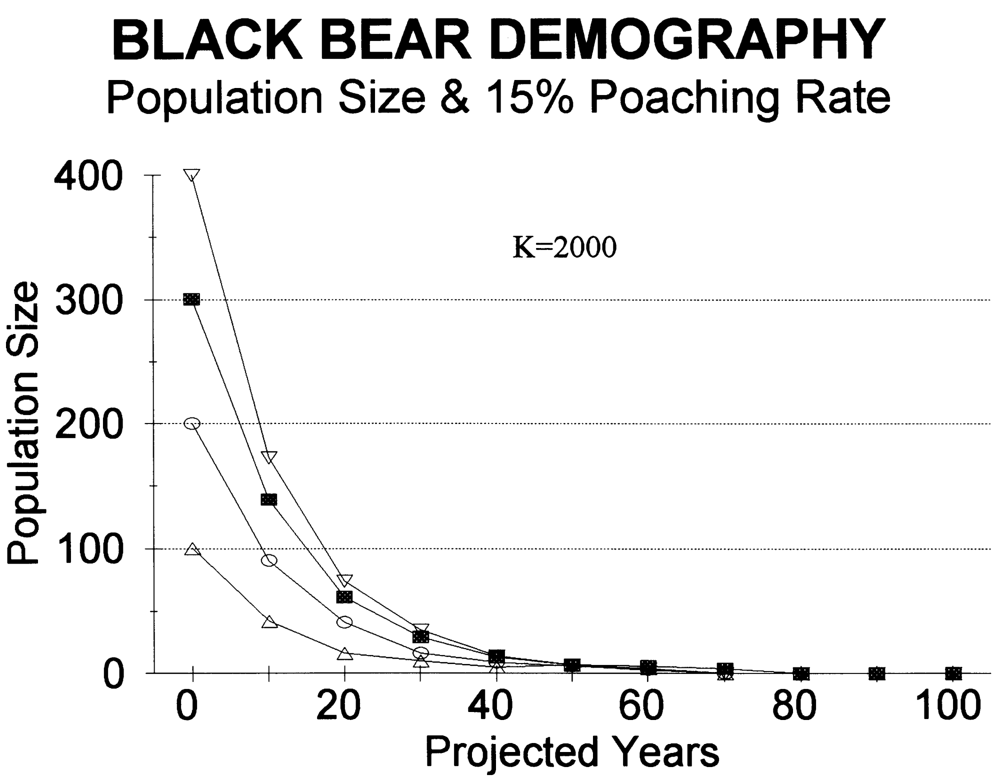

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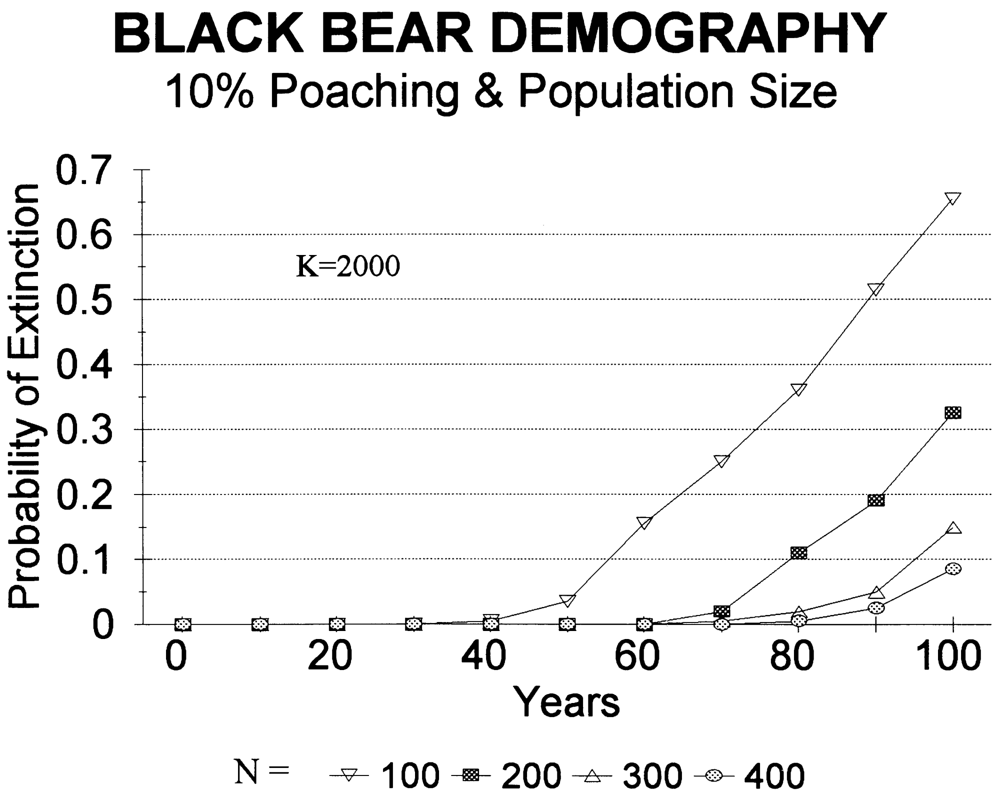

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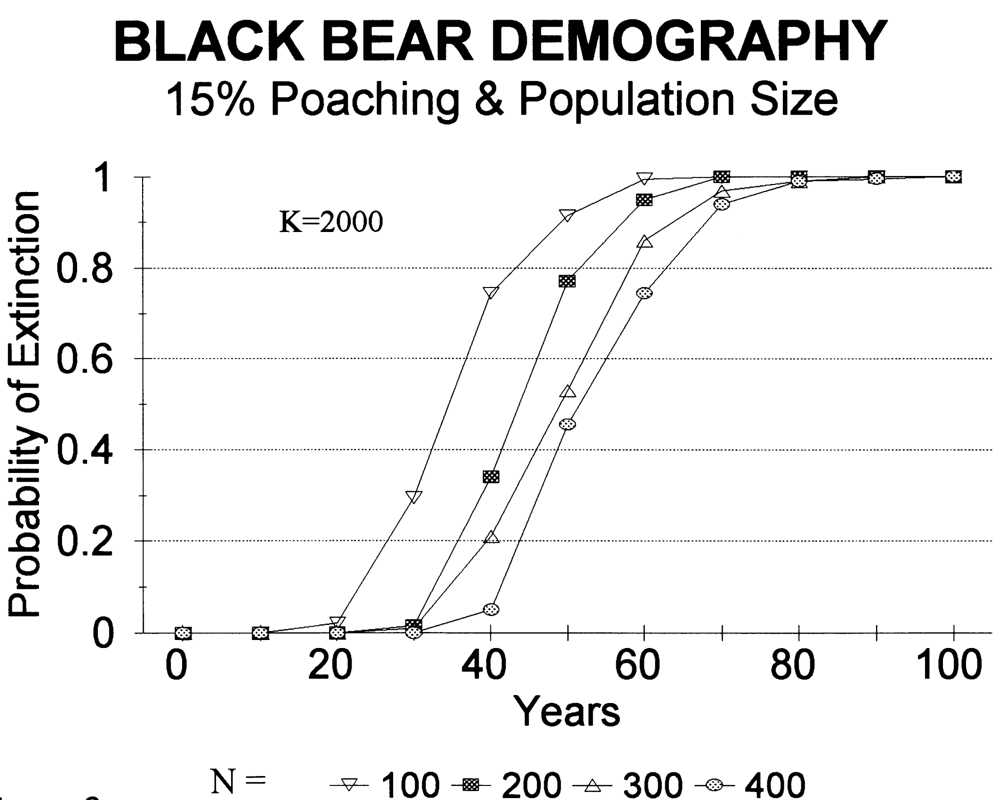

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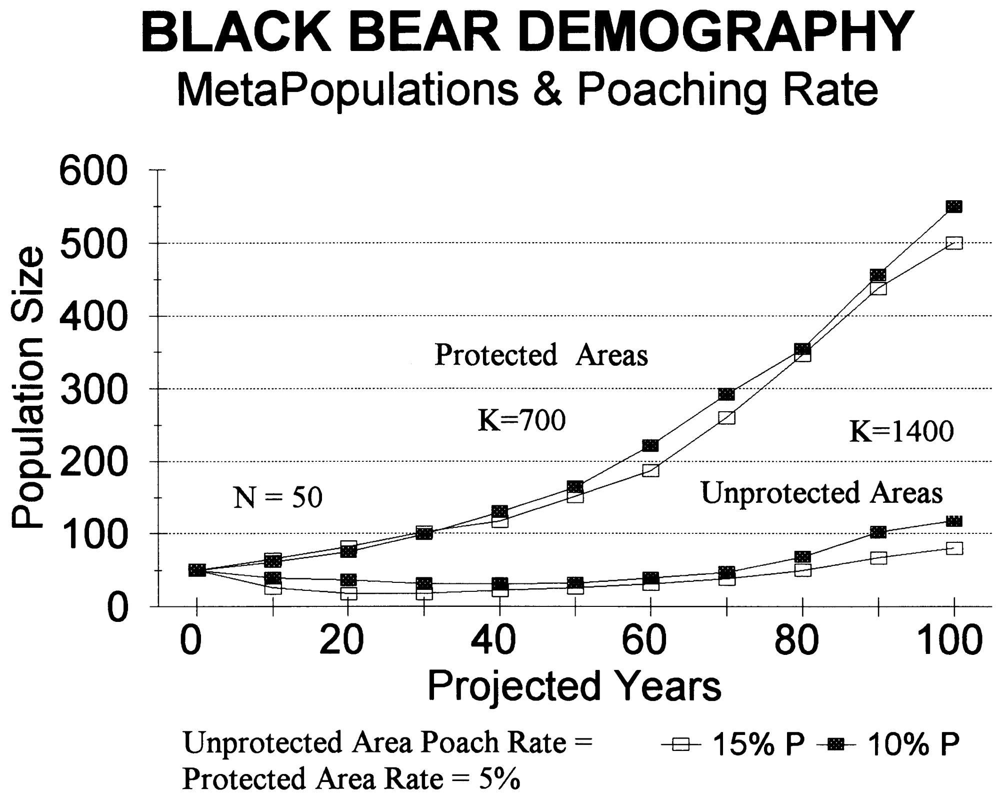

Figure 7.

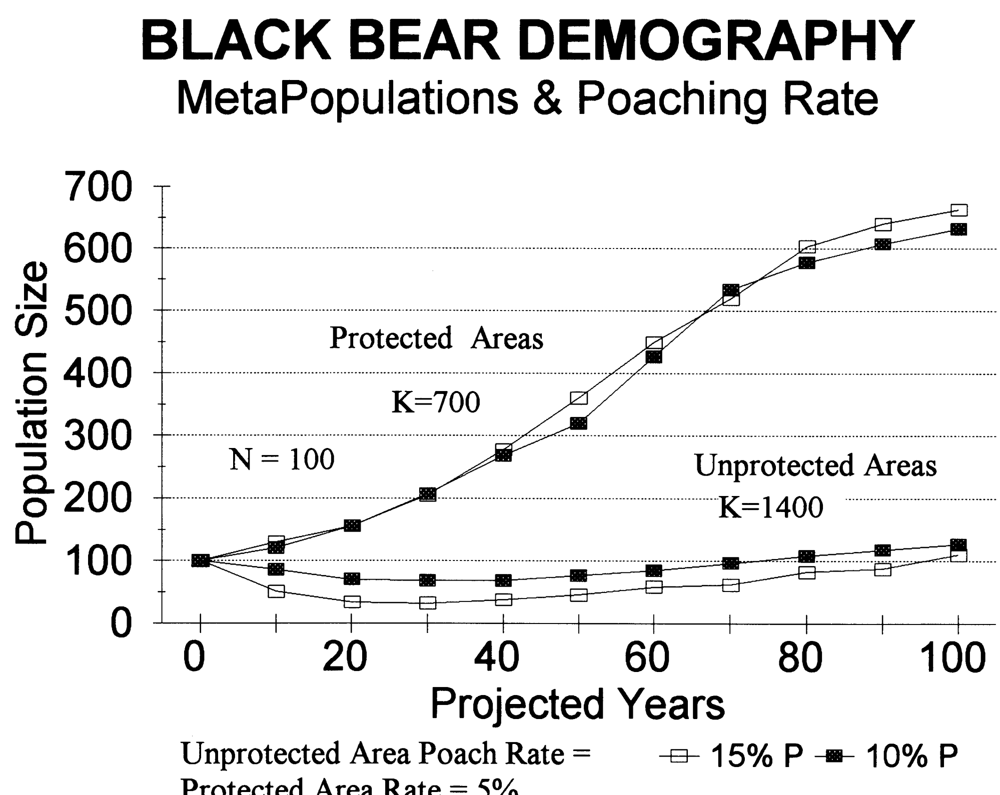

Figure 8.

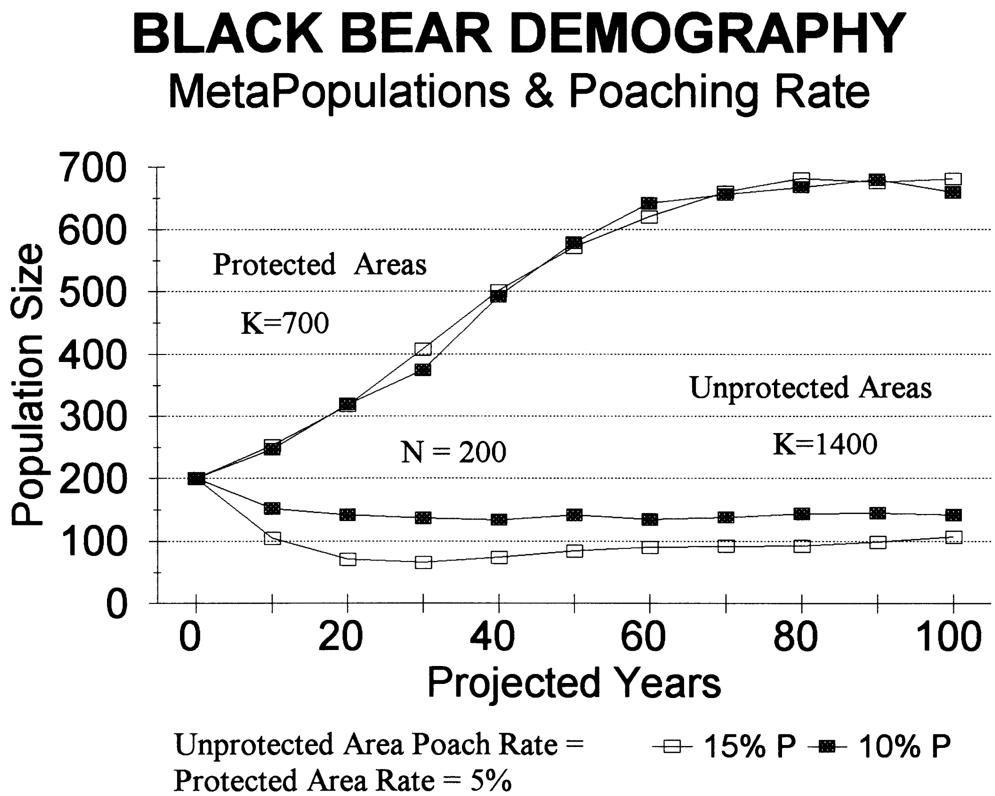

Figure 9.

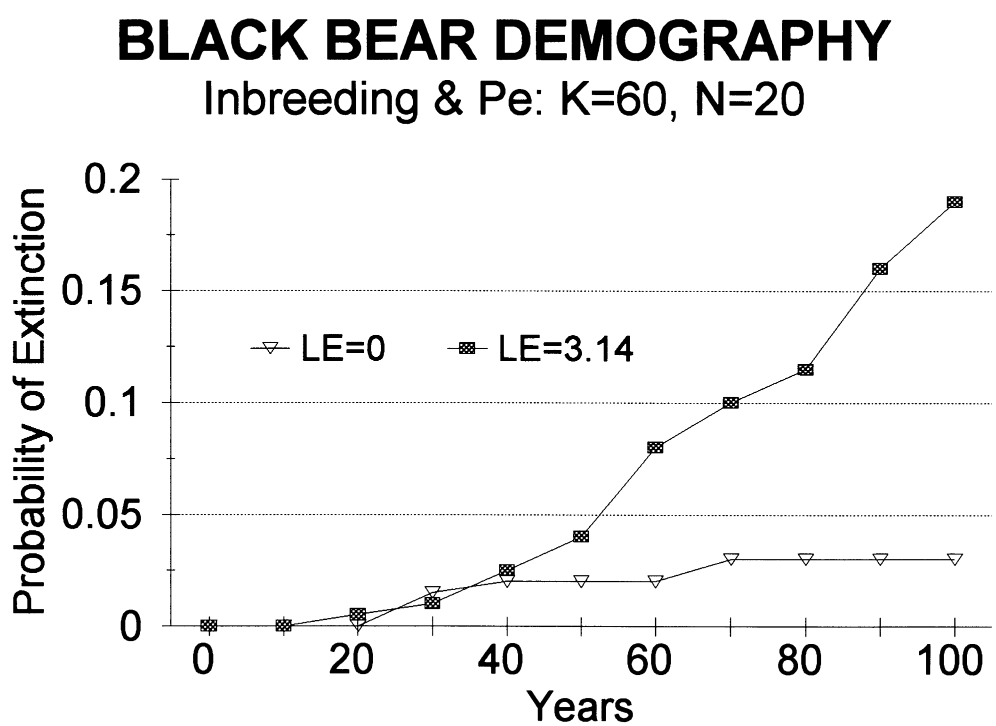

Figure 10.

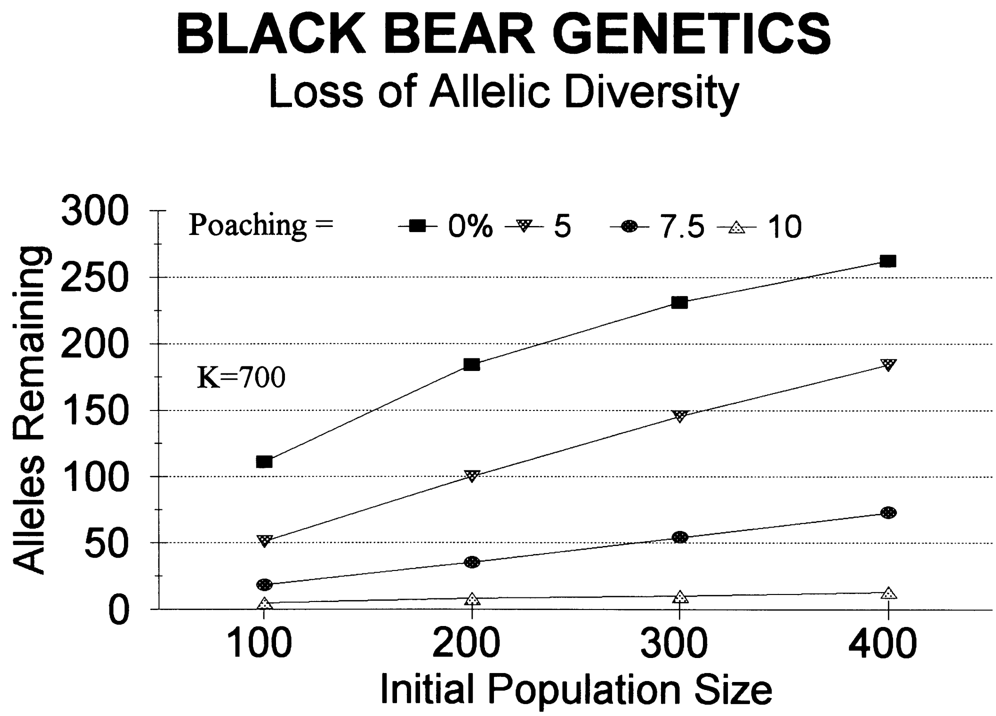

Figure 11.

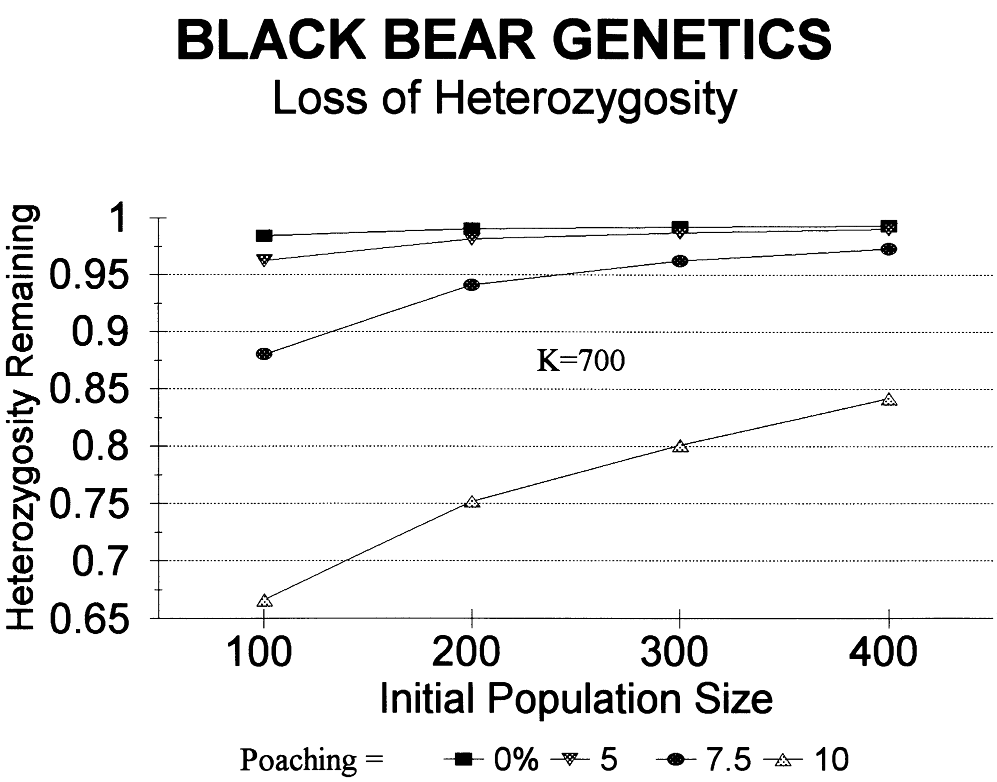

Figure 12.

ASIATIC BLACK BEAR

Ursus thibetanus formosanus

POPULATION AND HABITAT VIABILITY ASSESSMENT WORKSHOP

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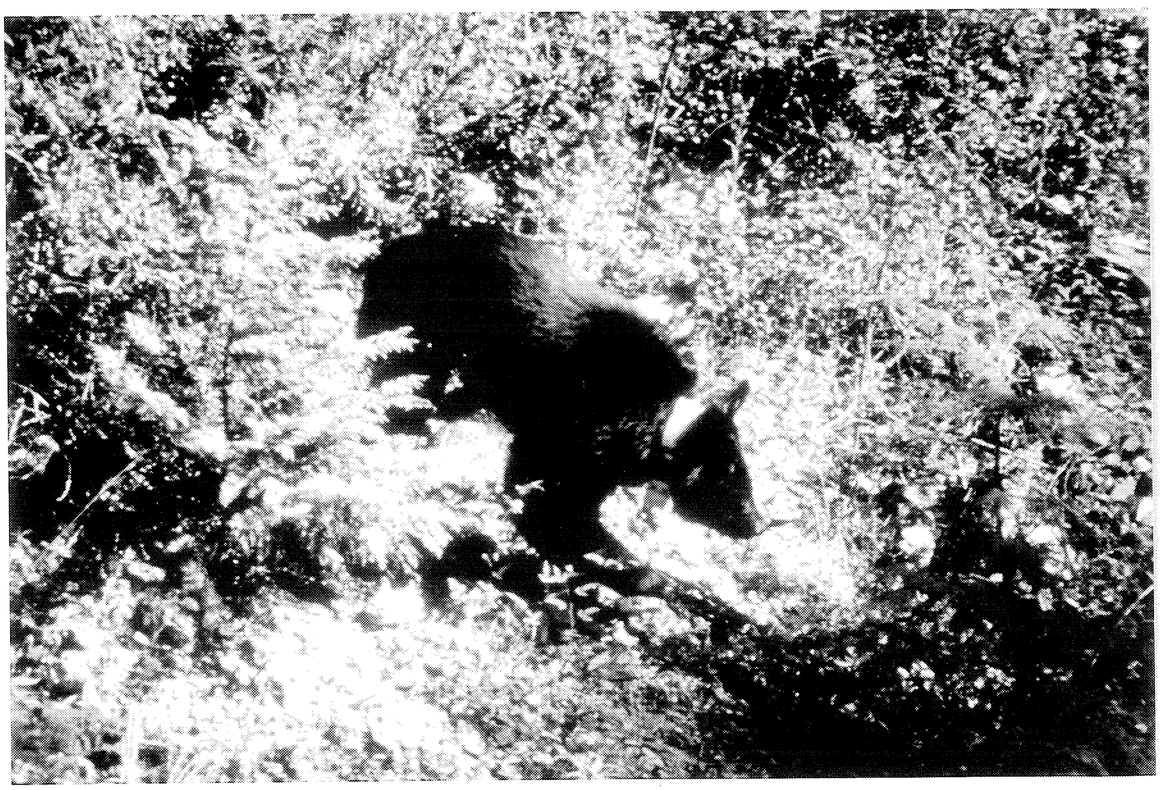

Section 4

Protection and Management of the Wild Population

野外族群的保育與經營管理

近期目標

1.避免黑熊族群數目降低

2.持續調查及偵測黑熊野外族群數量，以及其遺傳變異在分類及亞種上獨特性。

行動

1.增進保護棲息地以及防止盜獵。

2.發展標準化的問卷來收集黑熊在臺灣出沒的記錄，以及處理沒收黑熊的流程。

3.評估既有保護區的邊界，來涵蓋較大的黑熊棲息地或連結黑熊棲息地。

4.持續以及發展必要的野外研究來偵測黑熊的野外族群大小，以及收集相關生態訊息。

5.建立在研究者以及管理、保育黑熊者之間的訊息聯絡網，來交換保育訊息。

6.結合黑熊生物及保育知識於較廣的保育教育上並指導黑熊觀察以及處理沒收黑熊的程序。

7.收集以及分析野外黑熊族群的遺傳變異。

長期目標

維持黑熊野外族群的持續

行動

1.整合野外黑熊觀察資料，並藉以評估黑熊族群的消長以及密度的變化。

2.持續收集黑熊的生態資料，整合野外以及圈養繁殖的黑熊計畫，形成各黑熊保育、經營、教育政策計畫的緊密合作。

3.計畫於2-3年內召開臺灣黑熊的座談會，來分析各項目標的進展程度，並對黑熊族群現況做更佳的評估。

4.強化既有國家公園以及保護區對黑熊的保護，並在鄰近地區確立土地利用的模式，化爲保護區或減少人類與野生黑熊之間的接觸和衝突。

WILD POPULATION MANAGEMENT

A. Short Term Goals.

Prevent further decrease of the black bear population. Survey and monitor wild population status. Do taxonomic studies to determine subspecies uniqueness and level of genetic variation.

1. Improve the ability to protect habitat and prevent poaching.

2. Develop an accurate (standardized) questionnaire to collect information about the distribution of bears and bear sign in Taiwan.

3. Evaluate extending boundaries of protected areas to include larger areas of the bears' habitat or to connect bear habitats.

4. Continue the necessary field research to monitor wild population size and to collect ecology data on the bears.

5. Develop a strong communication network between the researchers and managers to share information regrading bear conservation.

6. Develop a program to incorporate bear conservation information into broader conservation education programs and introduce the use of the bear observation form.

7. Collect and analyze genetic information on the wild population.

B. Long Term Goals.

Maintain a sustainable population size of black bears.

1. Integrate observation data to evaluate the population size of the black bear and to estimate the changes in population density of the bear.

2. Continue to collect ecological information on the black bears. Integrate in situ (protected areas) and ex situ (captive breeding) bear programs in Taiwan and form a collaboration between bear conservation management programs.

3. Schedule another Asiatic black bear workshop in two to three years to analyze progress toward goals and to evaluate more accurately the status of the populations of the bears.

4. Strengthen the protection of the National Parks Reserves. Design land use patterns in the vicinity of these areas as protected areas and minimize human-wildlife conflicts.

ASIATIC BLACK BEAR

Ursus thibetanus formosanus

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Section 5

Utilization

台灣黑熊的利用管理

短程策略

降低或消除本地族群下降之趨勢

1. 台灣黑熊的市場瞭解—獵户及原住民訪談

2. 現有國內市場的瞭解—所有熊種的市場

3. 市場管理

   1）只准許中醫熊膽的利用

   2）與中醫藥業者合作以瞭解現有存量與年消費值

   3）未來熊膽的供給建議限由美加地區之美洲黑熊來供給

4. 宣導教育

   1）提昇民眾對中藥的認知，並提倡替代品的使用以降低熊膽需求

   2）加強政府與中醫藥界的溝通與合作

   3）加強中醫藥的研究—替代品及療效

5. 現有族群狀況

   1）瞭解現有族群分佈，並分辨隔離族群

   2）監控飼養族群狀況，防患逸失與棄養的發生

中程策略

族群穩定或穩定上昇

1. 評估檢討市場管理制度

2. 發展棲地保護策略

   1）緩衝區（帶）及走廊的設立，防患人熊衝突

   2）找出可從事復育的地點

   3）發展移地復育策略

3. 大眾宣導策略

   1）提昇人們對野生族群的容忍度

   2）持續中醫藥的宣導。

長程策略

目標：族群穩定或穩定上昇

1.評估檢討市場管理制度

2.實施超載棲地個體移地復育計畫

3.持續宣導以降低人熊衝突

4.過剩個體的永續利用

MANAGEMENT OF FORMOSAN BLACK BEAR UTILIZATION

Short Term Goals:

Reverse present declining trend of Taiwan's black bear population.

1. Conduct interviews with hunters and local people to better understand the present market for Taiwan's black bear.

2. Gather information to better understand the present market for bears and bear products in Taiwan.

3. Regulate the market for bears and bear products in Taiwan.

   a. Restrict utilization of bear products to the gall bladder for use in TCM only (currently bear gall bladder is also used in traditional remedies not under the purview of TCM and meat is eaten as a delicacy).
   b. Devise a system in cooperation with the traditional Chinese medicine societies to determine existing amounts and per annum use of bear gall bladder in TCM.
   c. Consider the only present possible source of a legal supply of bear gall bladder, i.e. the United States and Canada, through government to government trade.

4. Expand education, research, and cooperation.

   a. Promote public education encouraging use of substitutes for bear gall bladder and improve the public's general understanding of traditional Chinese medicine to decrease consumption of bear gall bladder.
   b. Increase communication between the TCM community and pertinent government agencies to improve overall cooperation and facilitate implementation and enforcement of policy.
   c. Promote research on animal parts used in TCM with the goal of identifying substitutes for bear gall bladder; identify both effective and ineffective utilization of animal products.

5. Formosan bear population.

   a, Understand the present distribution of Formosan black bears in the wild and identify isolated or small populations.
   b. Closely monitor captive bears, including exotic species, to prevent possible escape or abandonment.

Medium-Term Goals:

Stabilize the Formosan black bear population in the wild.

1. Evaluate the effectiveness of legal domestic bear gall bladder market controls.

2. Expand protected habitat.

   a. Establish buffer zones around isolated populations and possibly in all existing protected areas to facilitate population growth and achieve long term viable population size; and prevent possible human - bear conflicts in the future.
   b. Create corridors linking separate populations to increase variation of gene pool for existing populations.
   c. Identify areas for bear reintroduction.
   d. Establish a strategy to increase existing small populations through translocation.

3. Public Education Programs.

   a. Promote tolerance of bears in communities surrounding bear habitat, to include existing populations and future populations.
   b. Promote tolerance in the general public toward bears and wise use of bear habitat.
   c. Continue public education concerning utilization of animal parts in traditional Chinese medicine.

Long Term Goals:

Achieve stability or increase in population of Formosan black bear.

1. Evaluate the effectiveness of legal domestic bear gall bladder market controls.

2. Use individuals in overcrowded habitat as founders for new populations.

3. Continue public education to resolve possible conflicts arising from negative bear - human interactions in certain areas.

4. Sustainable use of surplus bears.

ASIATIC BLACK BEAR

Ursus thibetanus formosanus

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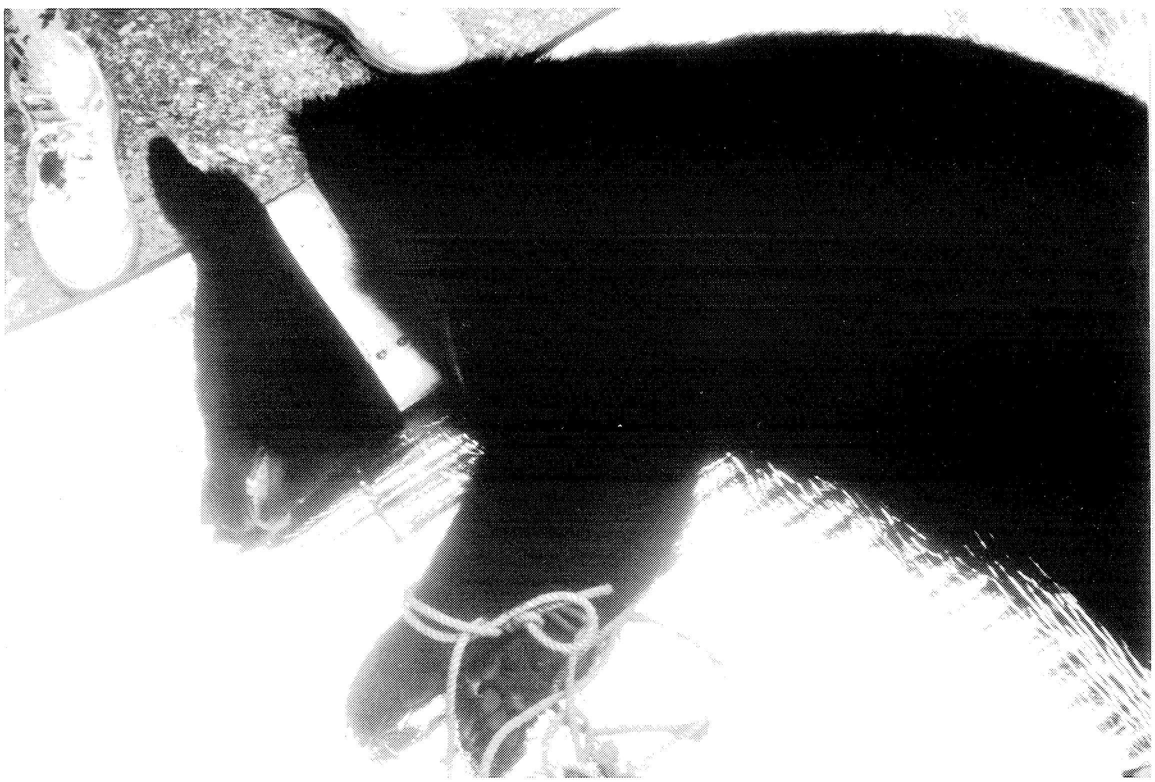

Section 6

Conservation and Management of the Captive Population

圈養族群的保育管理

一、短期

1.個體資料建立

1)物種血緣鑑定，及其技術發展

2)血統書之建立

2.基本資料建立及研究

1)生理、解剖、疾病、醫療、飼養、管理、繁殖、行爲、生長等研究及資料建立

2)引進國外亞洲黑熊相關資訊

3.成立工作小組

1)成員包括遺傳、畜牧、獸醫、生物及生態專家

2)建立資料網路

3)定期召開研習會

4)積極與野外黑熊保育單位及工作者聯繫

5)整合圈養與野外保育之技術

4.建立黑熊繁殖基地及急救收容站

1)公立動物園

2)特有生物中心

3)急救收容站（屏技、動物園及特有生物中心）

5.繁殖技術之研究

1)繁殖生理研究

2)物種冷凍保存研究

3)引進黑熊繁殖技術，必要時派員出國受訓

6.經費之募集

1)民間企業贊助

2)認養計畫

3)爭取政府相當比例經費支持

二、中期

1.擬定合作性、計畫性之繁殖計劃

2.持續性工作之執行

三、長期

1.物種血緣交換

2.復育計畫之可行性探討

CONSERVATION MANAGEMENT OF THE CAPTIVE POPULATION

Programs to be initiated within 1-3 years.

1. Establish a registry of captive Formosan black bears.

   a. For each animal, identify and record its origin and genetic makeup.

   b. Further develop methods for ensuring accuracy of lineage of individual animals.

   c. Develop a studbook for the Formosan black bear.

2. Develop basic knowledge of the species.

   a. Develop information on the physiology, anatomy, disease, veterinary care, husbandry, behavior, and growth.

   b. Research and compile relevant data on Asiatic black bear from other countries.

3. Form a working group of captive breeding specialists.

   a. Group members may include geneticists, animal scientists, veterinarians, biologists, and ecologists.

   b. Establish an information network.

   c. Hold meetings routinely to exchange information.

   d. Aggressively develop contact with field researchers, scientists, and conservation organizations.

   e. Apply knowledge and techniques gained from captive populations to field research. Similarly transfer knowledge and techniques developed in the field to benefit captive husbandry.

4. Construct breeding centers and rescue facilities.

   a. Taipei city zoo to act as breeding center and rescue facility.

b. Taiwan Endemic Species Institute to act as a breeding center and rescue facility.

c. National Ping-tung Polytechnic to act as a rescue facility.

5. Research bear reproduction.

a. Engage in research on reproductive physiology.

b. Develop a gene resource bank (frozen zoo) with sperm and embryos.

c. Acquire from other countries techniques and knowledge for black bear reproduction. If appropriate send staff abroad to study.

6. Garner financial resources.

a. Secure sponsorship from private business.

b. Adopt-An-Animal Program.

c, Seek and secure an appropriate proportion of government funding to support bear conservation programs.

B. Programs to be initiated within 3-5 years.

1. Propose a coordinated breeding program to involve all appropriate entities.

2. Continue all necessary programs that were initiated earlier.

C. Programs to be initiated within 5-10 years.

1. Develop a program to exchange genetic materials between captive Formosan population and other appropriate populations. This may include transfer of animals as well as genetic materials such as sperm and ova.

2. Investigate the feasibility of reintroduction.

ASIATIC BLACK BEAR

Ursus thibetanus formosanus

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Section 7

Law and Policy

法律與政策

一、政策

1.
如何讓黑熊的保育政策及計畫成爲國家的優先重點計畫？

黑熊保育策略的制定，首先要藉教育的方法去除一般人對黑熊的恐懼心理，以降低民眾對黑熊保育的排斥。

2.
如何增強保護區體系縱向及棋向的聯繫？是否增設自然保護區及保護區的野生動物走廊？

現階段由農委會自然景觀審議小組召集黑熊棲地主管機關行政人員、學者專家、及民間團體組成任務小組，負責研議加強我國自然保護區體系縱向及棋向的聯繫，並規劃自然保留區的設立原則，以及增設野生動物遷移走廊之可行，研議近程保育計畫，俟野生動物保育法通過立法後，再交由新法規定的主管機關去研議及執行後續政策。

3.
如何修正國土利用政策減少土地的超限利用對黑熊棲地的破壞？如何利用區域計畫法及山坡地保育法對保護區外的土地利用予以適當的管制？

議經建會設計國土利用作業準則，列入綜合開發計畫書內。並促請區域計畫法、山坡地保育法、山胞保留地開發管理辦法，依法嚴格管制高山地區土地超限使用。

二、法律

1.
如何推動野生動物保育法和環境影響評估法的通過及落實其執行？

加速推動環境影響評估法及野生動物保育法的通過。野生動物保育的主管機關的層級應予提升，賦予更多的人力及執法權。

2.
如何修訂相關法規如森林法的內容以促進台灣黑熊的保育？

森林法應配合修訂，在森林法總則內的主旨應加入保護生物多樣性，森林的定義應增加森林的生態系及生物組成；森林主管機關應設置森林警察，並賦予法源依據，讓森林主管機關可以設置自然保護區。

3.
如何利用環境影響評估法或制度，減輕國建計畫橫貫中央山脈及現有的保護區？

應用環境影響評估制度，對已劃設爲保護區的地區列入不審查之地區，對尚未劃設之地區嚴格審查，以減少環境的衝擊。

4.
國際法及國際公約。

野生動物保育法的保育動物名錄，國際部分應加入新公告的二種黑熊。

建議事項

一、政策類：

1.
讓黑熊的保育政策及計畫成爲國家的優先重點計畫。
2.
增強保護區體系縱向及橫向性的聯繫。
3.
增設自然保護區及保護區的野生動物走廊。
4.
修定國土利用政策減少土地的超限利用對黑熊棲地的破壞。
5.
利用區域計畫法及山坡地保育法對保護區外的土地利用予以適當的管制。

二、法律類：

1.
推動野生動物保育法的通過及落實其執行。
2.
修訂相關法規如森林法的內容以促進台灣黑熊的保育。
3.
利用環境影響評估法或制度，減輕國建計畫橫貫中央山脈及現有的保護區。

三、計畫類：

保護區的經營管理、盜獵、觀光、開礦、道路開闢問題：

1.
林地工程人員的行爲、登山客行爲、地地濫墾等都必需管理以防患大面積的森林火災。

2.
狩獵區缺乏，需要有地方發洩，由於需要人手執法及數據目前仍然無法利用狩獵區制度來處理問題。山羌、水鹿及野豬可能爲未來的主要狩獵動物，黑熊狩獵短期並不可行。但因爲獵槍係由警察局委託射擊協會代管，獵槍管制問題仍然很嚴重。射擊協會常以俱樂部方式，利用部份練習用的獵槍，開車在夜間進入森林獵野豬。目前興起的休閒、冒險的戰鬥營非常猖厥，對野生動物的干擾很大。

3.
鼓勵社區自治方式來保護野生動物，防止盜獵、電毒魚。但應該審愼的管理，過程中應予以監視及輔導該社區的領導者。例如國內三民鄉楠梓仙溪設立護溪運動，將溪魚做爲村內共有資產、出售釣魚證每張四百元給釣者，但爲了增加財富、經濟誘因給當地居民已經過度圖利而引進外來種及人工飼育。必需監視避免發生問題。

4.
自助式步道、高山登山步道爲主的生態觀光事業政策正在興起，觀光局正推動全國十大觀光路線，給國際旅客到全省北、中、部高山自然步道健行，許多文資法的保留區、及保護區的步道也被列入旅遊路線，影響很大。民間森林遊樂區的發展也要必需透過環境影響評估程序來評審。遊憩人數高峰期的管制，登山響導、人數管制等都是必需的手段，不定期區域巡查及設置管制站也是必要。遊憩垃圾廢棄物會引誘熊進入步道，造成困難。生態旅遊事業的興起，也對野熊棲地有很大的衝擊。國際專業採集者侵入保護區內採集稀有動物的情形經常出現，尤其是日本人，應該加以管制。新設的林業地區產業及觀光道路可以利用環境影響評估制度來審議。

5.
高山礦權毫無開採價值，但業者的意圖實際上如果不是要採森林產物，就是利用探礦權去貸款圖利，但因權責屬於經濟部礦業局，不需要知會林務局，林地探礦及採礦作業很難管理。礦業用地必需租用林地，因此引起許多礦權的業務處理問題，建議我國經濟部應通盤檢討高山礦權、探、採礦的政策及計畫，對既有探、採礦權應予以重新評估調查，建立從嚴審核制度。除非對國家有特殊重大價值的礦業地區給予保留外，其他地區應考慮逐年予以取消，以確保高山生態系的維護。

6.
加強山產店管理、查緝人員定時及不定時的查勀，獵人、山產店應加予登記、輔導、教育宣導法令，目前巡山員一組四人，巡查工作一年十二次，但仍然需要警力配合以支援取締。山老鼠以中部橫貫公路及東部海岸山脈仍然嚴重必需加強控制。林道系統缺乏維修，不容易抵達，因此執法不易。

7.
設計有效的程序，處理利益團體引發的衝突問題。宜多多利用公聽會、政府公共關係室、新聞發言人讓利益團體代表來傳遞溝通消息。建立預警制度、緊急處理小組處理媒體、民眾陳情、突發事件、收集黑熊資訊。並鼓勵理性的勸導，及中裁制度的建立。

8.
將全台各政府機關的黑熊資料、整合輸入全國的地理資訓系統，建立一套長程的黑熊族群監測模式、及經營管理系統，以處理各種決策及計畫。

9.
請評量研究學者協助找出黑熊保育計畫各階段的成功與否的指標、建立監視系統及資料庫，配合計畫的實施。

四、人力資源問題：

1.
應全面的建立支持台灣黑熊保育的力量，其層次應包括政府首長、民意代表、地方政府、司法人員，地方員警、保護區內及附近的居民、企業、民間團體及原住民的支援。

2.
順應國際保育團體潮流，遊說立法委員、競選立法委員、中央與地方財政畫分、積極參與保育立法等方式，經常增加中央及地方保育執法人員的人力、裝備、執法權及保育的補助經費。

3.
應加強辦理自然保育人員訓練營，增強其執法技能。環保署人員訓練所應可提供相關的課程給自然保育人員。

4.
建立保育警察獎勵、薪資、升遷管道的制度、注意獎金分配的公平性，爭取獎金、提升基層保育人員職等及數量，以激起執法的動機及士氣。保林人員的管理辦法，自行招考，以技工人員聘用、職等太低，應提升基層保育人員職等。

5.
成立黑熊研究獎學金，鼓勵青年學子參與黑熊保育及研究計畫。

6.
請政府及相關的自然保育機構、研議成立高山及黑熊的研究站。

7.
發動全國籌募保育研究及教育經費運動、利用黑熊保育郵票、企業捐款及財團法人基金會捐助。

8.
鼓勵民間及動物園認養自然保護區及保育類動物黑熊。

五、如何增進對臺灣黑熊族群現況及危機之了解，結合現有資源掌握其脈動並發展出適當的方式，有效地收集並監測未來臺灣黑熊的概況：

1.
立即發展標準化的問卷來收集黑熊在臺灣出沒的記錄，包括聲音、腳印、個體、食痕、抓痕、排遺的觀察記錄。

2.
確定處理沒收黑熊的流程，包括通報有關機關，決定此黑熊的去留（立即就地野放、動物收容所或動物園），並收集生物學有關的資料。
A.麻醉藥品種類及劑量。
B.測量型態（頭長、體長、體重、掌大小、身高……）。
C.性別及性成熟狀態。
D.抽血、測定血液成份、健康狀態以及遺傳變異（可由毛髮）。
E.外部寄生蟲取樣。
F.野放個體則需照會研究人員，以植入晶片或刺青來辨識個體，以戴頸環來追蹤個體。

3.
持續以及發展必要的野外研究來偵測黑熊的野外族群大小，以及收集相關生態訊息。

4.
成立臺灣黑熊存活工作小組的召集人或聯絡人向有關單位提出整合性的研究計畫。

5.
請原住民參與研究工作。

POLICY, LAW AND INTERNATIONAL COOPERATION

Problem Statements

Lack of strong and effective policy for Conservation of Formosan Black Bear

Barriers:

1. Negative attitude-traditionally treated species as a pest and a dangerous species which needs control in the wild.
2. Traditional uses of the bear stimulate the market of bear products.
3. Fear of being hurt when contacting bears in the wild.
4. Fear of crop damage.
5. Low perceived needs for bear protection among institutions from local to national government.
6. Lack of scientific data base for making policy and management choices.
7. Low public support for bear conservation at local and national level.
8. High cost of conservation projects.
9. High cost of poaching control.
10. Difficult to ensure short term benefit so long term commitment is requisite.
11. No guarantee of success of any project effort.
12. Much difficulty in accessing bear habitat to conduct conservation research and management tasks.
13. Lack of government budgets, manpower, young scientists, well trained law enforcers to support bear conservation projects.
14. Little collaboration among agencies sharing jurisdictions over bear habitats.

Other obstacles toward making conservation policy on the Formosan Black Bears a priority including the following factors:

1. A fear that this animal may become too abundant in the preserve and escape to invade the village and cause crop damage, attack mountain hikers, workers and local aboriginals.

2. Low economic value of local specimens of the species because the majority of bear products such as bear paw, gall bladders are not imported.

3. The fear that bear protection may stop economic use, tourism and land use development in the high mountain area.

4. There is not traditional culture of hunting bear in the aboriginal tribes available for supporting the needs of urgent to protect local bear.

5. There are no clear data about the population and poaching status in the wild. While there is concern about the species being seriously threatened or over exploited, there is no hard evidence to support the concern. Although the National Park system is claiming that the wildlife population bounds back quickly after law enforcement in the park lands, there are not data to support this statement.

Recommendation of strategies:

An extensive educational program shall be initiated first to help the law enforcers, legislators mass media and public to correct their misconceptions and help them lose their fear of this large terrestrial animal it becomes abundant. We strongly recommend to policy makers for bear conservation that they clearly state the potential benefits in many aspects of such a policy design and state multiple objectives to augment the likelihood of public support. To help increase public awareness and strengthen the priority and effectiveness of this policy in nature conservation below are aspects which may be helpful in the early stages.

1. The goals of setting protected areas for bears shall also emphasize the potential of protecting biological diversity, natural resources and water resources.

2. The policy shall emphasize the need for strengthening inter-agency coordination in enforcing existing natural conservation laws on the high land areas of Taiwan. These agencies include: National Park (Construction Planning and Administration, Ministry), Forestry Bureau (Taiwan Provincial Government). There also is required close cooperation in implementation of National Cultural Heritage Law and Wildlife Conservation Law and

Environmental Impact Assessment Laws (Environmental Protection Agency).

3. The policy shall offer solutions to the Council of Agriculture in seeking release from international sanction pressures from CITES and Pelly Amendment.

4. The policy shall also project the potential benefits of the commitment of significant resources to setting aside more preserves and increasing funding for poaching control for this specific species.

Problem Statement II: How to maintain the integrity of ecosystems for bears:

Threats affecting habitats of the Formosan black bears include:

1. Driven by short term economic benefits, many land use activities such as growing of bitter nut, tea plantation, orchards, highway construction, mining and recreation in the forest are emerging and are widely distributed at the high lands. The majority of development surrounds protected areas and fragile ecosystems. Fragmentation and isolation of protected areas are serious problems occurring everywhere on the island. The aboriginal movement in this island also contributed many issues including habitat loss, land conservation and in the highlands. The impact of development is clear; urgent action is needed to maintain the integrity of the high land ecosystem and protect the Formosan black bears from poaching, habitats loss from land use threats.

Recommended Strategies:

It is urgent to make policy changes as listed below, in order to maintain the integrity of the habitats.

1. It is urgent that each nature conservation agency reevaluate the threat status of each existing protected area in the high land areas, and make recommendations for management change to meet the needs of large mammals.

2. It is urgent that the Forest Bureau set aside more protected areas in the high land region where bears are sighted and valuable biological resources are in an undisturbed state. The Environmental Protection Agency needs to be delegated authority necessary to rule out inappropriate land use development at the mountain region.

It is necessary to apply the theory of Island Biogeography and landscape ecology in designing protected areas. The concepts of Man and Biospheres, buffer zone and core zone shall be considered during the process of planning and decisions. It is necessary to connect the existing protected areas with many corridors so that bears can access the entire protected area. This strategy may reduce the risks of genetic inbreeding depression.

3. It is urgent to set up a working group in the first stage under the current Commission of Natural and Culture Landscape, Council of Agriculture: The working group shall be responsible for the designation of new protected areas, or modify the boundary of current protected areas and revise master plans of existing protected areas. Members of this group may consist of bear specialists, government officers, wildlife ecologists, and representatives of nongovernmental organization.

4. In the long run, the mission of such a working group may be taken over by the new Head of Wildlife Conservation Law Amendment. The group may work with The Taiwan Endemic Animals Research Center, Zoo organizations, and Wildlife Research Institution. A nonprofit organization which aims to save the Formosan bear is encouraged to establish itself in the island.

5. It is urgent that the Economic Development of Executive Yen hosts a public hearing process and generate careful standardized operational procedures that help to guide land use activities. It is necessary to have a policy guidelines to help achieve sustainable development in the high land region and reduce its environmental impact on the adjoining lowland areas.

6. It is urgent that those in charge of the "National Regional Plan Law", "Mountain Hills Conservation Law" and "Indigenous Reserves' Development Procedures" shall become familiar with the issues in the high mountain region and enforce these laws strictly to stop the over-exploitation of the land, water and biological resources.

7. It is necessary to have more public participation process for local residents and aborigines to realize the needs of change. It may be achieved by means of educating these groups so that they may accept the concepts, principles, and practices of ecological sustainable development.

8. It is necessary to design a cooperative management plan which facilitate the involvement of indigenous people in planning, decision making, and the implementation of management plans.

9. Development of the local community serves a fundamental role in conservation of ecosystems. All local assets shall be mobilized and used in

every stages of conservation. This involvement is particularly urgent in the beginning stage.

10. To reach consensus on the strategies for conservation, self-determination and citizen votes may be necessary at some remote Indigenous villages. Local opinion leaders shall be respected and encouraged to lead the group decision.

Problem Statement:

There are many managements issues in the high mountain areas such as forestry fire, poaching, recreation, highway construction, mining, wildlife market.

Forestry fire policy:

It is urgent to increase the education program and the intensity of control the activities of engineers, high way constructors, hikers, forest workers, agriculture farmers in the high lands to reduce the risks of causing catastrophes such as small scale if landslides, and large scale mountain fires.

Wildlife poaching:

Despite the fact that the hunting is entirely prohibited in Taiwan, the unintentional hunting on Formosan bears by the aboriginal people still occurred in the past. Many shooting clubs still enter the forest lands to chase the wild boars and sometimes kill the boars for joys. New emerging adventure activities in the mountains also is creating issues for wildlife management.

Strategy: The gun and bullets control shall be enhanced by the police administration to reduce the issue. Such activities shall be discouraged in the high mountain areas.

Due to the lack of administration manpower, budgets and lack of data base for designating hunting areas, and for issuing hunting permits and allocating hunting quota, there is not legal game reserve available today for sport hunting. However it may be come true when the population of wildlife are abundant in the long run.

Mining Issues.

There are many mining permits in the Forest lands and national parks, and shall be dealt with. Most the mining rights are politically sensitive and take huge money to buy back the rights. The mining activities including exploring and excavation will caused tremendous of habitat loss of wildlife.

We highly recommend that the Mining Bureau and Ministry of Economics shall initiate a review process to check the status, value, and stocks of minerals of the mining right holders. The ministry of Economics shall cancel off those permits that have very low economic value and those mining sites that may cause tremendous environmental impacts.

Tourism Pressure:

The ecotourism and high mountain hiking business is recently promoted by the Bureau of Tourism, Ministry of Communication. 10 high mountain trails have been selected by the bureau for attracting the international hikers. The trail also include the patrol road inside the national preserves. It is cleared that the trashes littered by the hikers will attract the bears and increase the probability of bear and human contacts. The illegal collecting of endangered wildlife species and specimens by international hikers and nature collectors will also contribute the damage the ecosystem.

Strategies: Developers shall prepare environmental impact assessment report, whenever they propose forestry recreational plans. Mountaineer guides, camping regulations, and minimize the size of visitor number are also alternative measures for reducing the impact.

Cooperative management system

It is urgent to encourage the leaders in mountain villages to establish an autonomous cooperative management system. It provides incentive to local residents by regarding wildlife as common property of the local community and gaining profits from issuing use permits This model has been successfully adopted to protect the fishes in the stream of the Taiwan However some unexpected impacts have occurred that many leaders raise captive animals and introducing exotic species for short term profits. It indicates that the leaders shall be trained and well educated to avoid of such activities. This model may be widely diffused when the population of certain animals such as wild boars, muntjack reach certain level.

Mountain wildlife product marketing

The wildlife product trades between the mountain areas and neighboring areas is the major cause of the poaching activities. The trade is underground and difficult to detect and stop in this moment.

Strategy: The name and address of hunters, business people, traders shall be registered and investigated occasionally. The patrol team shall be organized and conducted frequently in the protected areas. Local police officers shall be involved to enforce the laws.

Conflicting Interests

There are many interest groups are relative with the wildlife products and habitats. To help promoting the communication and change of policy, a procedure is in need of design.

To assess and help resolve the conflicts, the government shall conduct many public hearings to encourage public inputs. The public relationship and speakers, mass media are action channels for the nongovernmental group and concerned citizens to complain about issues and targets of petition. There shall be a treatment team to handle the emergent event issues and needs a mediator or arbitrator to deal with the conflict study.

An evaluation researcher shall be invited to design feasible and appropriate methods and to seek for appropriate indicator in different stages to help the managers and program executers to record their process. A management information system shall be designed for long term monitoring.

A geographic information system is in need of design. The data collecting from all the natural conservation agencies shall be assembled into one system so that the data can be updated, analyzed, extracted and communicated for the policy maker and program managers. Some long term models are needed for the program managers to evaluate the degree of success of the project.

Problems of human resources

1. It is urgent to build up supporting bodies from all levels of government officers, representatives, juries, law enforcers, enterprises, businessman and nonprofit organizations , citizen groups and Indigenous people, school systems.

2. It is necessary to comply with international wildlife laws, international conventions, to lobby the legislators for pass of conservation laws, to run the election campaign to be legislator and local representatives, to form a green party. By this, it is hoped that the authority and tax income allocation shall be decentralized. The number of manpower, law enforcement equipments, budgets authority of each conservation agency from national to local governments shall be strengthen regularly.

3. The training camps shall be hosted regularly to increase the capability of law

enforcers, program managers, and conservation researchers. The Environment Protection Agency shall engage in personnel training programs and provide the necessary facilities to recruit natural conservation.

4. It is urgent to build up a system for promoting growth of conservation police officers on the island. The system shall improve the reward, salary, promotion, and equity of allocating money rewards. It shall also create an incentive for motivating the law enforcers, for increasing their commitments which include a strategy to upgrade the salary and position the common forest patroller.

5. It is necessary to raise money and form a scholarship to provide funding for young scientists to study bears in the remote mountain areas.

6. It is necessary to build several high mountain research stations to provide facilities and research equipment for doing long term research for bears and other high land wildlife.

7. It is urgent to conduct a fund raising campaign around the island to support conservation research and education. Conservation stamps marked with black bears is also an alternative.

8. It is appropriate for the citizen groups and zoo institutions to adopt a natural preserve and conserve a special animal.

ASIATIC BLACK BEAR

Ursus thibetanus formosanus

POPULATION AND HABITAT VIABILITY ASSESSMENT WORKSHOP

REPORT

Section 8

Conservation Education

台灣黑熊保育教育計畫

目標

分短、中、長期目標，如下：

短期：改變對因狩獵、買賣、使用行爲而影響黑熊族群量減少的對象的認知、行爲。

中期：改變對直接、間接破壞黑熊棲息地的對象的行爲，加強法令政策層面的制定與執行人力。

長期：建立大眾物權、動物權、環境價值觀、生態平衡等觀念及與此些觀念一致之行爲。

目標說明

所有短、中、長期目標的教育活動應從現在開始並行。囿於時間或人力，前三年的首要工作在於短期目標之達成。在第四、五，除了仍要注意狩獵、熊膽消費問題，將著重在黑熊棲息地的保護、法令修改、人力的加強。最後五年，除了持續既有的努力，將加強大眾價值觀、生物歧異度等概念及日常生活的落實。

各期計畫的對象與重點

短期計畫：

台灣黑熊的族群數瀕臨滅絕，必須立刻調整。其中人類直接影響野外族群的行爲，主要包括：消費者食用熊掌及熊膽的行爲、山產店、中藥商的營利販賣以及野外的狩獵，故以此四群人爲對象，進行呼籲。另外，亦建立一般大眾對台灣黑熊的認識以減少恐懼的心理。

消費者：改變以黑熊及其產製品爲食用、藥用之舊習。透過巡迴演講、模型、影片、大眾傳播媒體等，建立消費正確的中藥使用觀念，提供熊膽及其替代品（美洲熊、充貨）的訊息，引導減少使用熊膽。若必須使用，建議使用充貨或是美洲熊的膽，避免使用瀕臨滅絕熊的膽。另外，使消費者了解食用野生動物對自身健康、環境保護、國際形象所造成的危害。了解黑熊因抽膽汁、被斷掌的痛苦。

中藥商：召開說明會或研討會與中醫商溝通，告知熊膽療效報告及替代，並合作主動推廣熊膽的替代品的正確使用。邀請簽立聲明書、張貼「不賣瀕臨滅絕熊的膽」的貼紙。

山產店：藉著媒體或親訪，使其明白法令，並讓他們知道野生動物的消費正在減少，沒有錢途。

狩獵者：建立命運共同體的觀念—「野生動物與他們關係密切」、傳遞野生動物資產的觀念，以增加其保育黑熊的動機、並配合政策進行教育。
一般民眾：透過遊客中心、動物園、大眾媒體等介紹熊的習性，以減少一般人對熊的恐懼心理、並告知台灣黑熊常出沒的地點、及若遇到熊的應變方式。

中程計畫：

棲地破壞使得台灣黑熊的數量減少，必須有效的管理與教育，並且相關的法令，政策需要修定以便有效的經營、管理。環保人員的培育也使得法令的執行、研究調查、教育宣導更爲有效。

（一）減少棲地破壞：

開墾者、旅遊業者：建立其生態平衡、承載量的觀念、並提供具體的有利水土保持的農業操作方式、減少環境破壞及干擾的旅遊方式、並提倡生態旅遊。

消費者：介紹生態旅遊的優點、推動「不食用破壞山林的作物」與「不參與破壞山林的運動」。

保育區內及其附近的居民：灌輸生態旅遊的利基點，以改善對保育區的認同，進而主動維護。

（二）加強制定保育政策與法令的能力：

立法委員、司法人員、政府官員：使其了解野外黑熊現況、破壞壓力，建議黑熊保護政策面及立法，並告知保育經費、人力、裝備、權力的需要。

（三）加強保育人力：

員警、巡山員：專業的訓練。

義工：培育野外調查、監測的人員及教育宣導人員。

教師：加強黑熊習性的了解、保育現況、一些旅遊、購物應注意事項，特注意是否促使黑熊族群的減少和棲息地的破壞。

媒體：加強其生態保育知識和新聞報導的技巧。

長程計畫：

透過學校、機關團體、民間組織的教學、固定出版物及舉辦講座，針對學生、一般大眾，加強其「動物權」、「物權」、「生物歧異度」、「環境價值」等觀念。

CONSERVATION EDUCATION FOR THE FORMOSAN BLACK BEAR

Participants: Shun-Mei Wang, Chan-Hwa Ho, Chin-Lan Chang, Moa-Fen Lin, Gin-Yuen Wang, Shi-Gia Cheng, Kwan-Ho Chen, Wan-Pei Chang, Ko-Chou Lein, and Kin-Chu Tsai.

Actions:

The short range actions of conservation education are to educate people who stimulate bear hunting and bear gall bladder use; to reduce the decline of the wild black bear population.

The middle range actions of conservation education are to educate people whose behavior will directly cause the damage of bears' habitats. The long range actions of conservation education are to educate the general public about ecological principles, common property rights, and animal rights.

Criteria for setting action priorities: The education activities which aim at achieving different conservation objectives at short range, middle range, and long range shall also be initiated in the beginning stage. If there were time and resource constraint, those activities which help achieving short term objectives will be given first priority in the first three years. The efforts in the fourth and fifth years may focus on prohibiting hunting and use, recovering of bear habitat, comprehensive legislation and resource people training. In the next five years, it is hoped that ecological concepts and environmental values will be acquired by the general public and their behavior will be positive and environmentally sound.

Short Range Action Plans:

Consumers: The objectives are to educate consumers so that they are willing to change their traditional uses of Chinese medicines and their unwise use of bear paws and gall bladders. Hopefully education could lead them to use substitute bladders of American black bear gall bladder if it is necessary and gradually the consumers could stop using bears which are endangered. To the mass media and informal agencies, educators shall provide messages about the negative impact on of eating black bear on their personal health, the ecosystem, and the national image. The first stage may be expressing the painful suffering of bears from the loss of their paws and the removal of the bladder fluid.

Chinese Medicine Store Managers:

The action for Chinese medicine business is to host conferences for discussion of a sustainable way to use bear bladders and to correct the misuse of bear bladders and choose substitute bladders from American black bear or other bears which is over populated. It is necessary to work with the Chinese Medical College professor and the medicine business to educate the general public to choose appropriate ways of using substitute products.

Wildlife Market Businessman:

The objectives of education are to make them aware of the current laws prohibiting the use of the Formosan black bear and the eating of wildlife. It is hoped that the supplying of the wildlife market and the demands for wildlife stores could be gradually decreased.

Wildlife Hunters and Indigenous People:

The objectives of education are to build ownership systems of the indigenous community for the wildlife near their communities. They need to be taught about the concepts that man shall maintain a harmonious and close relationship with wildlife and the supporting living systems.

General Public:

The objectives of education plans are to introduce the general public to the life history, behavior, and distribution of Formosan black bears. It is hoped that the highly populated human communities can reduce their negative attitude towards bears, could avoid disturbing bear habitats, and could learn appropriate skills to escape when meeting accidentally with bears in the wild or elsewhere.

Bear Farm Raisers:

The objectives of educating bear farmer raisers are to teach them how to provide bears with comfortable facilities and to seek for better treatment procedures for their bears. It is hoped that the raiser would build up more responsible behaviors to captive bears and could have better information on who and which agency can take care of bears health.

Middle Range Action Plans

The objective of conservation education is to alleviate damage on bear habitats through educating local farmers, the tourism business, and consumers.

Farmers and Tourism Leaders:

To those farmers on the high hills and to the leaders of tourists, our suggestions are to increase their knowledge about population ecology, carrying capacity and the dynamics of natural balance in ecosystems. It is hoped that they would build up responsible attitudes and environmentally sound ethics affecting their agricultural practices. To the tourism leaders, we hope that they select mountain hiking traits and tourism activism to reduce the impact on bear habitats and bear behavior in the wild.

Wildlife Consumers:

To the wildlife consumers, education actions are to introduce ecologically responsible eco-tourism activities for visitors and to educate them with knowledge about the places they are going to visit before their vacation trip. Information should urge reducing food and tea plantations on the high regions and should stop hiking in the most sensitive bear habitats. To the residents living in the protected areas, the objective of the education program is to change their beliefs and ethics about the utilization of their land in the protected area. Let them know what is good for them and their future. Their life in a beautiful scenic environment is helpful to their bodies, spirit, and culture.

The objectives of the middle range education program are to educate legislators and government officers so that they will pass new laws and support the policies related to bear conservation. It is necessary the facts and ecological knowledge to legislators, law officers, and governments so that they can get rid of their fear and negative attitude towards bears. We need to win their support for a larger budget for supporting patrols, equipment, and manpower to stop hunting of wild bears.

Law Officers and Volunteers:

The next objectives of the education program in the middle range are to increase the human and resource supports for those law officers, volunteers, school teachers, and mass media for helping the conservation of the black bear. To those policemen in National parks and highland areas who are currently responsible for patrol and poaching control, it is necessary for the educators to teach them more professional skills and more accurate and current knowledge on black bears. It is hoped that they can conduct more effective investigations, field management, and remove quickly the traps set by the local people and lowland hunters. because the conservation program needs to train volunteers for assisting field research, conducting monitoring, education, law enforcement and habitat restoration.

Education System:

The conservation program shall diffuse the conservation messages through formal and informal education systems of the Island. It is necessary that more pre-service and in-service training programs and curricula be planned, designed, and implemented to increase the knowledge of teachers about the black bear. It is hoped that the citizen could learn more about what kind of behavior and life style shall be needed if this generations wants to achieve a sustainable development society. Our young generation needs to learn how to respect black bear habitats and not to negatively affect their population, behavior and habitats.

The mass media are the most effective and fastest means for diffusing the conservation message to the general public. The journalists shall be taught through both pre-service and in-service programs. They have to learn more accurate knowledge about bears and to gain concepts of natural resources conservation. Their communication and reporting skills are definitely essential to this conservation policy.

Long range Actions

The long range goals of the recommended conservation education program are to educate the general public through effective communication tools, through textbooks inside the formal education system, by posters, pamphlets, and magazines in the non-formal system and by campaigns from non-governmental agencies. The focus of education is not only to build up citizens with concepts of Biodiversity conservation, animal rights, and earth rights but also to teach value clarification and critical thinking skills which are fundamental to help them choose appropriate ways for saving the Formosan black bear in the wild.

(一)　有關「台灣黑熊的利用管理」部份：

- 中醫熊膽的利用，並非絕對，中醫學界及政府有關單位應以尋找替代草藥或其它非動物產品之藥材為主。
- 以供給美加地區之美洲黑熊熊膽做替代品的建議，是飲鴆止渴的作法。增加供貨的結果，必將刺激市場需求增加，中國大陸囚熊抽膽汁不僅用於醫藥，且已發展成熊膽肥皂、熊膽洗髮精等即是明証。將黑熊之生命物化的結果，民眾永遠無法學習尊重自然生態及野生動物之課題，希望犧牲美洲黑熊生命以換取台灣黑熊生命的作法，無異緣木求魚，亦缺乏地球村之觀念。且不同種或亞種黑熊熊之分辨技術，尚乏可靠研究及可信結論，開放其它黑熊之利用將是一大漏洞。
- 所謂過剩剩個體的永續利用缺乏明確定義，何謂過剩？是否需要科學實証之研究。所謂利用是否即完全等於宰殺？在未能充份定義之前，即勿列入結論。
- 談到利用，只見中醫、市場等領域之探討，生態、文化、觀光、教育等層次完全忽略，或未見深入探討。若在結論中呈現出台灣黑熊保育的目的只是為了宰殺、供應中醫藥市場，將再度暴露國人以野生動物為食補藥之老饕文化，是國人之恥。

(二)有關「保育策略」部份——

- 食補藥補之老饕文化是野生動物保育做不好的最大因素，因此提倡「拒吃！拒買！拒養！」之全民運動是最澈底及實際的社會教育行動。
- 「惻隱之心，人皆有之」，中醫、中藥商店、及全體國人若能充份體會野生動物生命之珍貴，於生態維繫、物種多樣維護之價值，必能發自內心配合世界潮流，保護黑熊。
- 真正對台灣黑熊保育會生負面作用的反倒是一些似是而非的意見，諸如以美洲黑熊熊膽、大陸囚熊抽取膽汁當做替代品等，不僅無視國內及全球各保育團體對於動物福利之關懷，且將火上加油，助長黑熊獵捕壓力。

Comments of Life Conservation Association Representative

1. About the Management of Formosan Black Bear Utilization

The Use of bear gall bladder or bear bile in Chinese Medicine is not absolutely essential. Chinese herbal doctors and related government sections should seek other herbs or non-animal products as substitutions.

The suggestion of using American Black bear gall bladder as substitution is to drink poison to kill thirst. The increase in supply will only result in a higher market demand. In mainland China, bear gall bladder is not only used in medicine, it is also used in making soap, shampoo, etc. These are all explicit examples. When we materialize the life of bear, the public will never learn to respect nature and wildlife. To Sacrifice American black bear in order to save their counterpart Formosan Black bear is by no means to drill the boat to catch a fish. Such idea is completely ignorant at the concept of the global ecosystem. Moreover, the distinction of different species needs more scientific backgrounds. Allowing the exploitation of other bears will only cause a serious damage to the global ecosystem.

The so-called continuous use of surplus individuals lacks clear definitions, what does that mean by surplus? Does it need and scientific research? Does "use" here mean "massacre"? Please don't draw a conclusion to anything that is not yet well defined.

When we are talking about the use of bear gall bladder, our focus only points to Chinese medicine and market, but never turns to ecology, culture, tourism, and education. If the purpose of conserving Formosan Black bears is to save them from being slaughtered and sold in Chinese medicine market, it will only reveal that the Chinese feed culture of consuming wildlife as tonic is a shameful one.

2. About "The strategy" on Policy and Education

The culture of taking wildlife as tonic is the obstacle of wildlife conservation. Therefore, the campaign of "Not to Eat, Not to Buy, Not to Wildlife Captive" will be a thorough and practical social education.

"People are merciful." If Chinese herbal doctors, Chinese herbal stores and everyone can cherish the precious life of wildlife, and understand their importance in maintenance the ecosystem and Biodiversities, one must be able to show concerns to them and follow the main stream of wildlife conservation and protect Formosan Black bear.

The real negative effect of Formosan Black bear conservation will come from those paradoxical opinions, such as the use of American or Asiatic Black bear gall bladder as substitutions, it is not only negligence of the national and global concerns over the wildlife conservation but also putting oil on a burning lamp intensifying the pressure of bear hunting.

ASIATIC BLACK BEAR

Ursus thibetanus formosanus

POPULATION AND HABITAT VIABILITY ASSESSMENT WORKSHOP

REPORT

Section 9

List of Participants

「族群與棲地存續分析(PHVA)技術用於本土野生動物之保育研究」研習會——以亞洲黑熊的台灣族群爲例

擬邀請之核心工作人員(Members of Working Group)及旁聽人員研習會與會人員的概況

	姓名/單位名稱	參加人員	參加天數	討論組別					
				1	2	3	4	5	6
1	行政院農業委員會	李三畏副處長							
2	行政院農業委員會	王冠邦	2		*		*		
3	行政院農業委員會	楊惠良	1						
4	行政院農業委員會	方國運	1						
5	國家科學委員會科教處								
6	衛生署藥政處	蕭美玲處長	1						
7	衛生署藥政處	江雙美科長	1						
8	衛生署藥政處	廖文斌（素）	3		*				
9	環境保護署綜合計畫處	吳全安	3	*		*	*		
10	教育部環境保護小組	林崇明	1						
11	國立自然科學博物館	陳彥君	3	*				*	*
12	財政部關稅總局	葉延芳	1						
13	內政部營建署國家公園組	楊宗儒				*	*	*	
14	法務部調查局	張建屏	3		*				
15	法務部調查局	林棟樑	3		*				
16	法務部調查局	陳　理	1						
17	法務部調查局	趙齊相	1						
18	交通部觀光局	任菊貞	1						
19	交通部觀光局	盧春成	1						
20	玉山國家公園管理處	張馨蘭（素）	3					*	
21	玉山國家公園管理處	許亞儒	2	*				*	
22	玉山國家公園管理處	蘇志峰	2	*			*		
23	太魯閣國家公園管理處	林耀源（素）	2	*					

24	太魯閣國家公園管理處	張明洵（素）	3	*		*	*	*	
25	雪霸國家公園管理處	吳祥堅	3	*		*			
26	陽明山國家公園管理處	陳玉賢	1						
27	墾丁國家公園管理處								
28	臺灣省政府農林廳	吳　榮	1						
29	臺灣省政府農林廳	秦思原	1						
30	臺灣省政府林業試驗所	趙榮台	2						
31	臺灣省政府林業試驗所	陳一銘	2						
32	臺灣省政府林業試驗所	葉文琪	2						
33	臺灣省政府林業試驗所	陸聲山	3				*	*	
34	臺灣省政府農林廳林務局	楊秋霖	2						
35	臺灣省政府農林廳林務局	劉瓊蓮	2						
36	臺灣省特有生物研究保育中心	廖光正組長	1				*		
37	臺灣省特有生物研究保育中心	鄭錫奇	3		*		*		
38	臺灣省特有生物研究保育中心	林麗娜（素）	3	*	*	*			
39	國立台灣大學動物系	林曜松主任							
40	國立台灣大學動物系	周蓮香博士	1						
41	國立台灣大學動物系	羅仕治	1						
42	國立台灣大學動物系	黄向文	3		*		*		
43	國立台灣大學森林系	袁孝維博士	2				*		
44	國立台灣大學森林系	方韻如	3				*	*	*
45	國立台灣大學森林系	林文龍（素）	3	*	*		*		
46	國立台灣大學畜牧系	林仁壽教授							
47	國立台灣師範大學生物所	王穎教授	3						
48	國立台灣師範大學生物所	陳怡君	3						
49	國立台灣師範大學生物所	陳輝勝	3						
50	國立台灣師範大學生物所	蔡金助	3						
51	國立台灣師範大學生物所	林妙芬	3						
52	國立台灣師範大學生物所	印莉敏	3						

53	國立台灣師範大學環境教育所	王順美副研究員	3	*	*	*	*	*	*
54	國立中山大學生物系	徐芝敏博士	3			*	*		*
55	國立屏東技術學院森林系	裴家騏教授	3		*				
56	中國醫藥學院中醫學系	張賢哲教授	1						
57	國立宜蘭農工專科學校畜產系	吳輔祐	3		*	*	*		
58	國立宜蘭農工專科學校畜產系	郭士逢	3			*	*		
59	高雄市萬壽山動物園	洪登富	2						
60	高雄市萬壽山動物園	陳柏材（素）	2						
61	六福村野生動物公園	黄志碩	1		*				
62	台北市動物園之友協會	洪文棟會長							
63	中華民國關懷生命協會	釋悟泓法師（素）	3	*	*	*		*	*
64	美化環境基金會	丁天奎	1						*
65	美化環境基金會	宋慧芹	1						
66	信賴地球基金會	張敬玉							
67	信賴地球基金會	張念蘇							
68	瓦歷斯・尤幹先生	瓦歷斯.尤幹先生							
69	Traffic Taipei	盧道杰	3			*			
70	臺北市立動物園	陳寶忠副園長							
71	臺北市立動物園	楊健仁組長							
72	臺北市立動物園	梁明煌編審							
73	臺北市立動物園	陳益明技正							
74	臺北市立動物園	王圻技正							
75	臺北市立動物園	紀純眞輔導員							
76	臺北市立動物園	王金源輔導員							
77	臺北市立動物園	鄭世嘉輔導員							
78	臺北市立動物園	陳建志輔導員							
79	臺北市立動物園	季昭華獸醫							
80	臺北市立動物園	趙明杰技正							
81	臺北市立動物園	高紹文技正							

82	臺北市立動物園	金志美技士							
83	臺北市立動物園	徐吉財技士							
84	臺北市立動物園	連國洲技士							
85	臺北市立動物園	韓德生技佐							

Asiatic Black Bear Participant List

San-Wei Lee
Deputy Director
Forestry Dept. Council of Agri.
The Executive Yuan
#37 Nan-Hai Road
Taipei, Taiwan
Republic of China
PH: 011-886-02-3812991
FAX: 011-886-02-3125857

Guan-Bang Wang
Researcher
Resources Conservation Div.
Forestry Dept. Council of Agri.
The Executive Yuan
#37 Nan-Hai Road
Taipei, Taiwan
Republic of China
PH: 011-886-02-3812991
FAX: 011-886-02-3310341

Hui-Liang Yang
Researcher
Resources Conservation Div.
Forestry Dept. Council of Agri.
The Executive Yuan
#37 Nan-Hai Road
Taipei, Taiwan
Republic of China
PH: 011-886-02-3812991
FAX: 011-886-02-3310341

Kuo-Yun Fang
Researcher
Resources Conservation Div.
Forestry Dept. Council of Agri.
The Executive Yuan
#37 Nan-Hai Road
Taipei, Taiwan
Republic of China
PH: 011-886-02-3812991
FAX: 011-886-02-3310341

Mei-Ling Hsiao
Director
Bureau of Pharmaceutical Affairs
Dept. of Health
The Executive Yuan
#100, Ai-Kuo E. Road
Taipei, Taiwan
Republic of China
PH: 011-886-02-3210151-310
FAX: 011-886-02-3971548

Shuang-Mei Chiang
Section Chief
Bureau of Pharmaceutical Affairs
Dept. of Health
The Executive Yuan
#100, Ai-Kuo E. Road
Taipei, Taiwan
Republic of China
PH: 011-886-02-3210151
FAX: 011-886-02-3971548

Wen-Pin Liao
Specialist
Bureau of Pharmaceutical Affairs
Dept. of Health
The Executive Yuan
#100, Ai-Kuo E. Road
Taipei, Taiwan
Republic of China
PH: 011-886-02-3210151
FAX: 011-886-02-3971548

Chung-Min Liu
Specialist
Committee on Chinese Med. and Pharm.
Dept. of Health
The Executive Yuan
#100, Ai-Kuo E. Road
Taipei, Taiwan
Republic of China
PH: 011-886-02-3210151-353

Chuan-An Wu
Senior Specialist
Bureau of Comprehensive Planning
Environmental Protection Admin.
The Executive Yuan
7F, 41 Chung-Hua Road
Taipei, Taiwan
Republic of China
2PH: 011-886-02-3117722-2747
FAX: 011-886-02-3754262

Chung-Ming Lin
Assistant Researcher
Environmental Protection Div.
Ministry of Education
The Executive Yuan
5F, 102, Ai-Kuo E. Road
Taipei, Taiwan
Republic of China
PH: 011-886-02-3910058,3214898
FAX: 011-886-02-3223747

Yen-Fang Yeh
Editor
Directorate General of Customs
Ministry of Finance
The Executive Yuan
#85, Shin-Sheng S. Rd., Sec. J
Taipei, Taiwan
Republic of China
PH: 011-886-02-7722392-603

Lee Chen
Section Chief
Investigation Bureau
Ministry of Justice
The Executive Yuan
#74, Chung-Hua Rd., Shin-Tien City
Taipei, Taiwan
Republic of China
PH: 011-886-02-9112241

Chieng-Ping Chang
Investigator
Investigation Bureau
Ministry of Justice
The Executive Yuan
#74, Chung-Hua Rd., Shin-Tien City
Taipei, Taiwan
Republic of China
PH: 011-886-02-9112241-555

Dong-Liang Ling
Investigator
Investigation Bureau
Ministry of Justice
The Executive Yuan
#74, Chung-Hua Rd., Shin-Tien City
Taipei, Taiwan
Republic of China
PH: 011-886-02-9112241

Chi-Shiang Chao
Investigator
Investigation Bureau
Ministry of Justice
The Executive Yuan
#74, Chung-Hua Rd., Shin-Tien City
Taipei, Taiwan
Republic of China
PH: 011-886-02-9112241

Chu-Chen Jen
Tourism Bureau
Ministry of Transportation and Comm.
The Executive Yuan
9F, 290, Chung Shiao E. Rd. Sec. 4
Taipei, Taiwan
Republic of China
PH: 011-886-02-3491719
FAX: 011-886-02-7115274

Chung-Chen Lu
Assistant Specialist
Ministry of Transportation and Comm.
The Executive Yuan
9F, 290, Chung Shiao E. Rd. Sec. 4
Taipei, Taiwan
Republic of China
PH: 011-886-02-3491719
FAX: 011-886-02-7115274

Yao-Yuan Lin
Section Chief
Construction and Planning Admin.
Ministry of the Interior
The Executive Yuan
15F, 333, Tung-Hua S. Rd., Sec. 2
Taipei, Taiwan
Republic of China
PH: 011-886-02-7374764
FAX: 011-886-02-7374094

Shin-Lan Chang
Specialist
Yushan National Park Headquarters
#112, Min-Sheng Rd., Shuei-Li Shiang,
Nan-To County
Taiwan
Republic of China
PH: 011-886-049-773121

Ya-Ru Sheu
Specialist
Yushan National Park Headquarters
#112, Min-Sheng Rd., Shuei-Li Shiang,
Nan-To County
Taiwan
Republic of China
PH: 011-886-049-773121

Chi-Fong Su
Specialist
Yushan National Park Headquarters
#112, Min-Sheng Rd., Shuei-Li Shiang,
Nan-To County
Taiwan
Republic of China
PH: 011-886-049-773121

Li-Min Yin
Interpreter
Yushan National Park Headquarters
#112, Min-Sheng Rd., Shuei-Li Shiang,
Nan-To County
Taiwan
Republic of China
PH: 011-886-049-773121

Ming-Shuing Chang
Section Chief
Taroko National Park Headquarters
#291, Fu-Shi, Fu-Shi Village,
Shiow-Lin Shiang, Hua-Lien County
Taipei, Taiwan
Republic of China
PH: 011-886-038-621100
FAX: 011-886-038-621050

Shiang-Jien Wu
Section Chief
Shueiba National Park Headquarters
#615-20, Dong-Kuan St., Doug-Shi Town,
Taichung County
Taiwan
Republic of China
PH: 011-886-04-588-8647

Yung-Wu
Specialist
Technology Div. Dept of Agri. & Forestry
Taiwan Provincial Government
#8, Kuan-Hua Rd., Chung-Shin Village
Nan-To County
Taiwan
Republic of China
PH: 011-886-049-351528
FAX: 011-886-049-3511447

Szu-Yuan Chin
Junior Specialist
Technology Div. Dept of Agri. & Forestry
Taiwan Provincial Government
#8, Kuan-Hua Rd., Chung-Shin Village
Nan-To County
Taiwan
Republic of China
PH: 011-886-049-351528
FAX: 011-886-049-3511447

Jung-Tai Chao
Research Scientist
Div. Forestry Protection
Taiwan Forestry Research Institute
#53 Nan-Hai Rd.
Taipei, Taiwan
Republic of China
PH: 011-886-02-3817107

Yi-Ming Chen
Research Assistant
Div. Forestry Protection
Taiwan Forestry Research Institute
#53 Nan-Hai Rd.
Taipei, Taiwan
Republic of China
PH: 011-886-02-3817107

Sheng-Shan Lu
Research Assistant
Div. Forestry Protection
Taiwan Forestry Research Institute
#53 Nan-Hai Rd.
Taipei, Taiwan
Republic of China
PH: 011-886-02-3817107

Wen-Chi Yeh
Technician
Div. Forestry Protection
Taiwan Forestry Research Institute
#53 Nan-Hai Rd.
Taipei, Taiwan
Republic of China
PH: 011-886-02-3817107

Chiou-Lin Yang
Section Chief
Div. of Conservation
Taiwan Forestry Bureau
#2, Hang-Chow S. Rd. Sec. 1
Taipei, Taiwan
Republic of China
PH: 011-886-02-3515441
FAX: 011-886-02-3413246

Chiung-Lien Liu
Forester
Div. of Conservation
Taiwan Forestry Bureau
#2, Hang-Chow S. Rd. Sec. 1
Taipei, Taiwan
Republic of China
PH: 011-886-02-3515441
FAX: 011-886-02-3413246

Guan-Cheng Liao
Researcher
Taiwan Endemic Species Research Inst.
#1, Min-Sheng E. Rd., Chi-Chi Town,
Nan-To County,
Taiwan
Republic of China
PH: 011-886-049-761258
FAX: 011-886-049-764600,761582

See-Chi Jen
Assistant Researcher
Taiwan Endemic Species Research Inst.
#1, Min-Sheng E. Rd., Chi-Chi Town,
Nan-To County,
Taiwan
Republic of China
PH: 011-886-049-761258
FAX: 011-886-049-764600,761582

Li-Nuo Lin
Assistant
Taiwan Endemic Species Research Inst.
#1, Min-Sheng E. Rd., Chi-Chi Town,
Nan-To County,
Taiwan
Republic of China
PH: 011-886-049-761258
FAX: 011-886-049-764600,761582

She-Chi Luo
Assistant
Dept. of Zoology
National Taiwan University
#1, Roosevelt Rd., Sec 4,
Taipei, Taiwan
Republic of China
PH: 011-886-02-3630231

Shiang-Wen Huang
Graduate Student
Dept. of Zoology
National Taiwan University
#1, Roosevelt Rd., Sec 4,
Taipei, Taiwan
Republic of China
PH: 011-886-02-3630231

Shiao-Wei Yuan
Associate Professor
Dept. of Forestry
National Taiwan University
#1, Roosevelt Rd., Sec 4,
Taipei, Taiwan
Republic of China
PH: 011-886-02-3630231
FAX: 011-886-02-3654520

Wen-Lun Lin
Graduate Student
Dept. of Forestry
National Taiwan University
#1, Roosevelt Rd., Sec 4,
Taipei, Taiwan
Republic of China
PH: 011-886-02-3630231
FAX: 011-886-02-3654520

Yun-Ru Fang
Graduate Student
Dept. of Forestry
National Taiwan University
#1, Roosevelt Rd., Sec 4,
Taipei, Taiwan
Republic of China
PH: 011-886-02-3630231
FAX: 011-886-02-3654520

Jen-Hsou Lin
Professor
Dept. of Animal Science
National Taiwan University
#1, Roosevelt Rd., Sec 4,
Taipei, Taiwan
Republic of China
PH: 011-886-02-3630231

Yin Wang
Professor
Institute of Biology
Nat'L Taiwan Normal University
#88, Ting-Chow Rd., Sec., 4
Taipei, Taiwan
Republic of China
PH: 011-886-02-9326234
FAX: 011-886-02-9312904

Yi-Chun Chen
Graduate Student
Institute of Biology
Nat'L Taiwan Normal University
#88, Ting-Chow Rd., Sec., 4
Taipei, Taiwan
Republic of China
PH: 011-886-02-9326234
FAX: 011-886-02-9312904

Huei-Sheng Chen
Research Assistant
Institute of Biology
Nat'L Taiwan Normal University
#88, Ting-Chow Rd., Sec., 4
Taipei, Taiwan
Republic of China
PH: 011-886-02-9326234
FAX: 011-886-02-9312904

Jin-Chu Tsai
Research Assistant
Institute of Biology
Nat'L Taiwan Normal University
#88, Ting-Chow Rd., Sec., 4
Taipei, Taiwan
Republic of China
PH: 011-886-02-9326234
FAX: 011-886-02-9312904

Miao-Fen Lin
Graduate Student
Institute of Biology
Nat'L Taiwan Normal University
#88, Ting-Chow Rd., Sec., 4
Taipei, Taiwan
Republic of China
PH: 011-886-02-9326234
FAX: 011-886-02-9312904

Shung-Mei Wang
Associate Researcher
Inst. of Environmental Education
Nat'l Taiwan Normal University
#88, Ting-Chow Rd., Sec., 4
Taipei, Taiwan
Republic of China

Chih-Min Hsu
Associate Professor
Dept. of Biology
National Sun Yat-Sen University
#70, Lien-Hai Rd., Gu-Shang District
Kao-hsiung
Taiwan
Republic of China

Chia-Chi Pei
Chairman
Dept. of Forestry
Nat'l Ping-Tong Institute of Technology
#1, Shuei-Fu Rd., Nei-Pu Shiang,
Ping-Tong County
Taiwan
Republic of China
PH: 011-886-08-7703202

Hsien-Che Chang
Chairman
Dept. of Chinese Medicine
Chinese Medicine Coolege

Fu-Yu Wu
Associate Professor
Dept. of Animal Science
Nat'l I-Lan Inst. Agrculture & Technology
#1, Sheng-Non Rd., I-Lan City
Taiwan
Republic of China
PH: 011-886-039-360132
FAX: 011-886-039-358850

Shyh-Fong Guo
Teaching Assistant
Dept. of Animal Science
Nat'l I-Lan Inst. Agrculture & Technology
#1, Sheng-Non Rd., I-Lan City
Taiwan
Republic of China
PH: 011-886-039-360132
FAX: 011-886-039-358850

Po-Tsai Chen
Veterinarian
The Zoo of Kaohsiung Scenic Dist. Admin.
#68, Lien-Hai Rd., Gu-Shang District
Kao-hsiung
Taiwan
Republic of China
PH: 011-886-07-5316624
FAX: 011-886-07-5316627

Den-Fu Hung
Technician
The Zoo of Kaohsiung Scenic Dist. Admin.
#68, Lien-Hai Rd., Gu-Shang District
Kao-hsiung
Taiwan
Republic of China
PH: 011-886-07-5316624
FAX: 011-886-07-5316627

Chih-Shuo Huang
Veterinarian
World Advneture at Leofoo Village
#60, Gong-Tze-Go, Ren-An-Li
Kuan-Shi Town, Shin-chu County
Taiwan
Republic of China
PH: 011-886-035-872626
FAX: 011-886-035-872707

(Bhiksu) Wu-Hung
Secretary General
Life Conservationist Association
11F, 109, Min-Sheng E. Rd. Sec. 3
Taipei, Taiwan
Republic of China
PH: 011-886-02-7150079
FAX: 011-886-02-7190806

Ted T.K. Ting
Executive Director
Beautiful Taiwan Foundation
16F, 93-1, Shin-Hai Rd., Sec. 1
Taipei, Taiwan
Republic of China
PH: 011-886-02-3621823

Lilian Sung
Secretary
Beautiful Taiwan Foundation
16F, 93-1, Shin-Hai Rd., Sec. 1
Taipei, Taiwan
Republic of China
2PH: 011-886-02-3621823

Keith Highley
Earth Trust Foundation
Nei-Hu P.O. Box 109
Taipei, Taiwan
Republic of China
PH: 011-886-02-6362374
FAX: 011-886-02-6365016

Suzie Highley
Earth Trust Foundation
Nei-Hu P.O. Box 109
Taipei, Taiwan
Republic of China
PH: 011-886-02-6362374
FAX: 011-886-02-6365016

Walace, Yugan
Representitive of Aboringinal
Fu-Chun Elementary School
#54, Alley 79, Chung-Shiao St.
Feng-Yuan City, Tai-chung County
Taiwan
Republic of China
PH: 011-886-04-5277579
FAX: 011-886-04-5251940

Dau-jye Lu
Programme Officer
TRAFFIC Taipei
Taipei P.O. Box 109
Taipei, Taiwan
Republic of China
PH: 011-886-02-3629787
FAX: 011-886-02-3629799

Kuang-Hou Chen
Wildlife Artist
1F, 121, Wu-cheng St.
Wan-hua District
Taipei, Taiwan
Republic of China
PH: 011-886-02-3070619

See-wu Chu
Director
Taipei City Zoo
#30, Shin-Kuan Rd., Sec. 2
Taipei, Taiwan
Republic of China
PH: 011-886-02-9382300
FAX: 011-886-02-9382316

Pao-chung Chen
Deputy Director
Taipei City Zoo
#30, Shin-Kuan Rd., Sec. 2
Taipei, Taiwan
Republic of China
PH: 011-886-02-9382300
FAX: 011-886-02-9382316

Chien-jen Yang
General Curator
Taipei City Zoo
#30, Shin-Kuan Rd., Sec. 2
Taipei, Taiwan
Republic of China
PH: 011-886-02-9382300
FAX: 011-886-02-9382316

Ming-hwang Liang
Editor
Taipei City Zoo
#30, Shin-Kuan Rd., Sec. 2
Taipei, Taiwan
Republic of China
PH: 011-886-02-9382300
FAX: 011-886-02-9382316

Yi-ming Chen
Senior Curator
Taipei City Zoo
#30, Shin-Kuan Rd., Sec. 2
Taipei, Taiwan
Republic of China
PH: 011-886-02-9382300
FAX: 011-886-02-9382316

Chi Wang
Senior Curator
Taipei City Zoo
#30, Shin-Kuan Rd., Sec. 2
Taipei, Taiwan
Republic of China
PH: 011-886-02-9382300
FAX: 011-886-02-9382316

Chwen-Jen Chi
Curator
Taipei City Zoo
#30, Shin-Kuan Rd., Sec. 2
Taipei, Taiwan
Republic of China
PH: 011-886-02-9382300
FAX: 011-886-02-9382316

Jin-Yuan Wang
Curator
Taipei City Zoo
#30, Shin-Kuan Rd., Sec. 2
Taipei, Taiwan
Republic of China
PH: 011-886-02-9382300
FAX: 011-886-02-9382316

Jenny Cheng
Curator
Taipei City Zoo
#30, Shin-Kuan Rd., Sec. 2
Taipei, Taiwan
Republic of China
PH: 011-886-02-9382300
FAX: 011-886-02-9382316

Jen-Jyh Chen
Curator
Taipei City Zoo
#30, Shin-Kuan Rd., Sec. 2
Taipei, Taiwan
Republic of China
PH: 011-886-02-9382300
FAX: 011-886-02-9382316

Chao-Hua Ji
Veterinarian
Taipei City Zoo
#30, Shin-Kuan Rd., Sec. 2
Taipei, Taiwan
Republic of China
PH: 011-886-02-9382300
FAX: 011-886-02-9382316

Ming-Chieh Chao
Senior Curator
Taipei City Zoo
#30, Shin-Kuan Rd., Sec. 2
Taipei, Taiwan
Republic of China
PH: 011-886-02-9382300
FAX: 011-886-02-9382316

Shao-Wen Kao
Senior Curator
Taipei City Zoo
#30, Shin-Kuan Rd., Sec. 2
Taipei, Taiwan
Republic of China
PH: 011-886-02-9382300
FAX: 011-886-02-9382316

Ellen C.M. Chin
Curator
Taipei City Zoo
#30, Shin-Kuan Rd., Sec. 2
Taipei, Taiwan
Republic of China
PH: 011-886-02-9382300
FAX: 011-886-02-9382316

Ji-Tsai Shu
Curator
Taipei City Zoo
#30, Shin-Kuan Rd., Sec. 2
Taipei, Taiwan
Republic of China
PH: 011-886-02-9382300
FAX: 011-886-02-9382316

Kou-Jou Lien
Curator
Taipei City Zoo
#30, Shin-Kuan Rd., Sec. 2
Taipei, Taiwan
Republic of China
PH: 011-886-02-9382300
FAX: 011-886-02-9382316

Yen-Wan Guo
Secretary
Taipei City Zoo
#30, Shin-Kuan Rd., Sec. 2
Taipei, Taiwan
Republic of China
PH: 011-886-02-9382300
FAX: 011-886-02-9382316

Fen-Chi Fu
Curator
Taipei City Zoo
#30, Shin-Kuan Rd., Sec. 2
Taipei, Taiwan
Republic of China
PH: 011-886-02-9382300
FAX: 011-886-02-9382316

Jia-Chuang Wu
Curator
Taipei City Zoo
#30, Shin-Kuan Rd., Sec. 2
Taipei, Taiwan
Republic of China
PH: 011-886-02-9382300
FAX: 011-886-02-9382316

Yi-Min Chen
Curator
Taipei City Zoo
#30, Shin-Kuan Rd., Sec. 2
Taipei, Taiwan
Republic of China
PH: 011-886-02-9382300
FAX: 011-886-02-9382316

Yun-Chan Wen
Curator
Taipei City Zoo
#30, Shin-Kuan Rd., Sec. 2
Taipei, Taiwan
Republic of China
PH: 011-886-02-9382300
FAX: 011-886-02-9382316

Guan-Ji Liang
Curator
Taipei City Zoo
#30, Shin-Kuan Rd., Sec. 2
Taipei, Taiwan
Republic of China
PH: 011-886-02-9382300
FAX: 011-886-02-9382316

Der-Sheng Han
Junior Curator
Taipei City Zoo
#30, Shin-Kuan Rd., Sec. 2
Taipei, Taiwan
Republic of China
PH: 011-886-02-9382300
FAX: 011-886-02-9382316

Y. Sherry Sheng
Metro Washington Park Zoo
4001 S.W. Canyon Rd.
Portland, OR 97221-2799
USA
PH: 1-503-226-1561
FAX: 1-503-226-6836

David Garshelis
Department of Natural Resources
Wildlife Research
1201 E. HWY 2
Grand Rapids, MN 55744
USA
PH: 1-218-327-4432
FAX: 1-218-327-4263

Ulysses S. Seal
Chairman
Captive Breeding Specialist Group
12101 Johnny Cake Ridge Road
Apple Valley, MN 55124
USA
PH: 1-612-431-9325
FAX: 1-612-432-2757

ASIATIC BLACK BEAR

Ursus thibetanus formosanus

POPULATION AND HABITAT VIABILITY ASSESSMENT WORKSHOP

REPORT

Section 10

Appendix

ASIATIC BLACK BEAR

Ursus thibetanus formosanus

POPULATION AND HABITAT VIABILITY ASSESSMENT WORKSHOP

REPORT

Section 10a

Bibliography

BIBLIOGRAPHY (From Wildlife Review)

Abramov, V. K.; D. G. Pikunov and V. I. Bazylnikov Seasonal Migrations of /Ursus Tibetanus/ G. Cuvier and /Ursus Arctos/ L. In the South of the Far East. Congr. Theriol. Int.; 2:316. 1978. Abstract Only. Wr 173

Abramov, V. K.; Pikunov, D. G.; Bazyl'nikov, V. I. Seasonal Migrations of Ursus Tibetanus, G. Cuvier, and Ursus Arctos, L. In the South of the Far East. Congressus Theriologicus Internationalis, 2nd, Brno, Czechoslovakia, 1978. Abstracts of Papers, P. 316. (Ceskoslovenska Akademie Ved, Brno)

Anderson, Daniel C.; Geistfeld, James G.; Maetz, H. Michael; Patton, Charlotte M. and Kaufmann, Arnold F. Leptospirosis in Zoo Workers Associated with Bears. Am. J. Trop. Med. Hyg.; 27 (1, Part 1): 210-211. Jan. 1978. Wr 171

Azuma, Shigeru and Harumi Torii Impact of Human Activities on Survival of the Japanese Black Bear. Bear Biol. Assoc. Conf. Ser.; 3:71-79. 1980. Wr 181

Bradfield, Ellen Hand-raising a Himilayan Black Bear. Anim. Keepers' Forum; 12(12):420-424. 1985. Wr 200

Bromlei, G. F. Comparative Characteristics of the Himalayan Bear and the Brown Bear in the Far East of the Ussr. Voprosy Ekologii; 6:29-31.; 1962

Bunnell, F. L. And D. E. N. Tait Population Dynamics of Bears - Implications. Dynamics of Large Mammal Populations. Charles W. Fowler and Tim D. Smith, Editors.; P. 75-98. 1981. Wr 199

Bunnell, F. L.; Tait, D. E. N. Population Dynamics of Bears - Implications. In Charles W. Fowler and Tim D. Smith (Eds.) Dynamics of Large Mammal Populations, P.75-98. (John Wiley & Sons, Inc., New York); 1981

Davis, D. D. Anatomy of the Heart in Bears (Ursidae) and Factors Influencing the Form of the Mammalian Heart. Gegenbauers Morphologisches Jahrbuch; 106:553-568.; 1964

De Graaf, Richard M. Hair Root Sex Chromatin in Selected Mammals. Unpublished M.s. Thesis, Univ. Of Massachusetts, Amherst, Massachusetts.; 1971

Degraaf, Richard M. And Joseph S. Larson A Technique for the Observation of Sex Chromatin in Hair Roots. J. Mammal.; 53(2):368-371. May1972. Wr 146:25

Didier, R. A Systematic Study of the Penis Bone of Mammals (Cont.): Procyonids, Ursids. Mammalia; 14(1):78-94.; 1950

Forthman, Debra L.; Suzanne D. Elder; Roger Bakeman; Timothy W. Kurkowski; Constance C. Noble and Samuel W. Winslow Effects of Feeding Enrichment on Behavior of Three Species of Captive Bears. Zoo Biol.; 11 (3):187-195. 1992. Wr 231

Furubayashi, Kengo; Kenichi Hirai; Koichi Ikeda and Tamio Mizuguchi Relationships Between Occurrence of Bear Damage and Clearcutting in Central Honshu, Japan. Bear Biol. Assoc. Conf. Ser.; 3:81-84. 1980. Wr 181

Hanai, Masamitsu Population Characteristics of the Japanese Black Bear in Hakusan National Park, Japan. Bear Biol. Assoc. Conf. Ser.; 3:63-66. 1980. Wr181

Hayman, R. W. Bears. Zoo Life; 9(4):132-141.; 1954

Hazumi, Toshihiro and Naoki Maruyama Movements and Home Ranges of Japanese Black Bears in Nikko. Int. Conf. Bear Res. Manage.; 6:99-101. 1986. Wr 213

Hazumi, Toshihiro; Harumi Torii and Shigeru Azuma The Conservation Status and Ecology of Himalayan Black Bear in Japan. Trans. Congr. Int. Union Game Biol.; 18:75. 1987. Abstract Only. Wr 211

Hazumi, Toshihiro and Naoki Maruyama Movements and Habitat Use of Japanese Black Bears in Nikko. Int. Conf. Bear Res. Manage.; 7:275-279. 1987. Wr 213

Hazumi, Toshihiro and Naoki Maruyama Movements and Home Ranges of Japanese Black Bears in Nikko. Int. Conf. Bear Res. Manage.; 6:99-101. 1986. Wr 213

Hedger, R. S. Foot-and-mouth Disease. In John W. Davis, Lars H. Karstad and Daniel O. Trainer (Eds.) Infectious Diseases of Wild Mammals - 2nd Ed., P.87-96. (Iowa State University Press, Ames, Iowa); 1981

Heine, H. The Hearts of Procyonidae, Ailuridae and Ursidae (Carnivora: Fissipedia); a Study on the Comparative Functional Morphology of Mammals. Zeitschrift Fuer Wissenschaftliche Zoologie; 186(1/2):1-51.; 1973

Hofmann, O.; Schreitmueller, T.; Brauntzer, G.; Wiesner, H. The Primary Structure of Polar Bear, Ursus Maritimus (Carnivora), and Asiatic Black Bear, Ursus Thibetanus (Carnivora), Hemoglobin. Biological Chemistry Hoppe-seyler; 367(1):53-60.; 1986

International Conference on Bear Research and Management, 4th, Kalispell, Montana, Bears - Their Biology and Management; a Selection of Papers. Bear Biology Association. Conference Series N; 3. (Iii),375 P. Illus.,maps; Edited by Clifford J. Martinka and Katherine L. Mcarthur. Published in 1980.

Jackson, R. W. The Urinary Nitrogen Distribution of Representative Members of Carnivora. Zoologica; 24(3):345-354.; 1939

Khramtsov, V. S. On the Winter Denning of White-breasted Bears on Southern Primorski Krai. Moskovskoe Obshchestvo Ispytatelei Prirody. Biulleten': Otdel Biologicheskii; 95(3):32-34.; 1990

Koseki, T. Notes on the Mammalian Remains Found at Iwaya, Yamagata Prefecture. Jinruigaku Zasshi; 83(4):355-359. (English Title: Anthropological Society of Nippon. Journal); 1975

Kucherenko, S. P. Distribution of Ursus Thibetanus in the Amur-ussuri Territory. Zool. Zh.; 52(3):466-468. 1973. From Biol. Abstr. 56(12), 1973. In Russian with English Summ. Wr 152:32

Leone, C. A.; Wiens, A. L. Comparative Serology of Carnivores. Journal of Mammalogy; 37(1):11-28.; 1956

Ma, Y. The Status of Bears in China. Acta Zoologica Fennica; 174:165- 166.; 1983

Martinka, C. J.; Mcarthur, K. L. 1980. (Eds.) Bears - Their Biology and Management; a Selection of Papers from the Fourth International Conference on Bear Research and Management Held at Kalispell, Montana, Usa, February 1977. Bear Biology Association. Conference Series N; 3. (Iii),375 P. Illus.,maps

Meyer-holzapfel, M. The Behavior of Bears (Ursidae). In W. Kuekenthal and T. Krumbach (Eds.) Handbuch Der Zoologie, Bd. 8, Pt. 10, Sect. 17. 28 P. Illus.; 1957

Milliken, Tom Concern over Japanese Bear Trade. Traffic Bull.; 7(1):5- 8. 1984. Wr 200

Mills, Judy A. Market for Extinction: the Asian Bear Trade. Aazpa (Am. Assoc. Zool. Parks Aquariums) Natl. Conf.; P. 128-133. 1992. Wr 235

Nall, J. D.; Maetz, H. M. Leptospirosis Outbreak in Birmingham Zoo. American Association of Zoo Veterinarians. Annual Proceedings 1975, P.162-166.

Neugebauer, Wilbert Foot and Mouth Disease in /Ursus Thibetanus/. [Maul- Un Klauenseuche Bei Kragenbaeren (/Ursus Thibetanus/).] Zool. Gart.; 46(3):195-197. 1976. In German. Wr 166

Nozaki, Eikichi; Shigeru Azuma; Toshiki Aoi; Harumi Torii; Tetsuro Ito and Kishio Maeda Food Habits of Japanese Black Bear. Int. Conf. Bear Res. Manage.; 5:106-109. 1983. Wr 192

Nurden, A. T.; Butcher, P. D.; Hawkey, C. M. Comparative Studies on the Glycoprotein Composition of Mammalian Platelets. Comparative Biochemistry and Physiology. Part B: Comparative Biochemistry; 56(4):407- 413.; 1977

O'Gara, B. W.; Li, Z. Overview of Wildlife Ranching in Asia. International Wildlife Ranching Symposium, 1st, Las Cruces, New Mexico, 1988. Proceedings, P.37-46. (New Mexico State University, Las Cruces)

Ognev, S. I. Mammals of Eastern Europe and Northern Asia. Vol. Ii: Carnivora (Fissipedia). Glavnauk - Gosudarstvennoe Izdatel'stvo, Moscow and Leningrad. 775 P. Illus.,maps; 1931

Ognev, S. I. Mammals of Eastern Europe and Northern Asia. Vol. Ii: Carnivora (Fissipedia). Israel Program for Scientific Translations, Jerusalem. (V),590,xv P. Illus.,maps Ots 60-21819; Translation Of: Zveri Vostochnoi Evropy I Severnoi Azii, T.ii. Published by Glavnauk - Gosudarstvennoe Izdatel'stvo, Moscow and Leningrad, 1931.

Ohshima, Kan-ichi; Hiroko Sugaya and Shigeru Numakunai A Survey on Muscular Trichinellosis in the Japanese Black Bear (Selenarctos Thibetanus Japonicus) Exterminated in Iwate Prefecture. J. Fac. Agric. Iwate Univ.; 17(2):151-156. 1984. In Japanese with English Summ. Wr 199

Prakash, Ishwar Asian Predators of Livestock. Parasites, Pests and Predators. S. M. Gaafar, Walter E. Howard and Rex E. Marsh, Editors.; P. 405-410. 1985. Wr 205

Rakov, N. N. On the Pecularities of Co-existence of the Boar, Brown Bear and Baribal Bear in the Amur Ussurian Territory. Zoologicheskii Zhurnal; 45(4):617-618.; 1966

Reid, D.; M. Jiang; Q. Teng; Z. Qin and J. Hu. Ecology of the Asiatic Black Bear (Ursus Thibetanus) in Sichuan, China. Mammalia; 55(2):221-237. 1991. In English with French Summ. Wr 225

Schaller, George B.; Teng Qitao; Kenneth G. Johnson; Wang Xiaoming; Shen Heming and Hu Jinchu The Feeding Ecology of Giant Pandas and Asiatic Black Bears in the Tangjiahe Reserve, China. Carnivore Behavior, Ecology, and Evolution. John L. Gittleman, Editor.; P. 212-241. 1989. Wr 215

Schaller, George B. Food Habits of the Himalayan Black Bear (Selenarctos Thibetanus) in the Dachigam Sanctuary, Kasmir. J. Bombay Nat. Hist. Soc.; 66(1):156-159. Apr. 1969. From J. Mammal. 51(3, Suppl.), 1970. Wr 143:38

Schneider, K. M. Of the Behavior of Some Carnivores Toward Consciously Irritant Scents. Deutsche Zoologische Gessellschaft.; 1952

Seal, U. S.; Phillips, N. I.; Erickson, A. W. Carnivora Systematics: Immunological Relationships of Bear Serum Albumins. Comparative Biochemistry and Physiology; 32(1): 33-48.; 1970

Seal, U. S.; Swaim, W. R.; Erickson, A. W. Hematology of the Ursidae. Comparative Biochemistry and Physiology; 22(2): 451-460.; 1967

Shibahara, T.; Nishida, H. An Epidemiological Survey of the Lung Fluke, Paragonimus, in Wild Mammals of the Northern Part of Hyogo Prefecture (Japan). Nippon Juigaku Zasshi; 47(6):911-920. (English Title: Japanese Journal of Veterinary Science); 1985

Sicher, H. Masticatory Apparatus in the Giant Panda and the Bears. Field Museum of Natural History, Chicago. Publications: Zoology Series; 29(4):61-73.; 1944

Stains, H. J. Comparative Study of the Calcanea of Member of the Ursidae and Procyonidae. Southern California Academy of Science. Bulletin; 72(3): 137-148.; 1973

Takahashi, Shunjo Changes in the Distribution of the Japanese Black Bear in the West Chugoku Mountains in Relation to Changes of Vegetation. Geogr. Rev. Jpn.; 52(11):635-642. 1979. From Ecol. Abstr. 1980/5:80I/6959. 1980. In Japanese with English Summ. Wr 182

Toledo, O. M. S.; Mourao, P. A. S. Sulfated Glycosaminoglycans in Normal Aortic Wall of Different Mammals. Artery; 6(5):341-353.; 1980

Torii, Harumi The Japanese Black Bear, Selenarctos Thibetanus Japonicus, in the North District of Shizuoka Prefecture: Analysis of the Hunting Reports. J. Mammal. Soc. Jpn.; 6(2):94-99. 1974. From Biol. Abstr. 59(4), 1975. In Japanese with English Summ. Wr 158:32

Tuttle, R. H. Bear Facts and Laetoli Tanzania Impressions. American Journal of Physiology; 63(2):230.; 1984

Van Keulen-kromhout, G. Zoo Enclosures for Bears, Ursidae: Their Influence on Captive Behaviour and Reproduction. International Zoo Yearbook; 18:177-186.; 1978

Vereshchagin, N. K. The Origin and Evolution of the Polar Bear. In A. G. Bannikov, A. A. Kishchinskii and S. M. Uspenskii (Eds.) Belyi Medved' I Ego Ozhrana V Sovetskoi Arktike; Sbornik, P.25-53. (Izdatel'stvo 'Gidrometeorologicheskii', Leningrad); 1969

Wallach, J. D. Ursidae. In Murray E. Fowler (Ed.) Zoo and Wild Animal Medicine, P. 628-637. (W.b. Saunders Co. Philadelphia, Pennsylvania); 1978

Wang, P.; Chen, M.; Li, F. Histological Study of Giant Panda, Ailuropoda Melanoleuca. Ii: the Microstructure of the Skin. Tung Wu Hsueh Pao; 30(4):305-310. (Latin Title: Acta Zoologica Sinica); 1984

Watanabe, Hiroyuki Damage to Conifers by the Japanese Black Bear. Bear Biol. Assoc. Conf. Ser.; 3:67-70. 1980. Wr 181

Yamanaka, N.; Noborio, H.; Kawanabe, S. Studies on the Control of Black Bear Damage to Forest Trees. Iii: Distribution of Standing Dead Sugi Trees (Crytomeria Japonica, D. Don) in the Kyoto University Forest in Ashiu. Kyoto-furitsu Daigaku Nogakubu Enshurin Hokoku; 63:11-22. (English Title: Kyoto Prefectural University Forests. Bulletin); 1991

Yi-ching, Ma. The Status of Bears in China. Acta Zool. Fenn.; No. 174. P. 165-166. 1983. Wr 193

Yokohata, Y.; Fujita, O.; Kamiya, M.; Fujita, T.; Kaneko, K.; Ohbayashi, M. Parasites from the Asiatic Black Bear (Ursus Thibetanus) on Kyushu Island, Japan. Journal of Wildlife Diseases; 26(1):137-138.; 1990

Yukawa, Masashi Selenarctos Thibetanus Japonicus in Hiroshima Pref. J. Mammal. Soc. Jpn.; 5(2):49. Dec. 1970. From J. Mammal.52(3, Suppl.), 1971. In Japanese. Wr 144:52

ASIATIC BLACK BEAR

Ursus thibetanus formosanus

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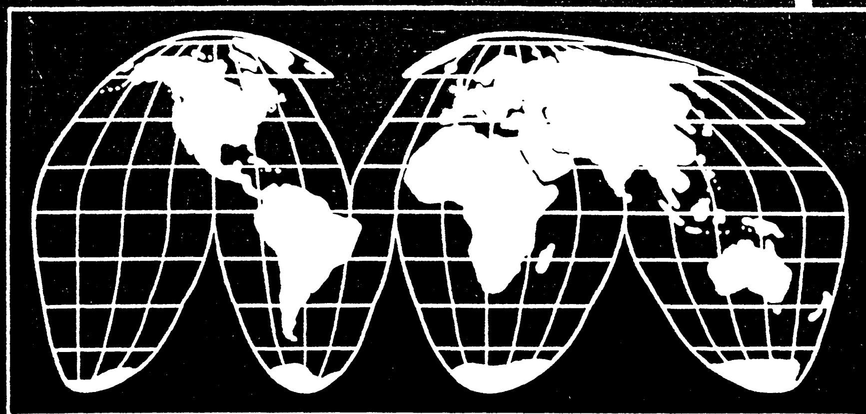
REPORT

Section 10b

IUCN Policy Statements



Captive breeding

IUCN POLICY STATEMENT

4 September 1987

THE IUCN POLICY STATEMENT ON CAPTIVE BREEDING

Prepared by the

SSC Captive Breeding Specialist Group

As approved by the
22nd Meeting of the IUCN Council
Gland, Switzerland

4 September 1987

1

SUMMARY: Habitat protection alone is not sufficient if the expressed goal of the World Conservation Strategy, the maintenance of biotic diversity, is to be achieved. Establishment of self-sustaining captive populations and other supportive intervention will be needed to avoid the loss of many species, especially those at high risk in greatly reduced, highly fragmented, and disturbed habitats. Captive breeding programmes need to be established before species are reduced to critically low numbers, and thereafter need to be co-ordinated internationally according to sound biological principles, with a view to the maintaining or re-establishment of viable populations in the wild.

PROBLEM STATEMENT

IUCN data indicate that about 3 per cent of terrestrial Earth is gazetted for protection. Some of this and much of the other 97 per cent is becoming untenable for many species, and remaining populations are being greatly reduced and fragmented. From modern population biology one can predict that many species will be lost under these conditions. On average more than one mammal, bird, or reptile species has been lost in each year this century. Since extinctions of most taxa outside these groups are not recorded, the loss rate for all species is much higher.

Certain groups of species are at particularly high risk, especially forms with restricted distribution, those of large body size, those of high economic value, those at the top of food chains, and those which occur only in climax habitats. Species in these categories are likely to be lost first, but a wide range of other forms are also at risk. Conservation over the long term will require management to reduce risk, including *ex situ* populations which could support and interact demographically and genetically with wild populations.

2

FEASIBILITY

Over 3,000 vertebrate species are being bred in zoos and other captive animal facilities. When a serious attempt is made, most species breed in captivity, and viable populations can be maintained over the long term. A wealth of experience is available in these institutions, including husbandry, veterinary medicine, reproductive biology, behaviour, and genetics. They offer space for supporting populations of many threatened taxa, using resources not competitive with those for *in situ* conservation. Such captive stocks have in the past provided critical support for some wild populations (e.g. American bison, *Bison bison*), and have been the sole escape from extinction for others which have since been re-introduced to the wild (e.g. Arabian oryx, *Oryx leucoryx*).

RECOMMENDATION

IUCN urges that those national and international organizations and those individual institutions concerned with maintaining wild animals in captivity commit themselves to a general policy of developing demographically self-sustaining captive populations of endangered species wherever necessary.

SUGGESTED PROTOCOL

WHAT: The specific problems of the species concerned need to be considered, and appropriate aims for a captive breeding programme made explicit.

WHEN: The vulnerability of small populations has been consistently underestimated. This has erroneously shifted the timing of establishment of captive populations to the last moment, when the crisis is enormous and when extinction is probable. Therefore, timely recognition of such situations is critical, and is dependent on information on wild population status, particularly that provided by the IUCN/Conservation Monitoring Centre. Management to **best** reduce the risk of extinction requires the establishment of supporting captive populations much earlier, preferably when the wild population is still in the thousands. Vertebrate taxa with a current census below one thousand individuals in the wild require close and swift cooperation between field conservationists and captive breeding specialists, to make their efforts complementary and minimize the likelihood of the extinction of these taxa.

HOW: Captive populations need to be founded and managed according to sound scientific principles for the primary purpose of securing the survival of species through stable, self-sustaining captive populations. Stable captive populations preserve the options of reintroduction and/or supplementation of wild populations.

A framework of international cooperation and coordination between captive breeding institutions holding species at risk must be based upon agreement to cooperatively manage such species for demographic security and genetic diversity. The IUCN/SSC Captive Breeding Specialist Group is an appropriate advisory body concerning captive breeding science and resources.

Captive programmes involving species at risk should be conducted primarily for the benefit of the species and without commercial transactions. Acquisition of animals for such programmes should not encourage commercial ventures or trade. Whenever possible, captive programmes should be carried out in parallel with field studies and conservation efforts aimed at the species in its natural environment.

DRAFT GUIDELINES FOR RE-INTRODUCTIONS

INTRODUCTION

These policy guidelines have been drafted by the Re-introduction Specialist Group of the IUCN's Species Survival Commission[1], in response to the increasing occurrence of re-introduction projects world-wide, and consequently, to the growing need for specific policy guidelines to help ensure that the re-introductions achieve their intended conservation benefit, and do not cause adverse side-effects of greater impact. Although the IUCN developed a Position Statement on the Translocation of Living Organisms in 1987, more detailed guidelines were felt to be essential in providing more comprehensive coverage of the various factors involved in re-introduction exercises.

These guidelines are intended to act as a guide for procedures useful to re-introduction programmes and do not represent an inflexible code of conduct. Many of the points are more relevant to re-introductions using captive-bred individuals than to translocations of wild species. Others are especially relevant to globally endangered species with limited numbers of founders. Each re-introduction proposal should be rigorously reviewed on its individual merits. On the whole, it should be noted that re-introduction is a very lengthy and complex process.

This document is very general, and worded so that it covers the full range of plant and animal taxa. It will be regularly revised. Handbooks for re-introducing individual groups of animals and plants will be developed in future.

1. DEFINITION OF TERMS

a. "Re-introduction": an attempt to establish a species[2] in an area which was once part of its historical range, but from which it has become extinct[3]. ("Re-establishment" is a synonym, but implies that the re-introduction has been successful).

b. "Translocation": deliberate and mediated movement of wild individuals or populations from one part of their range to another.

c. "Re-inforcement/Supplementation": addition of individuals to an existing population

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[1] Guidelines for determining procedures for disposal of species confiscated in trade are being developed separately by IUCN for CITES.

[2] The taxonomic unit referred to throughout the document is species: it may be a lower taxonomic unit (e.g. sub-species or race) as long as it can be unambiguously defined.

[3] CITES criterion of "extinct": species not definitely located in the wild during the past 50 years.

of conspecifics.

d. "<u>Conservation/Benign Introductions</u>": an attempt to establish a species, for the purpose of conservation, outside its recorded distribution but within an appropriate habitat and eco-geographical area.

2. AIMS AND OBJECTIVES OF THE RE-INTRODUCTION

a. Aims:

A re-introduction should aim to establish a viable, free-ranging population in the wild, of a species or subspecies which was formerly globally or locally extinct (extirpated). In some circumstances, a re-introduction may have to be made into an area which is fenced or otherwise delimited, but it should be within the species' former natural habitat and range, and require minimal long-term management.

b. Objectives:

The objectives of a re-introduction will include: to enhance the long-term survival of a species; to re-establish a keystone species (in the ecological or cultural sense) in an ecosystem; to maintain natural biodiversity; to provide long-term economic benefits to the local and/or national economy; to promote conservation awareness; or a combination of these.

Re-introductions or translocations of species for short-term, sporting or commercial purposes - where there is no intention to establish a viable population - are a different issue, beyond the scope of these guidelines. These include fishing and hunting activities.

3. MULTIDISCIPLINARY APPROACH

A re-introduction requires a multidisciplinary approach involving a team of persons drawn from a variety of backgrounds. They may include persons from: governmental natural resource management agencies; non-governmental organisations; funding bodies; universities; veterinary institutions; zoos (and private animal breeders) and/or botanic gardens, with a full range of suitable expertise. Team leaders should be responsible for coordination between the various bodies and provision should be made for publicity and public education about the project.

4. PRE-PROJECT ACTIVITIES

4a. BIOLOGICAL

(i) Feasibility study and background research

- An assessment should be made of the taxonomic status of individuals to be re-introduced. They must be of the same subspecies as those which were extirpated, unless adequate numbers are not available. An investigation of historical information about the loss and fate of individuals from the re-introduction area, as well as molecular genetic studies, should be undertaken in case of doubt. A study of genetic variation within and between populations of this and related taxa can also be helpful. Special care is needed when the population has long been extinct.

- Detailed studies should be made of the status and biology of wild populations (if they exist) to determine the species' critical needs; for animals, this would include descriptions of habitat preferences, intraspecific variation and adaptations to local ecological conditions, social behaviour, group composition, home range size, shelter and food requirements, foraging and feeding behaviour, predators and diseases. For plants it would include biotic and abiotic habitat requirements, dispersal mechanisms, reproductive biology, symbiotic relationships (e.g. with mycorrhizae, pollinators), insect pests and diseases. Overall, a firm knowledge of the natural history of the species in question is crucial to the entire re-introduction scheme.

- The build-up of the released population should be modelled under various sets of conditions, in order to specify the optimal number and composition of individuals to be released per year and the numbers of years necessary to promote establishment of a viable population.

- A Population and Habitat Viability Analysis will aid in identifying significant environmental and population variables and assessing their potential interactions, which would guide long-term population management.

(ii) Previous Re-introductions

- Thorough research into previous re-introductions of the same or similar species and wide-ranging contacts with persons having relevant expertise should be conducted prior to and while developing re-introduction protocol.

(iii) Choice of release site

- Site should be within the historic range of species and for an initial re-inforcement or re-introduction have very few, or no, remnant wild individuals (to prevent disease spread, social disruption and introduction of alien genes). A conservation/ benign introduction should be undertaken only as a last resort when no opportunities for re-introduction into the original site or range exist.

- The re-introduction area should have assured, long-term protection (whether formal or otherwise).

(iv) Evaluation of re-introduction site

- Availability of suitable habitat: re-introductions should only take place where the habitat and landscape requirements of the species are satisfied, and likely to be sustained for the for-seeable future. The possibility of natural habitat change since extirpation must be considered. The area should have sufficient carrying capacity to sustain growth of the re-introduced population and support a viable (self-sustaining) population in the long run.

- Identification and elimination of previous causes of decline: could include disease; over-hunting; over-collection; pollution; poisoning; competition with or predation by introduced species; habitat loss; adverse effects of earlier research or management programmes; competition with domestic livestock, which may be seasonal.

- Where the release site has undergone substantial degradation caused by human activity, a habitat restoration programme should be initiated before the re-introduction is carried out.

(v) Availability of suitable release stock

- Release stock should be ideally closely-related genetically to the original native stock.

- If captive or artificially propagated stock is to be used, it must be from a population which has been soundly managed both demographically and genetically, according to the principles of contemporary conservation biology.

- Re-introductions should not be carried out merely because captive stocks exist, nor should they be a means of disposing of surplus stock.

- Removal of individuals for re-introduction must not endanger the captive stock population or the wild source population. Stock must be guaranteed available on a regular and predictable basis, meeting specifications of the project protocol.

- Prospective release stock must be subjected to a thorough veterinary screening process <u>before</u> shipment from original source. Any animals found to be infected or which test positive for selected pathogens must be removed from the consignment, and the uninfected, negative remainder must be placed in strict quarantine for a suitable period before retest. If clear after retesting, the animals may be placed for shipment.

- Since infection with serious disease can be acquired <u>during</u> shipment, especially if this is intercontinental, great care must be taken to minimize this risk.

- Stock must meet all health regulations prescribed by the veterinary authorities of the recipient country and adequate provisions must be made for quarantine if necessary.

- Individuals should only be removed from a wild population after the effects of translocation on the donor population have been assessed, and after it is guaranteed

4b. SOCIO-ECONOMIC AND LEGAL ACTIVITIES

- Re-introductions are generally long-term projects that require the commitment of long-term financial and political support.

- Socio-economic studies should be made to assess costs and benefits of the re-introduction programme to local human populations.

- A thorough assessment of attitudes of local people to the proposed project is necessary to ensure long term protection of the re-introduced population, especially if the cause of species' decline was due to human factors (e.g. over-hunting, over-collection, loss of habitat). The programme should be fully understood, accepted and supported by local communities.

- Where the security of the re-introduced population is at risk from human activities, measures should be taken to minimise these in the re-introduction area. If these measures are inadequate, the re-introduction should be abandoned or alternative release areas sought.

- The policy of the country to re-introductions and to the species concerned should be assessed. This might include checking existing national and international legislation and regulations, and provision of new measures as necessary. Re-introduction must take place with the full permission and involvement of all relevant government agencies of the recipient or host country. This is particularly important in re-introductions in border areas, or involving more than one state.

- If the species poses potential risk to life or property, these risks should be minimised and adequate provision made for compensation where necessary; where all other solutions fail, removal or destruction of the released individual should be considered. In the case of migratory/mobile species, provisions should be made for crossing of international/state boundaries.

5. PLANNING, PREPARATION AND RELEASE STAGES

- Construction of a multidisciplinary team with access to expert technical advice for all phases of the programme.

- Approval of all relevant government agencies and land owners, and coordination with national and international conservation organizations.

- Development of transport plans for delivery of stock to the country and site of re-introduction, with special emphasis on ways to minimize stress on the individuals during transport.

- Identification of short-and long-term success indicators and prediction of programme duration, in context of agreed aims and objectives.

- Securing adequate funding for all programme phases.

- Design of pre- and post- release monitoring programme so that each re-introduction is a carefully designed experiment, with the capability to test methodology with scientifically collected data.

- Appropriate health and genetic screening of release stock. Health screening of closely related species in re-introduction area.

- If release stock is wild-caught, care must be taken to ensure that: a) the stock is free from infectious or contagious pathogens and parasites before shipment and b) the stock will not be exposed to vectors of disease agents which may be present at the release site (and absent at the source site) and to which it may have no acquired immunity.

- If vaccination prior to release, against local endemic or epidemic diseases of wild stock or domestic livestock at the release site, is deemed appropriate, this must be carried out during the "Preparation Stage" so as to allow sufficient time for the development of the required immunity.

- Appropriate veterinary or horticultural measures to ensure health of released stock throughout programme. This is to include adequate quarantine arrangements, especially where founder stock travels far or crosses international boundaries to release site.

- Determination of release strategy (acclimatization of release stock to release area; behavioural training - including hunting and feeding; group composition, number, release patterns and techniques; timing).

- Establishment of policies on interventions (see below).

- Development of conservation education for long-term support; professional training of individuals involved in long-term programme; public relations through the mass media and in local community; involvement where possible of local people in the programme.

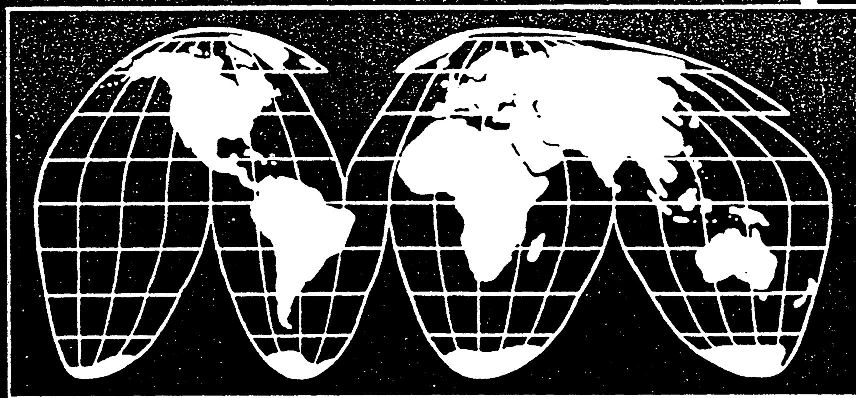
- The welfare of animals for release is of paramount concern through all these stages.

6. POST-RELEASE ACTIVITIES

- Post release monitoring of all (or sample of) individuals. This most vital aspect may be by direct (e.g. tagging, telemetry) or indirect (e.g. spoor, informants) methods as suitable.

- Demographic, ecological and behavioural studies of released stock.

- Study of processes of long-term adaptation by individuals and the population.
- Collection and investigation of mortalities.
- Interventions (e.g. supplemental feeding; veterinary aid; horticultural aid) when necessary.
- Decisions for revision, rescheduling, or discontinuation of programme where necessary.
- Habitat protection or restoration to continue where necessary.
- Continuing public relations activities, including education and mass media coverage.
- Evaluation of cost-effectiveness and success of re- introduction techniques.
- Regular publications in scientific and popular literature.



Research involving species at risk of extinction

La recherche en rapport avec des espèces menacées d'extinction

Investigaciones en que se usan especies en riesgo de extinción

IUCN POLICY STATEMENT
DECLARATION DE PRINCIPE DE L'UICN
POSICION DE LA UICN
14.6.89

Approved by the 27th Meeting
of IUCN Council

Adoptée durant la 27e Session
du Conseil de l'UICN

Aprobada durante la 27a. Reunión
del Consejo de la UICN

IUCN POLICY STATEMENT ON RESEARCH INVOLVING SPECIES AT RISK OF EXTINCTION

PROLOGUE

IUCN holds that all research on or affecting a threatened species carries a moral responsibility for the preservation or enhancement of the survival of that species. Conservation of the research resource is clearly in the interest of the researchers.

IUCN recognizes that the taking and trading of specimens of threatened species are covered by international agreements and are normally included in national legislation which provides authorized exemptions for the purpose of scientific research.

Basic and applied research is critically needed on many aspects of the biology of animal and plant species at risk of extinction (e.g. those listed by IUCN as Vulnerable, Rare, Endangered, or Indeterminate) to provide knowledge vital to their conservation.

Other scientific interests may involve the use of threatened species in a wide variety of studies. Taking into account the importance of many kinds of research, as well as potential threats such species could be subject to in such activities, IUCN, after careful consideration, adopts the following statements as policy.

POLICY

IUCN encourages basic and applied research on threatened species that contributes to the likelihood of survival of those species.

When a choice is available among captive-bred or propagated, wild-caught or taken, or free-living stock for research not detrimental to the survival of a threatened species, IUCN recommends the option contributing most positively to sustaining wild populations of the species.

IUCN recommends that research programmes on threatened species that do not directly contribute to conservation of the species should acknowledge an obligation to the species by devoting monetary or other substantial resources to their conservation, preferably to sustaining populations in the natural environment.

Whether animals involved are captive-bred, wild-caught, or free living, or whether plants involved are propagated, taken from the wild, or in their natural habitat, IUCN opposes research that directly or indirectly impairs the survival of threatened species and urges that such research not be undertaken.

PROTOCOLS

In this context IUCN urges researchers to accept a personal obligation to satisfy themselves that the processes by which research specimens are acquired (including transportation) conform scrupulously to procedures and regulations adopted under international legal agreements. Further, researchers should adopt applicable professional standards for humane treatment of animal specimens, including their capture and use in research.

IUCN urges that any research on threatened species be conducted in conformity with all applicable laws, regulations and veterinary professional standards governing animal acquisition, health and welfare, and with all applicable agricultural and genetic resource laws and regulations governing acquisition, transport, and management of plants.

ASIATIC BLACK BEAR

Ursus thibetanus formosanus

POPULATION AND HABITAT VIABILITY ASSESSMENT WORKSHOP

REPORT

Section 10c

Population Biology Overview: Chinese Version

R_o. 净繁殖率

每一代的变化率

如果 $R_o.<0$...........群体在减少

如果 $R_o.=1$...........群体稳定(数量不变)

如果 $R_o.>1$...........群体增加

T 增代时间

亲体诞生时间同幼仔诞生时间的平均时间。(相等情况是动物繁殖后代的平均年龄)。

小群体生物学

前言

濒危物种，就其定义而言，是有灭绝危险的物种。恢复这类物种的主要目标是要把其灭绝的危险程度降低，减少到某一种可以接受的水平，也就是尽可能减少到与其背景近似，即一切物种的正常的灭绝危险程度。

危险一词的概念用以确定恢复的对象，同时用于明确恢复本身的含义。危险情况是濒危物种管理的中心问题，这毫不奇怪。然而，遗憾的是，有充分理由认为，作为人类的我们，天生来不善于评估已经危险到什么程度了。在这一方面，如果我们的工作能够进一步做好，物种的恢复就会进一步成功。为了帮助管理人员处理危险情况，迫切需要有一些工具。我们需要改进对危险情况的估计，需要对不同的潜在管理方案带来的危险进一步排列出其先后次序，需要在评估危险的时候进一步客观，同时，(通过内部先后一致的检查办法)，对于整个程序加以质量控制。在所要评估的危险当中，有灭绝和基因多样性。

最近几年来，这方面的工具，从数量上来说，增加了。野生生物管理和群体生物学之间的一些空白已经为保护生物学这门应用科学所填补。泛泛称为「群体生存分析」的一整套办法问世了。

这类技术的威力足以改进危险情况的辨认工作，排列出相关的危险的轻重缓急，以及评估各种可供选择的方案。另外的一个优点是可以把一部分决策过程，从无法向其提出挑战的主观见解变成为在数量上相当多的基本理论，(因而也就可以受到挑战)。

在下列几段，乔恩·巴卢，汤姆·富斯和鲍勃·莱希分别介绍「群体生存分析」(PVA)的不同方面。文章是根据其他有关「群体生存分析」著作改写的，(即乔恩·巴卢等人以及鲍勃·莱希等人在一九八九年分别发表的「群体生存分析」)，概括介绍构成「群体生存分析」基础的一些群体生物学概念。每一位在这方面有贡献的人，都根据自己的经验和专长来谈这个问题，因此内容和看法会有所不同，其中也会有一些重复的地方，不过，这只不过是用不同的词句来重复某

一点而已，因此对初接触这方面问题的人会有所帮助。一般介绍以后，将介绍野生的和饲养的大熊猫和小熊猫群体的情况，并在此基础上详细介绍「群体生存分析」，同时还要对增加这类物种恢复的可能性，提出一些建议。

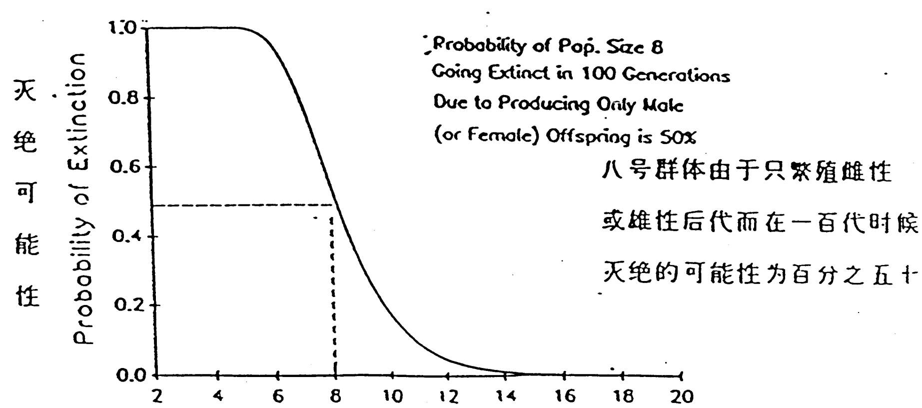
小群体概况

巴卢

单一物种保护计划的基本目标是降低群体灭绝的危险性。在这方面，第一步工作是认清有可能造成群体灭绝的因素。基本威胁自然是群体数量下降。如果一个群体在数量上减少，而又不采取行动来扭转，灭绝自然不可避免。即便一个小群体在数量上没有减少，即便实际上还有所增加，然而这个群体也仍然是前途未卜的。小群体受到许多因素的挑战，而这些因素可以增加这个群体灭绝的可能性，其简单原因，不外是这个群体是个小群体。

对小群体的挑战

小群体受到的挑战，就其分类，可以说是内在的，(在不涉及环境情况下，群体内部基因和数量上的偶然变化)，也可以是外部的，(环境作用于群体的基因和数量)。在最基本的单位方面，也就是在个体方面，群体受到的内在挑战为数量上的变化。数量上的变化，是群体内死亡和生育率以及性别比例受群体中个体的偶然变化而发生的正常变化。群体大小方面的波动可以单纯是由于个体繁殖，或者存亡的偶然差异而引起的。这种偶然的波动可以严重到使群体灭绝。举例来说，对于十分小的群体的关注是这个群体在一代中繁殖的所有个体都是一个性别的话，



图一(Fig.1)说明统计数量上的差异:一代只繁殖一个性别后代，一百代时灭绝的可能性。

群体大小 Population Size

Figure 1. Example of demographic variation: Probability of extinction by 100 generations due solely to producing only one sex of offspring during a generation.

其结果是这个群体会灭绝。图一说明，在不同大小的群体中，在一百代的时候发生的这种可能性。八号群体在这期间的某一个时间由于单一的性别比例而灭绝的机会是百分之五十。

死亡率高，或者是繁殖率低的巧合作用，也可能引起同样后果。然而，在大的群体中，这种危险基本上微不足道。一般来说，一个个体在大群体中对群体总趋势的影响小于在小群体中的影响。其结果是，除了极小群体之外(少于二十隻动物)，数量上的差异，相对来说，是一个比较小的挑战。

对于小群体来说，比较显著的一个外部威胁是环境变化。环境条件的变化显然对于群体繁殖和生存的能力有影响。就群体大小而言，对环境变化敏感的群体比不敏感的群体在群体大小问题上容易波动，增加了灭绝的危险。举例来说，濒危的佛罗里达州螺鸢直接受水位的影响，因为水位决定食物(螺)的多寡;在水位低的年分，孵化成功率可减少百分之八十。群体非常不稳定。(贝辛格著，一九八六年)。

对于小群体来说，另外一种威胁是灾难，如传染病。灾难和环境变化的其他形式有相似之处，这就自在于全都是外部条件。尽管如此，还是要单独列出，因为影响大，预测灾害的发生也困难。灾难也可以视为对群体的大部分产生灾难性后果的因素，然而相对来说，是很少发生的事情。传染病对于一个群体可以有直接或者是间接影响。举例来说，在一九八五年，野生啮齿动物鼠疫使黑足貂的基本捕获对象草原松鼠数量减少，结果对仅剩下的黑足貂产生了严重的间接影响。同年晚一些时候，犬瘟热使野生群体中的大部分死亡，结果只好把余下的六隻全部人工饲养起来。(索恩与别利茨基著，一九八九年)。

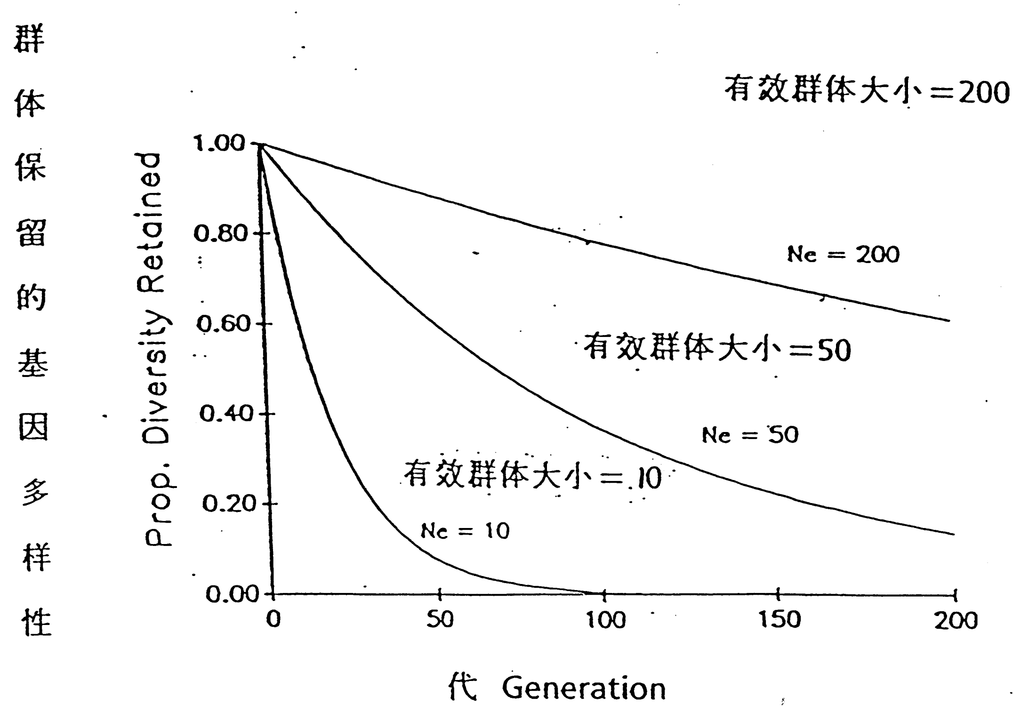
灾难是难得发生一次的，然而却能够使群体中个体大批减少。灾难性事件有自然方面的，(水灾，火灾，飓风)，或者是人为方面的(砍伐森林，或者是破坏生境的其他行为)。群体，不论其大小，都受灾难影响。当前，影响物种灭绝率最严重的，莫过于砍伐热带森林。对于热带物种的灭绝率，到本世纪末的时候有各种不同估计，在百分之二十到百分之五十之间(卢戈著，一九八八年)。

小群体也容易受基因方面的挑战。在基因方面的基本考虑是基因变异方面的损失。在每一代中，遗传给下一代的基因都是亲体的随机基因样。在小群体当中，随机基因样很小，只代表亲体基因十分微小的一部分。亲体中的基因变异偶然也可能没有传给下一代。在这种情况下，群体就失去了这部分基因。这个过程叫做遗传漂移，因为，随着时间的转移，群体的基因特点可

能漂移，或者变化。在小群体中，遗传漂移可以使基因多样性迅速损失掉。群体越小，损失速度越快。

保护计划内容以保留基因多样性为基本目标，其理由有几个。物种如果要能够长期生存下去，则必须保留住适应变化中的环境的能力(演变)。自然选择过程需要有基因变异，因此，保护策略中必须有为物种长期存在所需要的基因变异。除了要有长期演变考虑之外，已经证明，基因多样性对于维护群体的健康也十分重要。有越来越多的研究显示，基因多样性和许多涉及繁殖，生存和抗病等方面特点有一般的，然而却不是普遍的相互关系(阿伦多夫和利里合著，一九八六年)。基因变异水平低的个体比基因变异大的个体容易有较高死亡率和较低繁殖率。

近姻交配(在有血缘关系的个体之间)也会使群体失去基因多样性。小群体中的所有的动物相互之间会迅速都有血缘关系。有血缘关系的亲体繁殖的后代由于是近亲交配而从雌雄亲体那里得到等位基因。近亲交配的个体比非近亲交配的个体更容易有同型基因;这类个体的基因多样性小于没有血缘关系的亲体繁殖的后代。

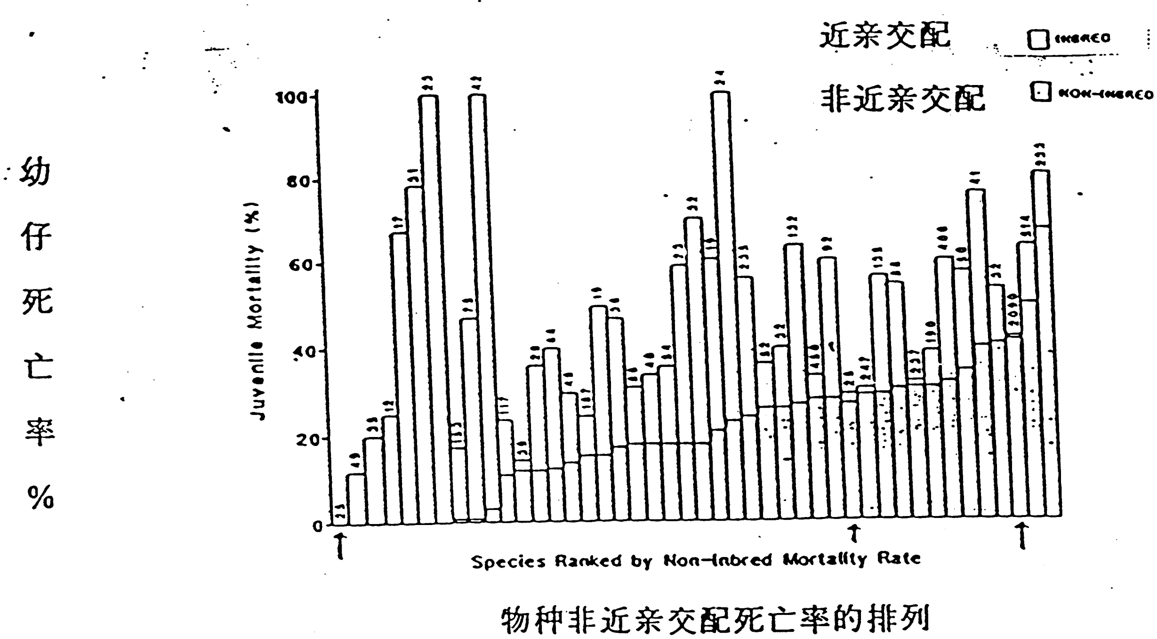


图二(Fig.2)。不同有效群体大小的群体在二百代的时候丧失的基因多样性(Ne).

Figure 2. Loss of genetic diversity over 200 generations in populations with different effective sizes.(Ne).

图二说明不同大小的群体丧失基因多样性的情况。基因多样性丧失率是群体有效大小的一个功能(Ne为群体有效大小。每一代损失的多样性为1/2Ne。)从技术上来说，一个有效群体的大小应与真实群体有同样的基因多样性丧失率。这是理想群体的大小。现在已经有很多文献说明如何去估计一个有效群体的大小(兰德与巴罗克拉夫合著，一九八七年);然而，也可以用每一代对基因库有贡献的动物头数作为对群体有效大小的粗略估计。有效群体的大小，因此比群体中的实际头数，要小的多。进行过的一些估计暗示，有效大小往往只是群体总头数的百分之十到百分之三十。

对于外来物种近亲交配的影响所积累的数据，也说明了保持基因多样性的重要性。许许多多研究结果都表明，在很多野生生物中，近亲繁殖能够显著影响繁殖和生存(罗尔斯与巴卢合著，一九八三年，以及怀尔德等合著，一九八七年，图三)。造成近交衰退的，有两方面原因，其一，同型基因的增加使基因组中的有害隐性等位基因表露出来了;其二，在异型结合组只单纯因为有两个等位基因而比同型结合组更适合的情况下，近亲交配会降低近亲交配繁殖出来的后代的健康水平，使之不能够在群体中占优势。在这两种情况下，近亲交配造成基因多样性的丧失，对于群体的生存，都有着有害影响。

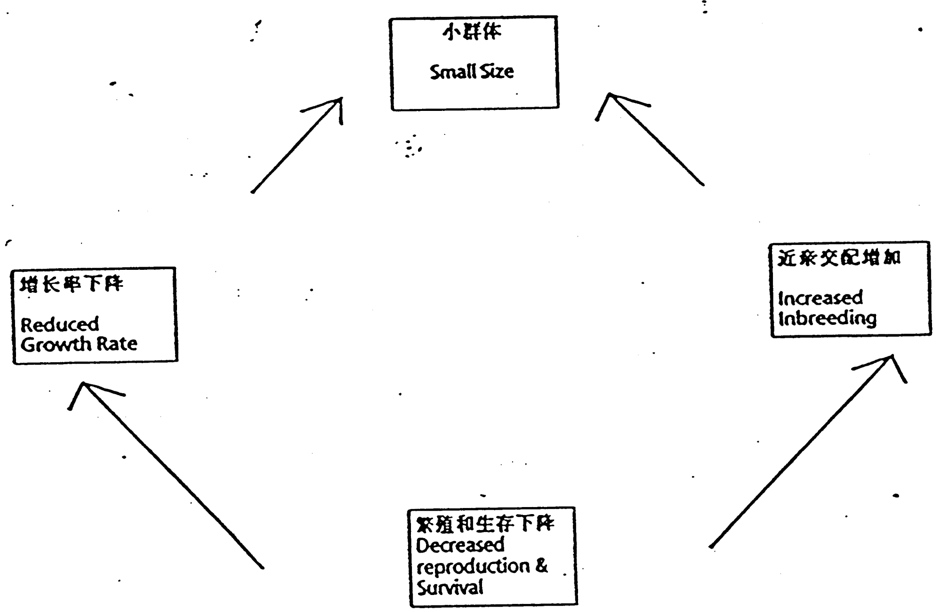


图三。(Fig.3)在四十五种饲养动物群体中近亲交配造成的幼仔死亡情况(摘自罗尔斯与巴卢合著一九八七年)

Figure 3. Effects of inbreeding on juvenile mortality in 45 captive mammal populations (From Ralls and Ballou, 1987).3

小的，孤立的群体，在没有得到来自其他群体的迁移的情况下，会丧失基因多样性，同时，随着时间的转移而近亲交配现象严重，从两方面危及这类群体的长期生存，因为这类群体，不但会失去演变所需要的基因多样性，而且，其近期生存，也会因为近亲交配对生存和繁殖的有害影响而受到威胁。

上面谈到的基因和数量两方面的挑战，在小群体中，显然并非独立起作用。一个小群体，近亲交配情况越来越多以后，生存与繁殖的可能性就越来越小，群体结果会缩小。近亲交配率上升使群体变小，而群体变小又引起更多的近亲交配现象，其结果不但是容易在数量上发生变化，而且，在疾病和严重的环境变化方面，也容易受影响。每一种挑战都会加深另外的一些挑战，结果造成负反馈作用。这种作用称之为「灭绝漩窝」(吉尔平与苏莱合著，一九八六年」。长此下去，群体越来越小，越容易灭绝。图四。



图四(Fig.4)小群体近亲交配造成负反馈作用形成的「灭绝漩窝」。

Extinction Vortex caused by negative feedback effects of inbreeding in small populations.

「群体生存分析」

小群体面对的挑战多数都是随机发生的，是无法预测的偶然性事件造成的，其中有很多，一般来说，都可以减少群体长期生存的可能性。不过，由于这些都是随时发生的，所以对于群体的

灭绝和基因多样性的保存，究竟有什么样的确切影响，尚难準确预测。举例来说，尽管近亲交配是普遍现象，然而其影响，因物种不同而异(图三)，不可能準确预测某一个群体对于近亲交配会有什么反应。

尽管如此，仍然要发展和执行一些保护策略来解决这些无法预测的灭绝问题和基因多样性丧失问题。近年来发展出来的一个用以评估灭绝可能性与基因多样性丧失问题的程序叫做「群体生存分析」(PVA;苏莱著，一九八七年)。「群体生存分析」的定义是系统评估使群体陷入危险情况的各种因素的相对重要性，设法辨明那些对于群体生存有重要意义的因素。在某一些情况下，这可能容易做到 --- 对于大多数濒危物种来说，生境破坏往往是一个关键因素。但是，在另外一些时候，个别因素的影响，以及因素之间相互作用的影响，估计起来，就比较困难了。为了进一步了解这些因素的影响，目前已经发展出一些计算机模型，通过分析与模拟技术的结合使用，可以模拟出群体在一定时期的情况，估计出一个群体灭绝的可能性以及基因多样性的丧失情况。首先，要在模型中输入群体生活史特点的信息，其中包括首次繁殖的年龄，一窝幼仔的多少和分布情况，成活率，交配结构，年龄分布，以及和这里每一个变数有关系的变化估计情况，另外，还要考虑使用的是什么样的模型。此外，也可以考虑许多不同的外部因素，其中可能有环境变化水平，容纳量的变化，和近交衰退的严重程度。有一些模型还可以顾及到群体面临的一些威胁，如发生灾难的可能性，栖息地损失情况，以及疾病传染情况。(图五。)

「群体生存分析」

对于灭绝危险有影响的相互作用着的因素的评估过程

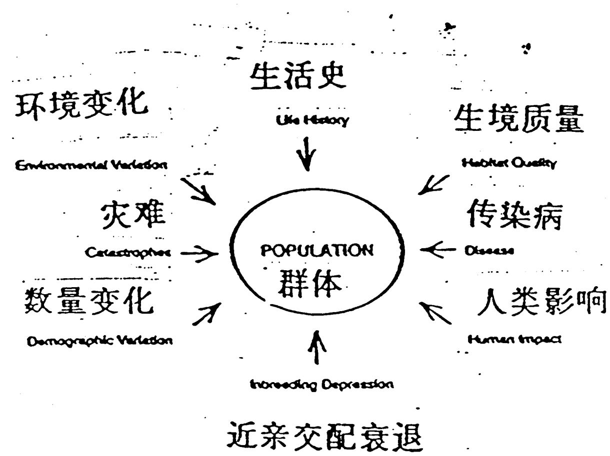


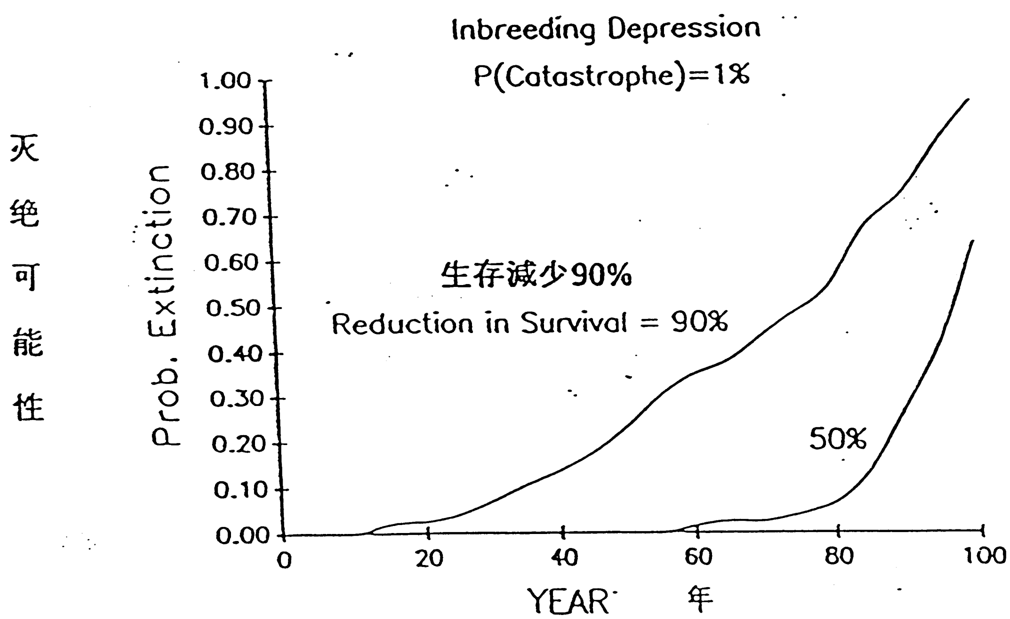
Figure 5. Population Viability Analyses (PVA) model the effects of different life-history, environmental and threat factors on the extinction and retention of genetic diversity in single populations.

图五。(Fig.5)「群体生存分析」模拟不同生活史，环境和威胁因素对一个群体的灭绝与保存基因多样性的影响。

这些模型使用生活史变数，外部因素以及潜在的威胁等来预见一个群体的前景，测量出随着时间的推移而保留住基因变异的程度，同时，如果发生灭绝现象(群体大小等于零)，也能够把灭绝的时间记录下来。模拟要重复进行，有的时候，重复几千次;这样才能够估计出和模拟结果有关系的各种数据的变数的作用。得出任取的一段时间的灭绝可能性所使用的方法，是取群体灭绝模拟的次数，然后再除以模拟总次数。(图六)。用以记录保留的基因变异水平的形式，是群体在特定点的原始异型结合的百分比，以及保留的原始等位基因的数量。

近亲交配衰退

P(灾难)=1%



图六。(Fig.6.)漩窝「群体生存分析」模型得出的假想群体灭绝例子。本模型中有近亲交配的负作用以及1%的灾难可能性。随着时间的转移而灭绝的可能性，根据灾难严重的程度而有两种水平，即生存减少90%和50%。

Figure 6. Hypothetical example of population extinction results from the VORTEX PVA model. The model includes negative effects of inbreeding and a catastrophe probability of 1%. The probability of extinction is shown over time for two different levels of catastrophe severity: a 90% reduction in survival vs 50% reduction in survival.

目前已经发展出来不少「群体生存分析」模型。国际保护自然资源和生物资源联合会(IUCN)的人工饲养专家小组(Captive Breeding Specialist Group)所使用的，是漩窝模型，是芝加哥动物

协会的罗伯特·莱希搞出来的，广泛用于发展不少物种的保护措施，其中有黑足貂，佛罗里达豹，波哥亚马孙鹦鹉，爪哇犀牛和四种不同的狮猴。

模型的真正价值不在于同时研究群体所有变数的影响。这许多因素相互之间的作用，过于复杂，不适合于以许多而不是几种考虑为出发点去研究群体预测的结果。在一定时间内只研究一，两个因素的时候，对于群体动态的了解，会更透彻，尤其是在选择了那些我们认为对群体有影响的因素，而放弃那些没有影响的因素的时候。

模型在发展保护策略时候的基本用途是可以把模型用于进行「万一」分析。举例来说，如果有了流行性传染病，野外群体生存的可能性，万一减少，这对群体的灭绝和对基因多样性的保存，会有什么影响呢?这种「万一」分析，也可以用于评价管理方面推荐的方案。举例来说，如果动物保护区的容纳量增加了百分之十，群体灭绝方面的可能变化，又是什么呢?

然而，模型并没有研究所有促成灭绝的潜在因素，因而往往低估了一个群体灭绝的可能性。有必要强调「群体生存分析」的目的，不是确切评估出灭绝的可能性，而在于辨认出考虑中的许多因素的相对重要性，同时也在于评估出，一系列管理方面的建议对于群体生存的影响。

「群体生存分析」对于管理目标的作用

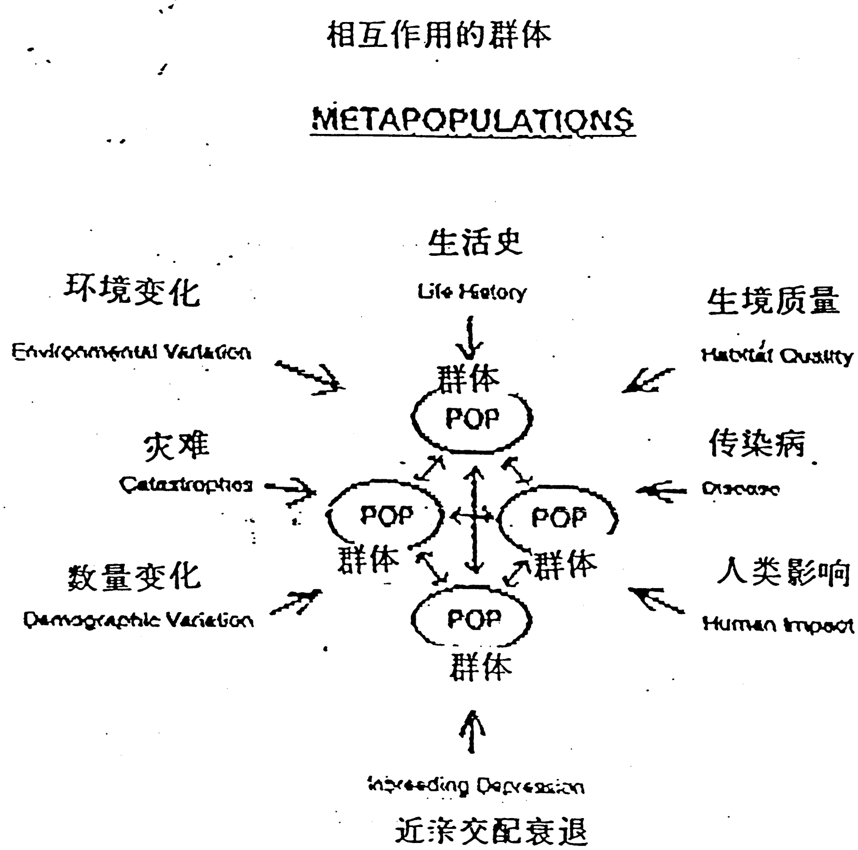
群体灭绝和基因多样性损失的概念，不是基于肯定，而是基于可能。「群体生存分析」模型提供的结果，能够使我们在对一个群体从现状和生物学的角度做出一些假设以后，了解到一些情况，不过，其结果是，我们在预测，或者是保证群体今后情况的时候，没有绝对的把握。

在我们试图发展保护计划来减少群体灭绝危险的时候，这样说，有其强烈含义。我们必须能够认识到，我们并不可能制定出和执行能够保证群体生存下去的建议方案，而只能够制定出和执行在一定期间内减少群体灭绝可能性的建议方案。

一个普通办法是发展出一些管理策略，以便使群体有百分之九十五的机会来生存一百年，并在同一期间，保存其基因变异的百分之九十。(谢福，一九八七年著;苏莱等一九八六年著)。这样就可以保证有极大的生存可能性，同时，也可以使群体在环境变化时保留住其基因方面的适应力的大部分，因而也可以演变。通过这种办法来实现这样的管理目标，就要有最低限度生存能力的群体(MVP).要全面评估管理策略，就必须对管理有确定的程度和时间构架，这些都必须具体化。

相互作用的群体

到目前为止所讨论的问题都涉及一个群体的灭绝和基因动态，然而，管理人员面对的问题常常牵涉到分布在几个相互作用的群体中的物种。这种情况，再加上动物在群体之间移动频繁(迁移)，多到一个群体的动态(灭绝或者是基因)可以影响到附近群体的动态的程度，我们就称这一组群体为相互作用的群体(图七)。在发展保护策略过程中，了解相互作用的群体的动态，有越来越大的重要性。



图七(Fig.7)群体中的所谓「片」“patch“的相互作用，形成相互作用的群体结构。保护策略必须要考虑到「片」的分布情况，也要考虑到，这对于「片」与「片」在灭绝方面的相互关系，以及群体在再恢复方面的相互关系。

Figure 7. The interaction between population 'patches' results in a Metapopulation structure. Conservation strategies must consider the spatial distribution of the patches and its effect on correlated extinctions and recolonization between patches.

相互作用的群体的管理焦点在于群体的分布情况，以及这对于整个系统在基因和数量动态方面的影响。相互作用的群体可以视为群体(即「片」)的组合)，而这些「片」在大小和彼此之间的距离上，均有所不同，其中有一些「片」定期灭绝，要由其他「片」移殖过来的个体重新给予生机。在保护问题上，要考虑到的最重要的一点是单个「片」的灭绝率，以及「片」与「片」之间的移殖率。(吉尔平著，一九八七年)。

正如上面所讨论到的那样，任何一个「片」的灭绝动态都会受到许多因素的影响，其中包括群体的大小，以及在群体中的个体减少以后，群体的复元率等。从相互作用的群体的角度来看，在「片」与「片」的灭绝率彼此没有关系的时候，也就是任何一个「片」的灭绝同另外一个「片」没有关系的时候，这时候的水平是最简单的。环境的变迁和灾难的发生能够增加「片」之间的灭绝关系，而这又会引起整个相互作用的群体灭绝的可能姓。正是因为会有这种情况，所以，在发展保护策略的时候，一个重要的组成部分是考虑「片」与「片」之间的距离，以及不同的「片」，在环境发生变化和发生灾难的情况下，在反应上，会有什么样的相似之处。

但是，从另外一方面来说，「片」与「片」之间距离越近，一个「片」在灭绝以后的再恢复率越高，因为会有邻近「片」的个体加入这个「片」。

「片」的灭绝和再恢复对于相互作用的群体保住基因多样性也有关系。孤立的，支离破碎的小群体很快就会失去基因的多样性。然而，在「片」与「片」之间如果有迁移，「片」与「片」的基因流动会加强，而相互作用的群体的有效大小也会显著加大。可是，在群体灭绝之后的再恢复情况再三涉及到十分有限的几个个体的时候(一对，或者是一个可以生育的雌性)，则这个群体的基因没有变异，因为建立者的作用是循环发生的。

群体再恢复有利方面的相互作用，以及相互有关系的「片」灭绝的负作用，使我们对于相互作用的群体在基因与数量方面的了解复杂化了。遗憾的是，能够把上面提到的单一群体灭绝同基因考虑这两方面的因素与相互作用的群体方面的理论结合起来的计算机模型，还没有发展出来，目前还不能够用于发展管理策略。

尽管这样，管理人员应当认识到，相互作用的群体有其复杂性。从长远角度看问题，一般来说，分布在几个地点的群体比仅仅留在一个地点的一个群体更牢靠一些，尤其是在「片」与「片」之间有基因流动(不论这是自然发生的，还是通过管理而发生的)，而不同的「片」又不

会受到同一种灾难的威胁的情况下。在许多情况下，饲养的群体可以是牢靠的群体，可以用饲养群体作为其他「片」的再恢复的源泉和多样化基因库，方法是把饲养群体引入其他群体。

野生和饲养小群体的相互管理作用

傅斯

前言

濒危物种的保护策略必须基于有生存能力的群体。保护现场的濒危物种固然需要，然而却还远远不够，因而也必须管理起来。

必须管理的原因是，在生境恶化与非持久性开发的情况下，能够长期维持下去的群体，从物种方面来说，并不多，也就是说，可能是几十，或者几百，(在某些情况下，也可能有几千)。这取决于是什么物种。在这种情况下，这些群体受到许多环境，数量和基因问题的威胁，而这些威胁都是随时可能发生的，引致灭绝。

小的群体可以在一场灾难(天气方面的灾难，疾病的流行，以至于开发)发生以后受到严重损失，如黑足貂，波哥亚马孙鹦鹉。波动并不十分严重的环境变化，也可以使小群体中的个体数量减少。从数量上来说，小群体可以受到生存和繁殖的偶然波动的干扰，而从基因上来说，会失去健康存在和适应变化所需要的基因多样性。

有最低限度生存能力的群体

在谈到所有这些问题的时候，可以说，群体越小，而个体数量少的时间拖的越长，危险性也就越大，灭绝的可能性增加。其结果是，为数量上少，而有可能长期无法增加个体数量的物种制定保护策略的时候，其基础必须是能够长期维持住一个有最低限度生存能力的群体(即MVP)，也就是说，要有一个尽管遇到基因，数量和环境问题，然而其大小却足以使其能够长期坚持下去的群体。

有最低限度生存能力的群体的大小，不能够用一个万能数字来概括所有的物种，更不能够在一切时间都内适用于一个物种。有最低限度生存能力的群体取决于一个方案要实现的基因和数量目标，以及引起关注的群体或者是分类群的生物学特征。另外，在确定有最低限度生存能力的群体的时候，还有一个复杂考虑，这就是当前的基因因素和数量因素需要分别考虑，尽管这两个因素相互作用着。再者，评估有关群体大小的科学模型尚在发展中，尽管是在快速发展着。虽然有这些问题，然而科学分析所要考虑的，既有一个方案的基因和数量目标，也有一个群体的生物学特点，因而有可能提示出，群体究竟应该有多大的各种幅度，才足以应付随时发生的问题，同时还可以有一定的保障。

<u>对于有最低限度生存能力的群体有重要意义的基因和数量目标</u>

希望群体能够达到的生存可能性的百分比(也就是50%或者是90%)；
保存下来的基因多样性的百分比(90%，95%等等)；
维持数量安全和基因多样性的时间长短(五十年，二百年等等)。

就数量同基因问题而言，可能希望有95%的生存可能性，并维持二百年。现在已经出现一些模型，预测不同大小的群体遭到上述威胁的时候可以维持多长时间。或者，就基因问题而言，也许希望在二百年间保持住平均异型结合的95%。在这方面也已经有模型。但是，要认识到，生存能力，恢复，自体持久性和持久力，只有在制定出众多的基因和数量目标以后才能够确定，其中还要有实施的方案持续进行的时间和预期一个群体存留的时间。

<u>对于有最低限度生存能力的群体有重要意义的生物学特点。</u>

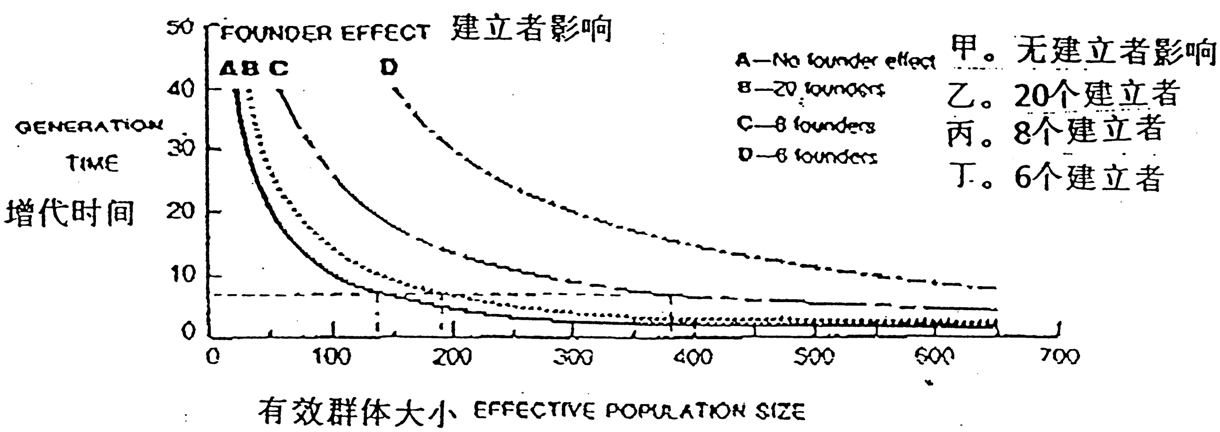
增代时间。基因多样性是一代代，而不是一年年损失的。因此，在同一个方案的特定时间内，繁殖期长的物种丧失基因多样性的机会要少一些。结果是，为了实现同一种基因目标，就繁殖期长的物种来说，有最低限度生存能力的群体就可以小一点。所谓增代时间，也就是，从质上来讲，是动物繁殖后代的平均年龄，而从量上来讲，是群体中，特定年龄的生存和能育性功能。这些可以自然发生变化，也可以通过管理来改变，也就是延长增代时间。

建立者的数量。所谓建立者，是来自于群体源(例如野生群)的一个动物，由它衍生出来一个群体，比如说，经过人工饲养而移殖到另外一个新地点，再不然，就是在强化管理方案最初执行的时候的个体。为了能够发挥作用，一个建立者必须有能力繁殖后代，同时在现存的群体中有其后代。从技术上来说，一个动物，要想成为一个全面的建立者，应当同群体源中的其他代表没有关系，同时也并非是近亲交配出来的。

基本上，建立者越多越好，也就是说，基因库的这个取样的代表性要强，同时，为基因目标而需要的有最低限度生存能力的群体要小。这里还有建立者数量影响的问题:建立者数量越多，数量随机情况引起的灭绝的可能性越小。但是，对于大的脊椎动物来说，到了某一点，就会有收获减少的现象(图八。)，起码就基因而言，有这种现象。由此说来，在建立一个群体的时候，一般都要有二十到三十个有效的建立者。如果满足不了这种要求，也就只好有多少算多少了。如果在阿拉斯加的冻土地带发现有一隻怀胎的雌性猛犸象，自然值得为这个物种设法发展出一个恢复方案，而不去考虑成功率低的问题。不过，一个方案如果坚持要有最适合的条件，这确实会提高成功率。

把原始基因多样性的百分之九十保留二百年

PRESERVATION OF 90% OF ORIGINAL GENETIC DIVERSITY FOR 200 YEARS



图八(Fig.8)建立者数量，物种增代时间和把原始基因多样性的百分之九十保留二百年所需要的群体有效大小。

Figure 8. Interaction of number of founders, generation time of the species, and effective population size required for preserving 90% of the starting genetic diversity for 200 years.

有效群体的大小。另外还有一个十分重要的考虑。这就是有效群体的大小，用Ne来代表。Ne与种群普查大小N不相同。Ne用以计量群体成员相互交配，以便把基因传给下一代的情况，通常小于N。以灰熊为例，Ne/N比例估计大约为0.25。(哈里斯与阿伦多夫合著，一九八九年)。其结果是，如果基因模型要求Ne为五百，才能够实现一套基因目标，有最低限度生存能力的群体有可能要多达两千。

生长率。生长率越高，群体由小恢复到大的速度越快，数量增加的结果可以减少数量上的危险，同时，也可以使所谓瓶颈效应时候损失的基因多样性，在量的方面减少。重要的一点是，要把有最低限度生存能力的群体同瓶颈大小区分开。

「群体生存分析」

由于考虑到许多因素，也就是有一系列目标和特点，而得出有最低限度生存能力的群体大小的过程，称之为「群体生存分析」，又称群体易受伤害分析。要想通过「群体生存分析」得出可以应用的结果，则需要有群体生物学家，管理人员和科研工作者相互作用的一个过程。「群体生存分析」已经应用于不少物种(即派克与使密斯合著，一九八八年;希尔等合著，一九八九年;巴卢等合著，一九八九年;莱希等合著，一九八九年;莱希与克拉克合著，付印)。

正如前边提到的，「群体生存分析」模型对基因和数量往往分别进行估计。基因模型显示，要想把基因库十分高的百分比维持几个世纪的话，则需要有几百个，乃至几千个群体。近来出现的一些模型已经可以同时对数量，环境的不稳定和基因的不稳定进行考虑。

对付数量和环境的随机性的最低限度生存能力的群体数量可能要高于保存住基因多样性的有最低限度生存能力的群体，尤其是希望在相当长的一段时间里有相当高的存活率的话。举例来说，百分之九十五的生存率有可能实际上需要有一个大群体，而且，这个群体所要持续维持的时间，可能会比要求有百分之五十生存可能性的群体持续的时间，大上二十倍;百分之九十生存率的时候，则只大十倍。从另外一种前景的角度来看，可以预期，在计算出来的等分时间来到之前，实际群体有百分之五十以上，有可能早已灭绝了。

大一些的脊椎动物物种的群体大小，几乎可以肯定需要有几百，乃至数千头，才有可能生存下去。就随机问题而言，多总比少好。

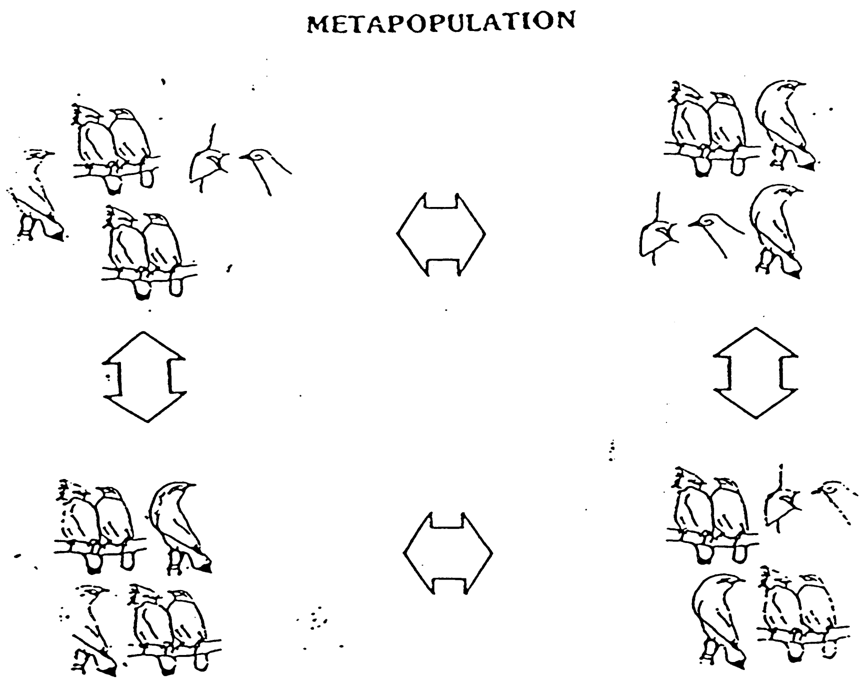
相互作用的群体和区域的最低限度

有最低限度生存能力的群体暗示，最低限度的，有关键意义的自然栖息地有可能难以，或者完全没有可能养活生存下去所需要的单一的，有连续性的群体中的数千个个体。

但是，如果把小一点的群体和保护地当做一个单一的，较大的群体(即相互作用的群体)来管理，而这些群体和保护地加起来等于一个有最低限度生存能力的群体(图九)，则小一点的群体也有可能生存下去，而小一点的保护地也会有养活群体的能力。实际上，把动物分到许多「亚群」之内，也有可能增加群体的有效大小，足以提高群体经受随机问题的能力。任何一个「亚群」都有可能因为发生这方面问题而灭绝，或者是几乎灭绝，然而通过其他「亚群」的再恢复，或者是补充，一个相互作用的群体就可以生存下去了。在自然界中，经常看到这种相互作用的群体，这种群体有其地方特色，也常常发生「亚群」的再恢复。

遗憾的是，野生群体支离破碎以后，再恢复所需要的迁移现象，有可能不会发生。因此，管理相互作用的群体的时候，要使动物移动，以纠正基因和数量方面发生的问题。(图十。)如此，在管理迁移的过程中，重要的一点是必须注意到迁移个体在基因和数量方面的情况。

相互作用的群体



图九(Fig.9)以许多「亚群」做为基础来管理相互作用的群体，以便使一个物种在野外可以生存下去。

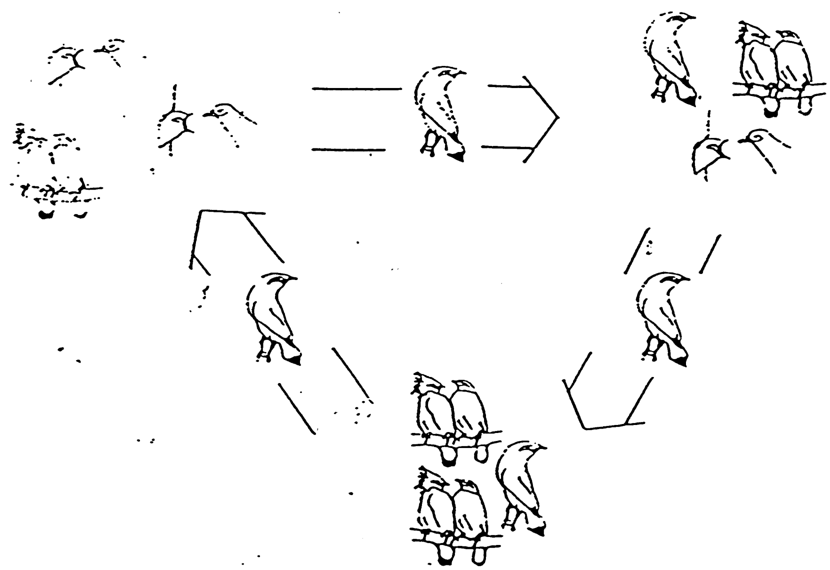
Figure 9. Multiple subpopulations as a basis for management of a metapopulation for survival of a species in the wild.

有管理的迁移仅仅是许多种加强管理和保护办法当中的一个。这些办法是保持群体在自然界生存下去所必须的和可取的。有最低限度生存能力的群体，从严格方面来讲，实际上暗示，这是一种善意的忽略。对于某一套要实现的目标来说，可以缩小有最低限度生存能力的群体的大小，再不然，如果是从另外一个角度来考虑问题，也可以延长特定大小的群体的持久时间，不过，在这种情况下，基因和数量问题，一经发生，马上就要通过管理上的介入而加以纠正。实质上，在这些措施当中，有 许多都有助于增加实际维持住的动物数量的Ne.，

就狼而言，这种动物已经受到管理介入。野生个体为数有限，由于受到人的打扰，要保护有生存能力的狼群体，十分困难，尤其是在人类发展已经使狼的潜在栖息地支离破碎的情况下，因

此计划把饲养的狼放回到大自然去。这种介入证明，在自然保护地和在这些地方生活的群体缩小的情况下，这些地方以及群体实际上是在变化成为一个特大动物园，因此，在基因和数量集中管理的问题上，要和管理饲养的群体一样。

对巴里灰掠鸟群体的迁移管理



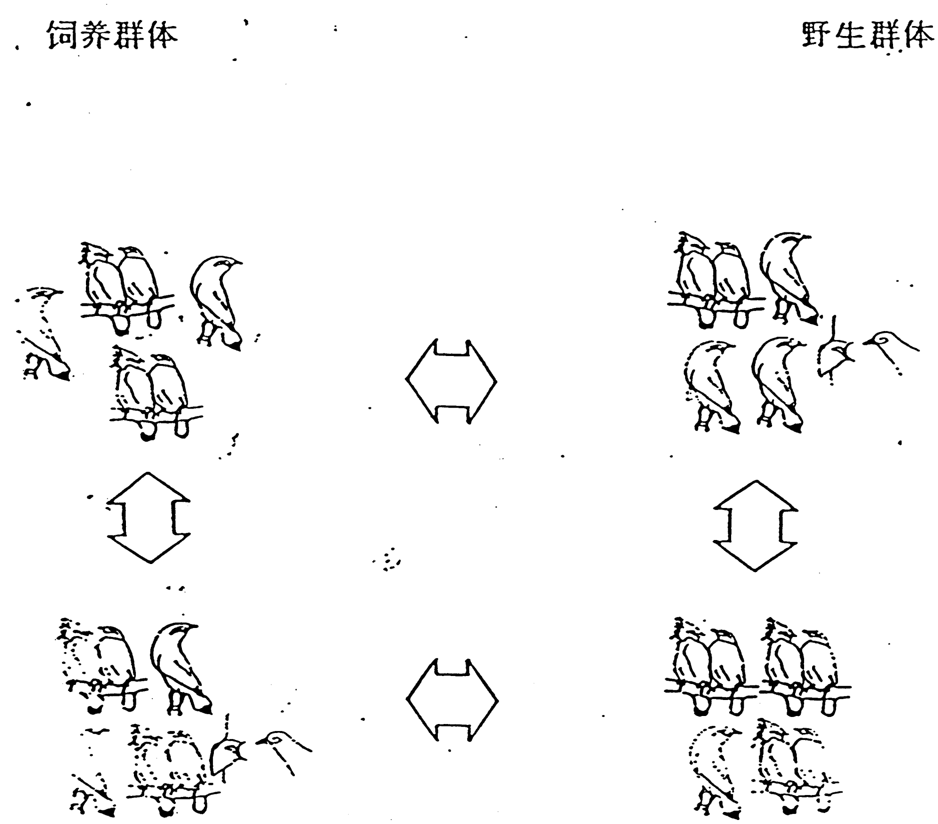
图十(Fig.10)管理亚群以维持相互作用的群体的基因流。

Figure 10. Managed migration among subpopulations to sustain gene flow in a metapopulation.

人工繁殖

增加物种生存能力的另外一种办法是用人工繁殖方法来增强野生群体。具体来说，人工繁殖有许多优点，其中有免受无法持久的开发利用，也就是没有偷猎问题;还有可以至少为群体的一部分缓解环境变化的影响;加强基因管理，从而增进对基因库的保护;加速群体向所需要的有最低限度生存能力的群体过渡的速度;可以加速把动物引入到新的地区，以及增加所要维持的动物的数量。

不过，这里要强调的一点是，人工繁殖的目的是强化而不是取代野外生存的群体。饲养的群体和动物园的作用必须是基因库和数量库的作用，定期向自然生境输送新的血液，以便重建灭绝的群体，或者是给因基因和数量问题而虚弱的群体以生机。



图十一。(Fig.11)利用饲养群体作为相互作用的群体的一个组成部分来扩大和保护一个物种的基因库。

Figure 11. The use of captive populations as part of a metapopulation to expand and protect the gene pool of a species.

大批濒危物种的生存会要依赖饲养群体的帮助，而且数量会越来越大。看来，理想的情况，同时又是不可避免的情况是，为物种制定保护策略的时候，要把野生及饲养群体结合进去，而这两种群体都处于相互作用的管理之下，以便能够彼此支援，都能够生存下去。(图十一)。饲养群体可以是对基因与数量材料具有关键性的一个库。野生群体，如果够大的话，可以使物种继

续受自然淘汰。国际保护自然与自然资源联合会已经采纳了这种总体战略。联合会目前建议，一个分类群，在数量上减少到一千以下，都要采取人工饲养办法。(国际保护自然与自然资源联合会，一九八八年)

物种生存计划

实际上有许多地区的动物园都在制定科学管理及高度协调着的项目来进行人工饲养，以补充野生群体。在北美地区，在美国动物园和水族馆协会(AAZPA)主持下，已经开展了这方面的努力，由国际保护自然与自然资源联合会的物种生存委员会的人工繁殖专家组配合工作(IUCN SSC CBSG)，称之为物种生存计划。(SSP)

饲养群体可以发挥帮助作用，然而前提是饲养群体的基础必须是有生存能力的群体。这也就是说，需要有尽可能多的建立者，尽快把群体正常发展到有几百个个体，同时，在基因和数量上，十分注意管理。这就是物种生存总计划的目的。也可以利用饲养项目来进行科学研究工作，以利管理饲养和野生群体，并使二者之间有相互作用。

饲养/野生策略的一个典型例子是美国鱼和野生生物管理局恢复计划/物种生存总计划共同搞的红狼项目。饲养的红狼大部分都是在华盛顿州的一个特殊场所繁殖的，然而，现在，有越来越多的动物园为红狼人为创造了自然生境，特别是那些历来是野生红狼出没的地方。

另外的一个把饲养同野生群体结合管理的突出的保护与恢复策略是用在黑足貂上的策略。显然，这个物种目前只有在饲养条件下才能够生存下去。由于建立饲养群体的决定，迟迟没有做出，这个物种的处境已经危险到，把所有的黑足貂都饲养起来，看来才是唯一出路。加利福尼亚州秃鹰也是这样。如果早一点采取行动来建立饲养群体，或许还可以有另外的选择办法。在波哥亚马孙鹦鹉和普通的鸽子的问题上，就有另外的选择办法。考虑到生存规律已经显示，黑足貂幼仔死亡率高，这暗示，在野外会死亡的那些幼仔从群体中移出以后，对群体不会有影响，或者只稍微有一点影响。对于许多动物和鸟类来说，情况都是这样。美国动物园和水族馆协会以及国际保护自然与自然资源联合会的物种生存委员会目前在世界各地都参加这种项目和策略。

「群体生存分析」

莱希

在仅剩下的一些自然区域，保护地，以及甚至在动物园里，一度十分大，有连续性和多样性的野生群体，现在都已经缩小到孤立的，支离破碎的小群体了。举例来说，黑犀牛过去有几十万，分布在非洲撒哈拉沙漠以南地区，如今，只有几千头生活在很少的几个公园和保护地上，每一个地区只能够养活几头，最多几百头。波哥亚马孙鹦鹉也是这样。这种鹦鹉是波多黎哥特有的，过去遍布整个岛屿，隻数也许不下一百万。到了一九七二年，仅剩下了二十隻(其中有四隻是饲养的)。大力下工夫的结果是这种鹦鹉稳健恢复，到了一九八八年年底，野生的，有三十四隻，而饲养的，有四十六隻。可是，在一九八九年，野生波哥亚马孙鹦鹉的生境和饲养群体所在的卢基约森林严重遭到飓风的破坏，看来，野生鹦鹉有一半遇难，它们筑巢的树木，大部分被毁掉，食物来源大量减少，因此，目前的野生群体是否有生存能力，值得怀疑。

群体变小，同时又与同类的其他群体隔绝的时候，这个群体则面对着许多不利于生存的基因和数量问题，尤其是偶然性问题，例如传染病的发生和发生的时间，所繁殖的后代的性别比例有偶然性的波动等，即使是孟德尔基因传递的偶然性，这时也可能比其他问题，例如群体是否有够大的栖息地，是否已经完全适应于这种生境，以及平均出生率大于中间死亡率等更重要。一个群体变小，陷于孤立的时候，基因和数量程序就会相互发生作用，形成令人情绪颓丧的，然而取名妥当的灭绝漩窝。近交衰退引起的基因问题以及对生境不适应的问题会使小群体变得更小，使寻找配偶和繁殖后代的不稳定性进一步加剧，结果是数量再减少，近亲交配现象增加，基因多样性减少。这样，群体就会加速走向灭亡。群体的大小若小于有可能使其被卷入灭绝漩窝的时候，，则把这种群体的大小称之为有最低限度生存能力的群体。

一个群体的最终灭绝通常是概论的，可能是遭到一，两年坏运气的后果，尽管最初的衰落是捕猎过渡和栖息地被破坏。近来发展的一些技术允许我们系统研究使小型孤立的群体受到威胁的数量和基因程序。把分析技术同模拟技术结合在一起以后，可以估计出一个群体生存到将来某一个时间的可能性。这个程序称之为「群体生存分析」(苏莱著，一九八七年)。如今，我们仍

然没有能够把所有的因素都输入分析与模拟模型(而同时也不了解我们所忽略的因素究竟有多重要，「群体生存分析」的结果，几乎可以肯定说是低估了群体灭绝的真正可能性。

「群体生存分析」的真正价值不在于粗略估计灭绝的可能性，而在于辨认清楚使群体受到威胁的各种因素的重要性，同时评估出，各种有可能采取的管理行动的价值(就提高群体坚持下去的可能性。公认为濒危物种中有少数物种已经恢复到足以不再被列为濒危物种;然而，也有一些，尽管受到保护，进行了恢复群体的努力，然而仍旧灭绝。这说明小群体受到的威胁的严重程度，同时也说明，有必要有一种更集中的，更系统化的恢复计划，动用一切可以利用的人力资源，分析资源，生物学资源以及经济资源。

支离破碎小群体的基因程序

在一个繁殖群体的数量为几十，或者是几百(而不是几千，或者更多)的时候，偶然事件会对基因和演变情况起主导作用。在没有选择的情况下，每一代都是上一代的偶然基因样品。在这种样品小的情况之下，基因变异(等位基因)的频数，由于偶然性机会，可以使下一代与上一代明显不同，一个群体也可能完全丧失变异。这个过程就叫做基因漂变。基因漂变是累积性的。等位基因频数没有恢复到原来状态的趋势(然而偶然也有这种可能性)，因此，一个变异祗要失去，便不可能复得，除非是通过突变，或者是从其他群体的迁移而重新引进。突变十分少见(不论对什么基因来说，都是百万分之一的机会)，以至于在小群体中，在人们所关注的时间范围内，基本上，无足轻重(莱希著，一九八七年)。通过迁移而恢复的变异，也只有在有其他群体，而这些群体又有可能作为基因材料来源的时候才有可能发生。

基因漂变(遗传漂变)，由于是随机过程，同样，也是非适应性质的。在少于一百个繁殖个体的群体中间，漂变可以淹没最强选择以外的一切影响:适应性质的等位基因可以因为漂变而丧失，结果群体中留下了有害的基因方差(也就是基因缺陷)。举例来说，佛罗里达豹有可能是群体中间一个十分有害的基因，从偶然性转变成为普遍性而造成的结果;尾巴上有一个结，恐怕是佛罗里达豹一个不十分有害的(至多是中性的)，然而却几乎已经完全固定下来的一个特征了。

在小群体中，基因漂变伴随着近亲交配而出现。这就是有基因关系的个体的相互交配。当交配的个体少的时候，近亲交配在所难免，成为普遍现象。近亲交配的动物有先天性缺陷的比率高，生长缓慢，死亡率大，生殖力低(近交衰退)。关于实验室使用的动物，家畜，(福尔克纳著，一九八一年)动物园饲养的动物(罗尔斯等著，一九七九年，罗尔斯，巴卢合著，一九八三年，以及罗尔斯等著，一九八八年)以及一些野生群体的近交衰退情况，已经有大量文献了。佛罗里达群岛鹿的幼鹿多半是雄性的，也有可能是近亲交配的结果，很少有一胎两仔，也可能是这原因。

近交衰退基本上可能是稀有的有害等位基因造成的，是稀有的有害等位基因的表现形式。许多群体都有一部分隐性有害等位基因(也就是群体的基因负担)。这种基因的影响往往是掩盖起来的，因为在任选的一个有繁殖力的群体中，总会有几个个体接受一个有害等位基因的两个相同的遗传基因。由于亲体在血缘上有关系，共有一些基因，因此，近因交配的动物有稀有等位基因的可能性就大一些，有同型结合体现象。如果经过选择而有效去掉小群体中间的有害倾向，逐步繁殖的群体就会去掉基因负担，即使再近一步近亲交配，也不会有多大问题。在十分小的群体当中，偶然性的漂变比选择性要强的多，因此，那些肯定是有害的倾向会普遍化(佛罗里达豹的隐结和群岛鹿多是一个性别的幼仔)，最终结果是使一个群体灭绝。

由于基因漂变而损失以基因方差形式出现的基因多样性，还有其他长期后果。一个群体越来越同一性质，就会越来越容易受到疾病，新的天敌，变化着的气候，以及其他环境变化的影响。当一切都是一样的时候，当适应能力不足的时候，即使是选择，也不能够再对适应力较强的群体发挥有利作用了。从某一种意义来说，每一种灭绝都是一个群体不能够对变化中的环境迅速适应的结果。

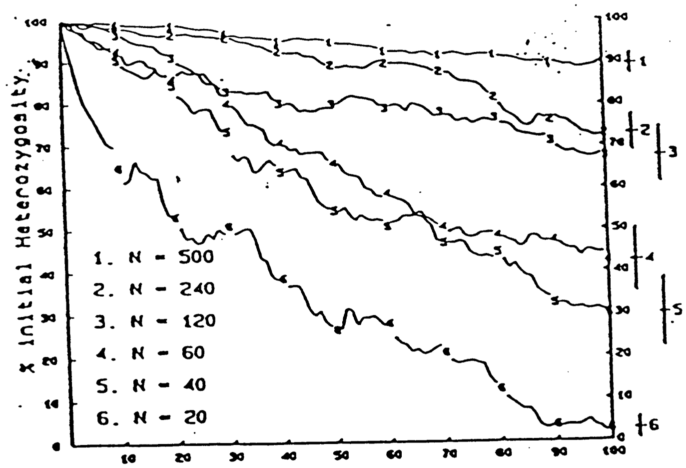
为了避免发生近亲交配的近期影响和基因变异的长期损失，一个群体必须是大群体，或者，至少要在一代，或者几代的时间内，渡过数量小的阶段(瓶颈)。波哥亚马孙鹦鹉增代时间长，所以目前的瓶颈，只存在于一，两代时间，希望能够在另外的一代时间结束之前，在进一步的基因衰退发生之前，能够摆脱这种情况。群岛鹿看来几千年一来都处在瓶颈当中，或许已经有两到三千代了。尽管我们还不能够预测，任何一个群体会损失什么基因变异(也就是基因漂变的性质)，然而我们却能够使预期的平均损失率具体化。图十二说明不同大小的任选繁殖群体的基因变异的中间数字。丧失基因变异的平均率(以异型结合性，数量倾向的加性变化，或者是等位基因频变的二项式方差来测量)可以因漂变而下降：

$$V_g(t)=V_g(o)x(1-1/(2Ne))^T$$

其中V_g是t代的基因方差，Ne是有效群体大小(如下)，或者大约是任选的一个繁殖群体中有繁殖力的个体的数量。图十三说明基因损失方差在不同群体有很大差异;有一些群体有可能(偶然机会)高于，或者低于图十二的平均数。在我们所关注的群体当中，可以接受的基因变异损失率取决于群体健康同基因变异的关系，健康水平下降的程度是否可以接受，以及人类对于保护野生群体的自然变异所寄于的价值等。就近期而言，已经观察出，基因变异(异型结合)减少百分之一，---这相当于近亲交配变异悉数百分之一的增长---使健康的某一些方面(生殖力和生存力)下降百分之一到二。这是在一些不同的群体中观察到的(福尔克纳著，一九八一年)。通常，饲养家畜的人可以接受每一代低于百分之一的近亲交配，认为这不会引起严重退化。在不同物种和一个物种的不同群体中，健康同近亲交配的关系，十分不同，有一些近亲交配程度很大的群体，不但能够生存，而且繁殖也很好(如海象，欧洲野牛和四不像)，而对其他许多群体的近亲交配努力，却使近亲交配的个体大部分，或者全部死亡(福尔克纳著，一九八一年)。
丧失基因适应性引起的关注又引出了这样一个建议，那就是对于濒危分类群的管理计划，必须争取做到保持原始群体的基因变异的百分之九十(福斯等著，一九八六年)。一个群体对于选择的适应性反应同选择出来的特性的基因变异成比例，因此，争取保留住百分之九十，就可以保住一个群体有原始群体百分之九十的适应能力。这样，就一百年期限来说，一个中等大小，增代时间为五年的脊椎动物，每一代的基因变异损失平均是百分之零点五，换言之，任选的一个群体要大约有一百个有繁殖能力的个体。

群体大小相比较

原始异型结合性



1.种群普查大小 = 500
2.种群普查大小 = 240
3.种群普查大小 = 120
4.种群普查大小 = 60
5.种群普查大小 = 40
6.种群普查大小 = 20

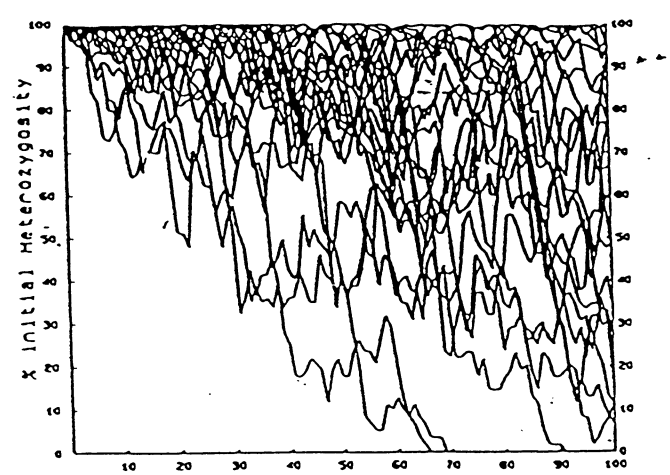
代 Generation

图十二(Fig. 12).基因漂变引起的基因变异平均损失(以异型结合，或者是基因变异加性来测量)。这是二十五个计算机模型模拟出有二十，五十，一百，二百五十和五百个任选的繁殖个体的群体情况。此图取自莱希所著，一九八七年。

Figure 12. The average losses of genetic variation (measured by heterozygosity or additive genetic variation) due to genetic drift in 25 computer-simulated populations of 20, 50, 100, 250 and 500 randomly breeding individuals.Figure from Lacy 1987a.

基因漂变 ----- 过程中的变化

最初异型结合性



Generation

代

图十三(Fig.13).有任选的一百二十个繁殖个体的二十五个群体在基因位点上的异型结合损失情况，由计算机模拟出。莱希所著，一九八七年

Figure 13. The losses of heterozygosity at a genetic locus in 25 populations of 120 randomly breeding individuals, simulated by computer. Figure from Lacy 1987a.

大部分群体，不论是自然的，重新引进的，还是饲养的，都是由少数个体建立的，一般都比最终的遗传载体数量要少的多。在「瓶颈效应」(建立者影响)最初发生的时候，基因漂变速度可以特别快。群体小的时候就是这样。为了最大限度减少建立者影响造成的基因损失，管理下的群体，最初要有二十到三十个建立者，同时群体要尽可能扩大，达到最终的遗传载体量。(福斯等著，一九八六年，以及莱希所著，一九八八年及一九八九年)。一个最初的群体，有了二十个有繁殖能力的建立者以后，这个群体大约就可以有建立者来自的群体源的百分之九十七点五的基因变异。随着群体中个体的增加，每一代有百分之二点五的损失率，还可以降低。在建立者「瓶颈效应」发生的时候，基因变异损失十分快，因此，一个管理下的群体的最终的遗传载体数量有可能要比上边所说的一百个有繁殖能力的个体还要多得多，才可能使基因损失总数维持在百分之九十以下(或者是订出的其他指标)。

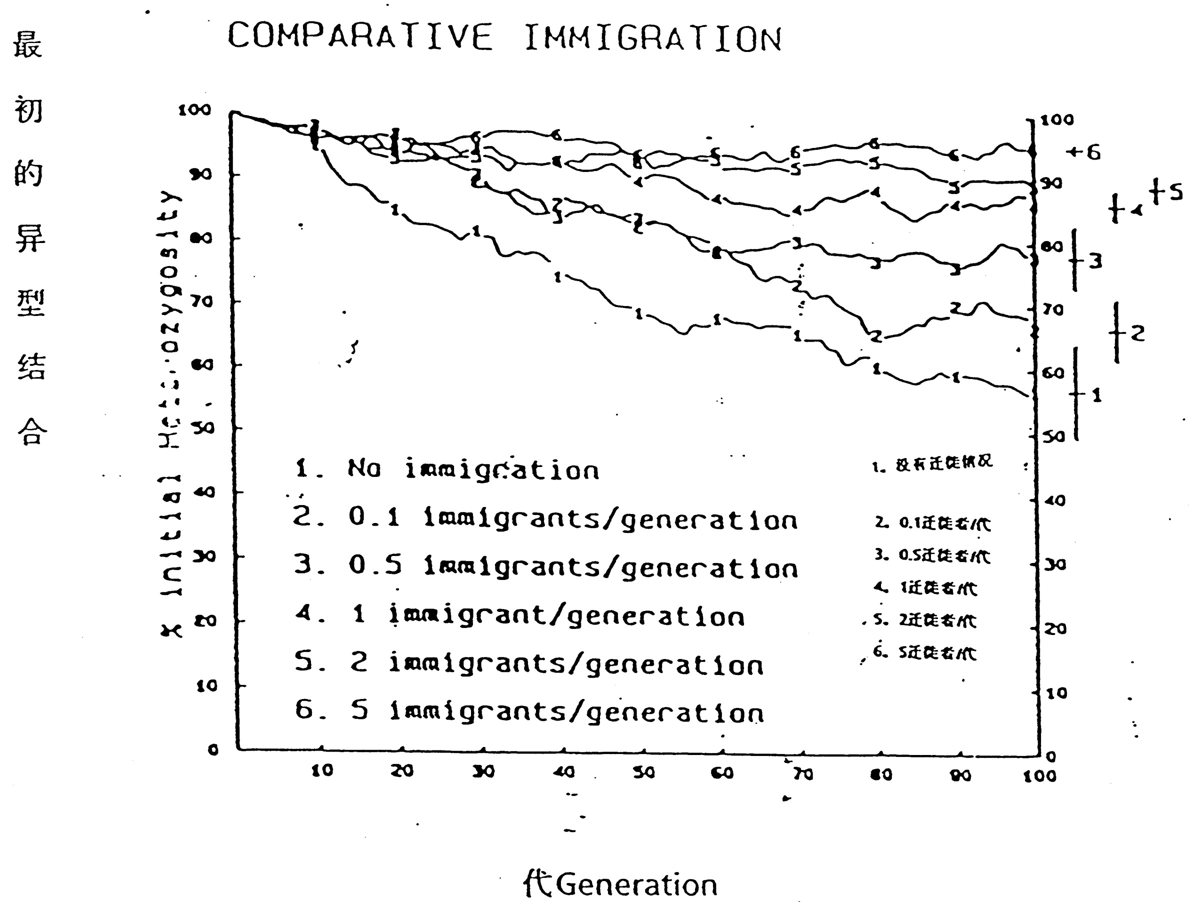
上述等式，图表以及计算结果的根据都是群体随机繁殖，然而，在自然群体中，如果有随机繁殖，那也十分罕见。所谓有效群体大小，指的是一个随机繁殖的群体的大小(这个群体的配子聚合是任意的)，而这个群体由于基因漂变而损失的基因变异率同所关注的那个群体完全一样。如果繁殖个体在性别比例上不平等的话，大于一生中的繁殖过程的随机变化时，或者是群体数量波动时，变异的损失率则会大于一个随机繁殖的群体，使群体的有效大小缩小。如果相关的变数可以衡量的话，那么，每一个因素对于Ne的影响，则可以用标準群体基因公式计算出来。(克劳同木村合著，一九七〇年，兰格同巴罗克拉夫合著，一九八七年)。对于许多脊椎动物来说，进入生殖年龄，转入生殖群体以后的那些个体，繁殖情况大体上是随机的，因此，初步概算的时候，可以把每一代中有繁殖能力的个体总数看成为群体的有效大小。在饲养的群体中(死亡率相对低，而数量稳定)，群体的有效大小往往是普查群体大小的二分之一，或者是四分之一。在野生群体中，(在这种群体中，许多动物在没有到达繁殖年龄之前就会死去)Ne/N的比例，难得超出这个幅度，经常低于这个比例。

为了使中等大小的一个动物的基因损失减少到最低限度，群体的大小，可以按照上边提到的计算，使Ne等于一百，而N为二百到四百。一个群体的生活史特点，在建立者瓶颈效应发生时候预期的损失，管理计划在基因方面要实现的目标，以及管理期的长短，这些能够，而且也应该使我们可以取得并确定一个引起关注的饲养群体的一些较精确的估计数字。

尽管，任意一个小群体在一定的代数的时候都有可能灭绝，然而，群体不见得完全隔绝于同种。大部分物种的分布都可以用相互作用的群体来形容，也就是说，有许多半孤立状态的群

体，而每一个群体中都会有随机交配。群体分散可以放慢基因漂变引起的基因损失，也可以在群体缩小以后再变大，再者，还可以在当地群体灭绝的情况下，重新恢复生境中的这种物种。

比较迁徙情况

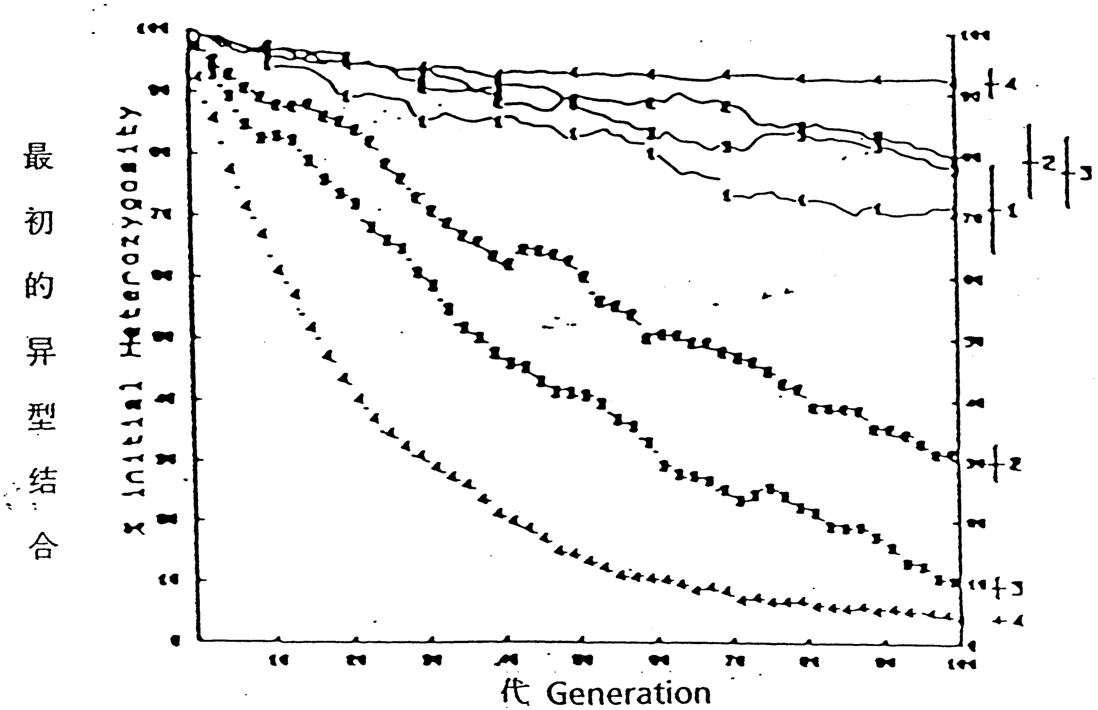


图十四。(Fig.14).大型群体源对于有一百二十个繁殖个体的群体所起的迁入作用。每一条线都代表二十五个计算机模拟的群体的中间异型结合情况(相当于一个群体中二十五个非联系着的基因位点的中间异型结合情况)。右边是标準误差线。取自莱希，一九八七年。

Figure 14. The effect of immigration from a large source population into a population of 120 breeding individuals. Each line represents the mean heterozygosity of 25 computer-simulated populations (or, equivalently, the mean heterozygosity across 25 non-linked genetic loci in a single population). Standard error bars for the final levels of heterozygosity are given at the right. Figure from Lacy 1987a.

如果有一个十分大的群体，可以连续作为一个小的，孤立的群体的基因来源的话，那么，即使是偶然才发生迁徙一次(一代只有一个个体)，也可以避免使这个孤立的亚群损失相当数量的基因多样性(图十四)。通常的情况是，一个作为基因来源的群体的大小不足以防止基因漂变现象，而另外一个普遍现象是相互作用的群体被分割为许多小的，孤立的群体，而每一个都受随机力量的影响。每一个亚群内部都会损失基因多样性，然而，由于不同的变异是亚群偶然损失掉的，所以整个相互作用的群体还会保留住最初基因多样性的大部分。(图十五)。亚群中间，即使只有一点交流(每一代只有一个迁移者)，然而这也会使每一个亚群都能够保住基因的多样性。这是因为重新引进了基因漂变的时候损失掉的基因变异。(图十六)。即使迁移量十分小，然而这仍然也能够抵销基因漂变的影响，因此，一个小群体如果绝对孤立，则这会对这个群体的基因多样性有十分大的影响(同时，也会对群体的数量稳定有十分大的影响)。群体基因理论已经阐明，任何一个完全孤立的小群体都不可能长久存在下去。

绝对性的再划分

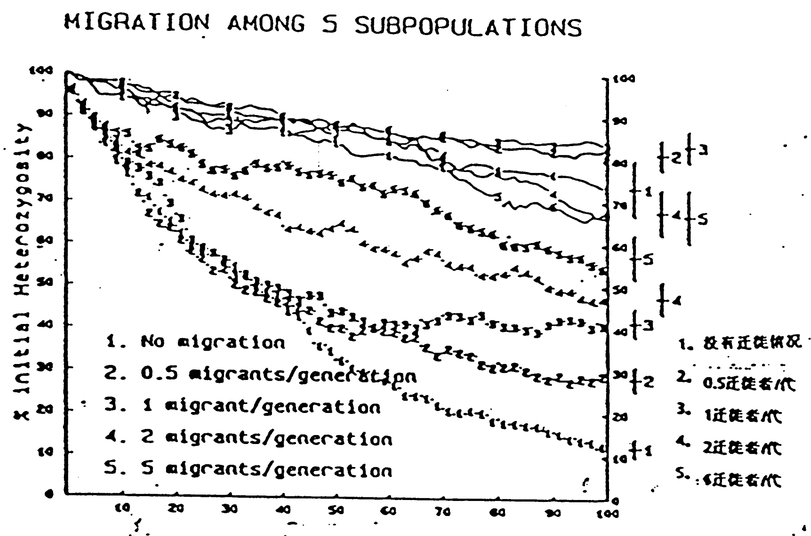


图十五。(Fig.15).把一个有一百二十个有繁殖能力的个体的群体分成为一个，三个，五个，或十个孤立的亚群造成的影响。虚线(数字)说明二十五个计算机模型模拟出来的亚群内的异型结合的中间数字。线代表模拟相互作用的群体中的全部基因多样性。取自莱西著，一九八七年。

Figure 15. The effect of division of a population of 120 breeders into 1, 3, 5, or 10 isolated subpopulations. Dotted lines (numbers) indicate the mean within-subpopulation heterozygosities from 25 computer simulations. Lines represent the total gene diversity within the simulated metapopulation. Figure from Lacy 1987a.

五个亚群之间的迁移情况

最初的异型结合



代 Generation

图十六。(Fig.16)在有一百二十个有繁殖能力个体的群体当中，五个亚群相互迁移以后的影响。虚线(数字)表明二十五个计算机模型模拟出来亚群中间的异型结合的中间数字。线代表相互作用的群体的基因多样性总情况。取自莱希著，一九八七年。

Figure 16. The effect of migration among 5 subpopulations of a population of 120 breeders. Dotted lines (numbers) indicate the mean within-subpopulation heterozygosities from 25 simulations. Lines represent the total gene diversity within the metapopulation. Figure from Lacy 1987a.

参考著作

「基因漂变与等位基因损失同异型结合相比」，F.W.阿伦多夫著，一九八六年.动物园生物学 5:181-190

「佛罗里达豹的群体生存分析」，向美国鱼和野生生物管理局提出的报告。J.D.巴卢，T.J.福斯，R.C莱希合著，一九八九年。美国明尼苏达州，艾波谷，国际保护自然和自然资源联合会物种生存委员会饲养专家组。

「数量，环境不稳定与螺鸢配偶遗弃情况」，S.R.贝辛格著，一九八六年。生境 67:1445-1459

「群体基因理论入门」，J.F.克劳同M.三村合著，一九七〇年，纽约哈珀与罗出版社。

「数量基因入门」，D.S.福尔科纳著，一九八一年。纽约朗曼出版社，第二版。

「繁殖计划」，T.J.福斯，R.弗莱斯涅斯，N.R.拉勃同B.李德合著，一九八六年。动物园生物学 5:139146

「小群体的演变」，I.R.福兰克林，一九八〇年，苏莱同威尔克斯序。保护生物学第135至150页。

「在管理下小群体中对于保护等位基因同基因异型结合的考虑」，P.A.福尔斯特与T.丸山合著；一九八六年，动物园生物学5:171-180

[空间结构和群体易受伤害性」，M.E.吉尔平，一九八七年。有生存能力的群体的保护，麻萨诸塞州，坎布里奇，坎布里奇出版社，第125至139页。

「有最低限度生存能力的群体:物种灭绝过程」M.E.吉尔平与M.E.吉苏莱合著，一九八六年。保护生物学。:稀有同多样性的科学。麻萨诸塞州桑德兰，第19至34页。

[偶然性灭绝的统计学」D.古特曼，一九八七年。有生存能力的群体的保护，麻萨诸塞州，坎布里奇，坎布里奇出版社，第11至34页。

[生态学:小群体动物模拟模型」，J.W.格里尔，一九八零年。创造性计算出版社 。6:116-322

「白头海雕群体活力的模拟办法」，J.W.格里尔，一九八零年。野生生物协会通告，8:316-322

「通过再引进而建立起来的建立者群体的活力」，J.W.格里尔与J.H.巴尔克莱合著，一九八八年。迁徙隼群体。爱达荷州博伊斯，迁徙隼基金会，第698至700页。

「大型哺乳动物在基因上的有效群体的大小:对估计量的评估」，R.. 里斯与F.W.阿伦多夫合著，一九八九年。保护生物学，付印。

「国际保护自然和自然资源联合会关于人工饲养的声明」。国际保护自然和自然资源联合会，一九八八年。

「管理下的群体的基因多样性损失:基因漂变，突变，迁徙和亚群的相互作用」，R.C莱希著，一九八七年。保护生物学，1:143-158.

「进一步分析犀牛小群体的基因同数量」，R.C莱希著，一九八七年。厚皮动物，9:16-19

「饲养动物群的基因变异:评估过去的损失，目前的现状，以及未来的瞻望」R.C莱希著，一九八八年。美国动物园与水族馆协会年度刊物，113-121

[对谱系中建立者代表的分析:相当于建立者与建立者基因组」，R.C莱希著，一九八九年。动物园生物学，8:111-124

「对于波哥亚马孙鹦鹉的群体生存分析与建议」，R.C莱希，U.S.希尔同N.R.弗莱斯涅斯合著，一九八九年。向美国鱼和野生生物管理局提出的报告。美国明尼苏达州，艾波谷，国际保护自然和自然资源联合会物种生存委员会饲养专家组。

「东部条文害鼠的群体生存分析」，R.C莱希同T.W.克拉克，一九八七年。小群体的管理与保护，芝加哥，芝加哥动物协会(付印)

「群体有效大小，基因变异以及在群体管理中的应用」，R.兰德同G.F..巴尔克劳合著，一九八七年。有生存能力的群体的保护，麻萨诸塞州，坎布里奇，坎布里奇出版社，第187至223页。

「对热带森林物种多样性减少的估计」，A.E.卢格著，一九八八年。生物多样性。华盛顿特区，全国学院出版社，第58至70页。

「分子演变基因」，M.内著，一九八七年。纽约，哥伦比亚大学出版社。

「自然群体中间基因多样化同传染病的相互作用」，S.J.奥拜恩同J.F.埃弗曼合著，一九八八年。生态与演变动态，3:254-259

「美国鱼和野生生物管理局恢复计划/物种生存计划为红狼制定的总计划草案」，W.派克同R.史密斯，一九八八年。生物多样性。华盛顿特区，全国学院出版社，第58至70页。

「灭绝:动物园的教训」，K.罗尔斯同J.D.巴卢合著，一九八三年。基因与保护，加洲门罗园，第164至184页。

「对致命等量的估计和哺乳动物近亲交配的代价」，K.罗尔斯，A.R.坦普尔顿同J.D.巴卢合著，一九八八年。保护生物学2:185-193

「有蹄类小群体的近亲交配与幼仔死亡率」，K.罗尔斯，E.T.佐恩同J.巴卢合著，一九七九年，科学，206:1101-1103

「保护生物学与黑足貂」，U.S.希尔，E.T.佐恩，M.A.伯甘同S.H.安德森合著，一九八九年，纽黑文，耶鲁大学出版社。

「物种保护的最小限度群体大小」，M.L.谢弗尔，一九八一年，生物科学，31:131-134

「有最低限度生存能力的群体:应付不测问题」，M.L.谢弗尔，一九八七年。有生存能力的群体的保护，麻萨诸塞州，坎布里奇，坎布里奇出版社，第69至86页。

「千年方舟:航行时间要多久，客仓要有多少间，旅客要有多少?」，M.苏莱，M.E.吉尔平，W.康威，同T.福斯合著，一九八六年。动物园生物学5:101-114

「把基因组全部传给一千代的可能性」，E.汤普森，群体生存分」和管理的分析方法，(準备付印)

「怀厄明州黑足貂人工繁殖努力」，E.T.佐恩同别利茨基合著，一九八九年，保护生物学与黑足貂，，纽黑文，耶鲁大学出版社。

「建立孤立的狮子群体的繁殖与基因后果」，D.E.维尔特，M.布什，K.L.古德罗，C.派科，A.E.普瑟，J.L.布朗，P.乔斯林同S.L.奥部赖恩合著一九八七年。自然，329:328-331

基因词汇

脱氧核糖核酸

脱氧核糖核酸;含有通常称为核苷酸单位的分子链。这是把从一个细胞，或者是生物体遗传下来的信息，保存和传递给下一个的材料。脱氧核糖核酸在细胞核的染色体上;另外一部分在立线体中，这部分虽然少一点，然而却也有相当数量。

基因

脱氧核糖核酸中构成有遗传功能的单位的那一节。

位点(基因)

即基因在脱氧核糖核酸中占据的那一部分。基因和位点经常可以替换使用。

等位基因

基因的交替形式。严格说来，等位基因指的是一个基因中可以决定交替特点的不同的表现形式。然而，从广义来说，指的是一个基因的两个不同板样，也就是每一个二倍生物体在每一个位点上的基因的两个板样。

等位基因或者是基因频数(频率)

一个群体中所有代表着一个特殊等位基因样的比例。

基因型

一个个体作为一个基因的两个板样所有的各种等位基因，举例来说，如果在一个位点可能有两个等位基因(A,a)，则就有可能有三个基因型，AA,Aa同aa.

异型结合

一个群体中，在一个位点上有异型结合的个体的比例(也就是说，有不同作用的，不同的等位基因)。

哈迪 -- 温伯格平衡

这是群体基因的一个原则，以等位基因的频数为基础来预测基因型的频数，前提是假设这个群体随机交配时间至少已经有一代了。在最简单的情况下，在一个位点上有两个等

位基因(A,a)，而这类等位基因的频数为P_A与P_a，则根据哈迪--温伯格平衡可以预测，在一代随纪交配以后，基因型的频数将是$AA=P_A^2$;$Aa=2P_AP_a$;$aa=P_a^2$.

预期的异型结合

这就是一个群体如果保持哈迪--温伯格平衡，预期会有的异型结合。预期的异型结合是由等位基因频数计算出来的，是随机交配预期在后代会出现的异型结合。1-SUM p_i's,而p_i=等位基因频数i。

基因多样性 = 建立者等位基因多样性

目前的群体预期会有的异型结合，而这个群体同建立者来源于的那个野生群体有关系。基因多样性有的时候可以用P来代表。$P=H_t/H_o$ 而H_t与H_o在t时与o的预期异型结合。如此，群体保留的基因多样性则是野生群体的一小部分。

基因组

一个个体的全套基因(等位基因)。

基因漂变

这一代同下一代由于等位基因实际上由亲体随机传给后代而在等位基因频数上发生变化。这种随机变化在群体传到下一代而数量变少的情况下，也就是基因样变少的情况下，会加大。

瓶颈

建立者传下来的系谱中有一代只繁殖一个，或者几个后代，因此建立者的等位基因没有全部传给下一代。

建立者

一个取自群体源(野生)而可以实际繁殖后代的个体，并在现存的，衍生群体中(饲养群体)有其后代。

建立者代表

从某一个建立者衍生出来的群体，在任取时间的基因比例，或者是部分。

现有代表

群体中现有的建立者代表的比例。

目标代表

希望达到的建立者代表的百分比，或者是作为目标而要达到的百分比。目标数字和群体中生存下来的每一个建立者的基因组部分成比例。能够实现这类目标代表价值，则可以最大限度保存基因多样性。

原始建立者等位基因

建立者在每一个位点的每一个基因的等位基因总数。原始建立者等位基因数量两倍于原始建立者基因组。

原始建立者基因组

一个建立者的全套基因，其总合则是建立者基因组。原始建立者基因组是原始建立者等位基因的二分之一。

建立者存留下来的等位基因

群体中每一个位点存留下来的等位基因数量，前提是假设每一个建立者在每一个位点上都把两个独特的等位基因带入衍生(饲养)群体。

建立者存留下来的基因组

群体中尚有的原始建立者基因组的数量。这种公制单位衡量群体谱系发生瓶颈效应而损失的原始多样性的多少。

建立者基因组等价体

为了维持目前饲养群体的基因多样性而需要从野外新捕获来的动物的数量。这种公制单位反映出发生的瓶颈效应和建立者代表不一致的时候所受到的损失。

建立者等价体

等价代表所要有的数量，以产生在现有群体中所观察到的同样的基因多样性。前提是承认瓶颈效应已经使建立者等位基因损失掉。建立者等价体用以衡量基因多样性的损失，而这类损失是现存群体中的建立者谱系的不均匀代表所引起的。

有效群体大小

这是发展出来的一种概念，用以反映出，在一个群体中，不见得所有的个体，在把基因材料传给下一代的时候，都有相等的贡献。或许有的还根本没有。有效群体大小用Ne来表示，其定义为，一个理想群体的大小应当和目前在考虑中的真正群体有同样的基因漂移(漂变)。一个理想群体为，可以有性繁殖;有随交配;有等量性别比例;有普瓦松家系大小，即一生中繁殖的后代;稳定的年龄分布与群体大小的稳定性，即数量上的稳定性。

亲缘悉数

从群体中一个个体任取的一个等位基因在第二个个体中由于有共同的祖先而出现的可能性。有同样情况的，是在两个个体中，由于两个个体都出自于同一个祖先而具有相同基因的比例。一个动物的近亲交配系数等于亲体亲缘关系的二分之一。

平均亲缘

一个动物以及现存的，衍生下来的群体中的所有动物(建立者除外)的中间，或者平均亲缘系数。中间亲缘系数两倍于同建立者有亲缘关系的衍生群体的基因丧失率，同时，也两倍于随机交配繁殖的后代的中间，或者是平均近亲交配的系数。

统计数量辞汇

年龄　　以年计算的年龄分类

P_x　　具体年龄生存

任取年龄的动物生存到下一个年龄分类的可能性。

L_x　　活到某一具体年龄

新生幼仔活到任取的年龄分类的可能性。

M_x　　具体年龄能育性

在一定的年龄分类中的动物繁殖的后代的平均数字(同亲体性别相同)也可以解释为有繁殖能力的动物的平均百分比。

r　　即刻变化率

如果 $r<0$...........群体在减少

如果 $r=1$...........群体稳定(数量不变)

如果 $r>1$...........群体增加

希腊字母Λ　　群体每年变化的百分比

如果希腊字母$\Lambda<0$...........群体在减少

如果希腊字母$\Lambda=1$...........群体稳定(数量不变)

如果希腊字母$\Lambda>1$...........群体增加