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Information Report on the Status of the Monk Seal in the Mediterranean

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1. INTRODUCTION

Population censuses showing how many monk seals may remain in different areas of the Mediterranean, together with an idea on the direct causes of death are useful but not enough to understand the real status of the species and to help policy making for their conservation. Such information constitute only basic data needed.

Documents providing such information have been prepared by RAC/SPA in the past (UNEP-MAP RAC/SPA 1995; UNEP-MAP RAC/SPA 1999) The information reflected within them is still valid, apart of the need of an actualisation on the number of seals mentioned for each area, always decreasing. Table 1 has been prepared in order to address this topic. It presents the most recent validated data regarding the population of Mediterranean monk seal presently remaining along all its range. It seems clear from this table, that the population is under threat and that coordinated conservation actions are still needed.

The main target of every conservation programme for a threatened species must be to reduce its extinction risk (Ballou 1993). According to Ballou, such risk is much amplified whenever the population size is small, because fortuitous causes add to environmental ones. e.g. : births happened along an important period may belong to the same sex.

Influence of environmental factors is also greater in small populations. Hence Environmental Variation (changes on environmental conditions affecting survival and/or reproduction) may provoke the extinction of a small population. Catastrophes, such as epidemics, hurricanes, habitat destruction by man, etc., are also factors affecting small populations first (Lacy 1993b).

Genetic Diversity or Genetic Variability may be more easily affected on small populations owed to genetic drift, which may drive many parents’ alleles not to be transmitted to their brood, fact which reduces their adaptability to the above mentioned situations (Lacy 1993a). Incest, or reproduction with a close relative, increases the brood homozygosis, factor which increases juvenile mortality in mammals (Ralls & Ballou 1987, in Ballou 1993).

These factors act together to make species with small populations more vulnerable to extinction (Ballou 1993, Foose 1993). The fenomenon has generated the concept of Minimum Viable Population (MVP; Foose 1993), a population big enough to allow long term persistence in spite of genetic, demographic and environmental problems.

The concrete case of the Mediterranean monk seal faces the entire risk factors for the survival of small populations: even in the two biggest nuclei, its population is not much bigger than 250 individuals in Greece (Cebrian 1998); and 130 in the Sahara coast (Aguilar 1997). (See Table 1). Its reproduction in caves probably influences pup mortality on the years when storms are more frequent than usual. Additional mortality by man has a sound impact. There exists also an increasing destruction of coastal habitat by human activities. The species was recently decimated by a red tide affecting the Atlantic colony (Aguilar 1997). Recent epidemics produced by morbilliviruses affecting seals in the North Sea and dolphins in the Mediterranean have reached the species habitat range, constituting a potential threat for monk seals (Cebrian 1993). Earthquakes and marine erosion produce cave collapses, with a collateral risk accentuated in the spots where the population is concentrated in a few caves, such in the Sahara coast. Genetic variability seems to be very low for the species, fact which has been already proved for the Sahara coast population (Pastor et al 2004).

All the factors affecting the species interact, increasing their influence in the extinction probability as the population decreases. That generates a positive feedback called extinction vortex (Gilpin & Soule 1986 in Ballou 1993).

2. CONCEPTS ON POPULATION VIABILITY ANALYSIS

In order to help understanding the collective effect of these factors in the extinction probability of concrete species population, predictability models able to be processed by computer have been developed. Those models may be subject to “Population Viability Analysis”, (PVA; Soule 1987 in Ballou 1993), which help us understanding where the priorities are, in order to help confronting the situation.

The biggest remaining population in the Mediterranean is that of the Aegean Sea, being most of the individuals distributed along the Greek coasts, although ecologically they almost certainly constitute a panmictic (common) population with the individuals inhabiting the Aegean Turkish coasts: juveniles of these mammals disperse after weaning, being able to reach long distances of at least 300 nautical miles (Cebrian 1995b), so at least these age classes may be fully shared by both countries while, although the number of resident adult individuals in the Turkish side is much lower, they would be probably double-counted if summed to the Greek side population numbers, since they may periodically undertake reproductive dispersion.

In order to properly evaluate the survival chances of the species in the Mediterranean, population dynamics modelling based in the Greek population of monk seal has been undertaken. This choice has been done based in the fact that the author has reliable data for the widest distribution area of the species in that country taken along a ten years long term research, allowing more trustworthy results. The choice of any smaller populations remaining in the Mediterranean, should reliable data exist, would have provided a certain prompt extinction date, without much opportunity to undertake simulations on possible management action.

Goedicke (1981) predicted the vanishing of the monk seal in Greece for the year 2000, suggesting even the extinction year for the different colonies known in the country. He based his calculations on an initial pool of 500 individuals estimated by Vamvakas et al (1978), to which he applied a 13,1% decrease rate based on Boulva (1978). However, those calculations did not consider other aspects apart from seal killing by fishermen, nor other population factors, and it has proved not to match the real situation.

To elaborate the present process the PVA programme VORTEX version 6 (Lacy, Hughes & Kreeger 1993) has been used. This is a programme employed by the Conservation Breeding Specialist Group of the Species Survival Commission of the IUCN, to propose management actions for threatened populations.

Different possible essays were run in the Greek populations of the Aegean and Ionian Seas, aimed to relate them to several hypothetical management measures which might play a role on precluding the extinction of the species.

The value of this approach relies on the fact that it does not only consider synchronously all the factors contributing to the extinction risk. It also allows to predict what may happen when a concrete factor is subject to changes. That helps to evaluate the real weight of that factor and, based on that method, managers may take action on the factors identified as the currently most influent on the extinction risk of the species evaluated.

The PVA also considers the existence of a meta-population constituted by several populations, with different migration rates amongst them. Such factor is of most importance in the present work, since it allows to consider the realistic fact that three separated populations may influence the extinction risk of the meta-population analysed (populations with a migration rate lower than 10%): Adriatic, Ionian and Aegean.

PVA analysis have however many limitations, since it is not possible to consider all the factors affecting a free ranging species. A detailed analysis of those limitations was developed by Lacy (1993a, 1993b). As a consequence, <u>the real extinction risk is usually underestimated</u>. The usefulness of essays such as the present one relies on the possibility of clarifying if a species may in fact disappear soon and to elucidate the factors with a higher role on the species depletion. Such assert has been demonstrated in many cases where PVA has been used to manage threatened species (Lacy 1993b).

3. POPULATION PARAMETERS OF THE MEDITERRANEAN SEAL

VORTEX requires a set of population parameters obtained through field research. The main ones have been obtained from the Greek population of monk seals (population size, first reproduction age, mortality, birth rate, etc; Cebrian 1998). For the cases where information from the Mediterranean area was not available, parameters have been taken from other monk seal populations (I.U.C.N. 1994).

3.1 <u>Demographic parameters considered</u>

- *Age at first whelping*: a minimum of 5 years old for the females is considered, while 6 years old would be the average age of first whelping. The minimum age for the males would be 7 years, but considering the existence of polyginy an age of 9 years old would be a more realistic age for a successful reproduction.

- *Maximum reproduction age:* The oldest Mediterranean seal recorded in captivity was 23 years old. Maximum reproduction age recorded in Pacific Monk seals is at least 23 years old (Johanos et al. 1994). Maximum age considered for these VORTEX essays is 25 years old.

- *Sex ratio at birth:* 1:1 or parity.

- *% of females reproducing per year:* A PVA training seminar carried out in Athens considered a value of 50% (UICN 1994). Wirtz (1968) observed that from 44 tagged females of Hawaiian monk seal 34% bred on two consecutive seasons, 32% only on the first season and 34% only on the second one. For these essays it is considered that 33,3 % of the females bred every year and the remaining ones every two years. This is based on the records of births in two areas monitored along the nineties (Zakynthos Island and Milos Sub-archipelagos) in relation to the total of adults known in those seal groups (Cebrian 1998).

- *Standard deviation in % of breeding females*: A value of 9%, observed along seven years in Zakynthos, is used.

- *Maximum number of pups by whelping event*: 1; births of twins have not been ever confirmed in this species.

- *Age specific mortality:* data from dense nuclei of monk seals obtained from the Atlantic populations of Mediterranean seal and from Hawaiian monk seals are taken (I.U.C.N. 1994), They are further adapted to the modifications accordingly reflected in the Appendix.

  Age 0: 20, 40, 60%
  Age 1: 10%
  Age 2: 10%
  Age 3: 8%
  Age 4: 6%
  Age >=5: 2, 4, o 6%

- *Standard Deviation in Mortality:* data from the Atlantic population are extrapolated (UICN 1994).

  Age 1: 10-20%
  Age 2: 5%
  Age 3: 3%
  Age 4: 3%
  Age >= 5: 1-2%

- *Initial population size*: minimum (246) and possible values (300) as well as half the minimum estimation (123) obtained from Cebrian (1998) are used. The latter is considered to evaluate an hypothetical big overestimation of the existing population.

- *Meta-population structure*: It is supposed that there is not structuring within the Aegean, since the general circulation pattern of currents in this sea suggest an homogeneous birth dispersal pattern there. On the contrary, the continental body of land must make difficult very much interchange between populations from the Aegean and Ionian Seas. Surface currents in the Ionian are year around from SE to NW up to 60 nautical miles (nm) offshore (Y.Y.1976). This probably creates a differential migration rate favouring that from the Aegean to the Ionian. The same current pattern allows the arrival of juveniles to the Adriatic from the Ionian, allowing in theory a future re-colonisation of that sea (Cebrian 1995b). The meta-population would be integrated by 214-271 individuals from the Aegean; 20-29 individuals from the Ionian; The Adriatic has not reproductive individuals but it has an average immigration rate of one juvenile every 2 years which are consequently lost by the Ionian.

- *Migration rates:* 5% from the Ionian to the Adriatic; 0% from the Adriatic to the Ionian; 5% from the Aegean to the Ionian; 2.5% from the Ionian to the Aegean. 0% between Adriatic and Aegean. The minimum dispersal age is considered one year old (disappearing age of juveniles from Zakynthos) and the maximum one 6 years old (average sexual maturity age for females and males.

- *Initial distribution of age*: It is considered stable for the Aegean and the Ionian. The Adriatic Sea has founders one year old, fact which does not allow to include them in the runs as a third population.

- *Consanguinity depression*: Another Monachini, the north elephant seal possess a high consanguinity, after its recovery starting from a decimated population. According to Lacy (1993b) its survival and reproductive rates have not been conditioned by that fact. That evidence suggests that lethal alleles do not act on *Mirounga spp.,* so we have considered that neither *Monachus monachus* possesses them.

- *Correlation between environmental variation (CV) of reproduction and that of survival:* They are considered related, since years with abundant of preys or few autumn storms may benefit adults reproduction and juvenile survival.

- *Reproductive strategy*: The species is considered polygynic. The programme is limited by the fact that randomness might allow the existence of a male coupling with tens of females; fact improbable in Greece given the fragmentation of breeding groups.

- *Percentage of adult males in the reproductive pool*: it is considered the proportion 11-8 of males in breeding groups in relation with satellite males found by Cebrian (1998) in Cyclades, which means 58%.

- *Density-dependence of reproduction*: Although a very lax population will have difficulties for couplings, that value is considered to be very low, since good breeding caves seem to act as congregation points for individuals during the breeding season, including areas with only two seals. High density of pups in a cave may make some of them more exposed to the unsafe sectors of the caves; but on the other hand, adoption of orphan animals, existing in monk seals, may be facilitated by aggregation. Based on habitat knowledge in the area considered for the study, it is supposed that only a population with a five-fold density than the maximum present one in the Aegean (=1355) and 15 fold the one in the Ionian (=450) would reduce the reproductive success. The carrying capacity would be roughly 1805 seals.

The equation which defines such situation in relation to density dependence in Vortex would be defined by values A=1 (conditioning the graphic line initial profile) and B=16 (conditioning its final profile) where:

$$P(N)= (P(0)-[\{P(0)-P(K)\}*(N/K)B])*N/(N+A)$$

Being P(N) the % of females breeding when the population is N; P(K) the % of them breeding when the population reaches the carrying capacity, K; and P(0) the proportion of females breeding when the population size is close to 0.

3.2 <u>Identification of priority parameters for the populations survival</u>

The parameters so far considered are supposed to be the closest available to the real situation in the Mediterranean remaining populations and without possibility of being controlled by managers.

Given the stochastic nature of extinction, final values might be very different than predicted. However, simulations ran after essaying changes in the parameters that can be controlled by man, provide valuable information on those parameters role. They also help to understand their degree of importance played to increase the possibility of recovering the monk seal from the verge of extinction.

- *Changes on carrying capacity*: This is a parameter which can be changed for the different programme runs. It is equivalent to the recovery of breeding and resting caves which have been degraded. The present carrying capacity of the monk seal habitat in the Mediterranean is much higher than the population necessary to completely re-establish the species in this sea. This is a very different situation to the one faced by the colony inhabiting the Sahara coast, which possesses only four known breeding caves and urgently needs breeding habitat improvement. Consequently essays on that sense are not necessary at the moment for the Mediterranean population

- *Collection of individuals*: different levels of collection will be essayed to evaluate the impact of killing by man, as well as to evaluate the possibility of translocation of individuals from or between seal populations. This translocations are considered as done without a later restitution of older individuals to their original colony. Translocations imply changes in the natural migration rates of the populations. Another factor to be analysed through these programme runs will be the populational usefulness of recovering seal pups.

- *Catastrophes able to damage the species*: There are two main ones able to affect many individuals synchronously: oil/chemical spills and epizootics. Earthquakes are frequent in the remaining population ranges for the Mediterranean but they affect few important caves at the same time and are not considered a main threat to populations constituted by small groups.

- Although catastrophes are stochastic phenomena, oil spill consequences can be reduced through contingency plans; epidemics severity may be mitigated through vaccination; and red tide effects may be tackled through temporary capture of individuals at risk.

All the data used for each simulation, as well as the results regarding survival, to which sections 4 to 6 here below refer, are shown in the Annex I.

4. POPULATION VIABILITY IN ABSENCE OF INTENTIONAL KILLING

4.1 Effect of demographic parameters

The effect of initial population size on the extinction probability was essayed under natural mortality conditions. It was verified that the meta-population would not became extinct for the next two centuries. Furthermore, its intrinsic growth rate **r** would be positive and the heterozygosity value higher than 97% even when considering a natural adult mortality of 6%, the usual one for other seal species (IUCN 1994).

Common result to all the essays is that the meta-population survival is not at prompt risk even considering the highest values of expected natural mortality for adults and pups.

Only extreme essays such as considering the maximum possible mortality acting on populations half the size of the probable one would suggest risks of extinction of 3% after more than 150 years. Such situation does not shows though to be a realistic one (for example 10 seals would be the total estimated population of the whole Ionian sea, while the author has recently observed there 13 individuals together).

The most pessimistic natural scenario (probable population subject to the highest natural mortality) give us just a 0,5% extinction risk after 152 years.

These results indicate that **the Mediterranean monk seal populations of the region may still recover from the risk of extinction should intentional killing stop.**

4.2 Effect of the meta-population structure

Intermigration creates a protective effect against extinction, as shown by several of the previous essays, where local populations becoming extinct recovered thanks to immigration for the other one used in the runs. This buffer effect is stronger in the essays for the smaller population (up to 69,6% extinction risks neutralised in some essays) but also valid to recover the originally biggest Aegean population.

If intermigration reaches zero value under the most severe natural mortality conditions (60% for pups and 6% for adults) for the minimum existing population, the risk of extinction for the Ionian population reaches values as high as 56,5%. These results illustrate the main role played by immigration to allow survival of small populations when the individuals come from a bigger one. Following these results **release of pups taken from a small population into a bigger one to reinforce it should be avoided.** Such actions have been done in the past, e.g. : a seal taken on 1988 from the Ionian Sea was later on released in the North Aegean Sea. Only a certainty that the individual has not other chances to reach reproductive age and mate might justify such action.

4.3 Effect of catastrophic events

Epizootics are not at all rare phenomena affecting marine mammals (Bonner 1989, Harwood & Hall 1990). A morbillivirus epidemic (Domingo et al 1990, Osterhaus et al 1992, Van Bressem et al 1993) reached Greek Seas between 1991 and 1992 (Cebrian 1995a). Although that virus did not affect monk seal cells under laboratory conditions (Osterhaus et al 1992, Visser et al 1993), a similar one decimated seal populations of the Baltic and North Seas on 1988, and at least a hooded seal reached the Mediterranean coasts of Spain few years later (Cebrian 1993). The risk of an epizootic is a latent one. A red tide produced mainly by the dinoflagelate *Alexandrium minutum* affected the monk seal population of the Sahara coast, possibly provoking the death of 68,5% to 81% of that population (Aguilar 1997).

The north eastern Mediterranean seas are amongst the World regions with a high density of wrecks and vessel strandings (Cooper 1983). Such events are frequently linked to fuel or oil spills. Such spills have happened in several cases in monk seal areas. Although records of monk seals deaths caused by that reason does not exist, it is known that oil spills kill marine mammals and it has been verified that seal caves polluted by tar become unsuitable for monk seal occupation for more than ten years (Cebrian 1998). Such problems may therefore affect the species survival.

For simulations on these topics the following frequencies and virulence were considered:

- *Viral epidemic*: the much scattered population of the monk seals in the Aegean and the Ionian with regard to the Sahara and the North European species would make a virus not to spread as easily as it occurred in those cases. Should an epizootic had happened along at least the last 30 years, records would exist in the related bibliography. In order to approach epidemic events effect it has been considered a frequency of three per century, provoking a 30% mortality and a reproduction rate decrease of 10% for the year of the event hit. It is considered here that a few dispersal juveniles may easily reach several other seal groups in a short time and transmit them a viral infection, even in the present low density conditions.

- *Oil spill*: Based in events happened in the region, and on the level of monk seals concentration in the region it was considered the possibility of a sound one every 20 years within each population, able to kill 5% of the individuals (animals close to the event place), and with a 5% reproductive rate depletion.

Essaying both effects on the minimum population subject to the highest natural mortality, the extinction risk reaches 36,5%, and a doubled frequency would overpass 90% extinction risk.

Considering both catastrophes separately: Epizootics alone may suppose a 20% extinction risk, while oil spills threats not accumulated to damage from epizootics would only provoke a 0,5% extinction risk.

A pessimistic severe occurrence of oil spills does not seems to create a sound increase on the extinction risk while the role of an epizootic might be strongly detrimental even in absence of killing by man and oil spills.

Contingency plans to address a monk seal epizootic in the region should be considered a presently unfulfilled priority.

5. POPULATION VIABILITY CONSIDERING LETHAL INTERACTIONS WITH MAN

5.1. Killing

It is difficult to evaluate the real level of intentional killings, since the secrecy surrounding them and limitations related to the retrieval of every dead seal to find out the death cause makes the obtained data lower than the real value.

Killing is not sustainable at the known levels. A properly monitored seal group of a Mediterranean island underwent the killing of 11 individuals in nine years, well in the nineties, being the authorship of the killings concentrated in very few persons (Cebrian 1998). A juvenile, a subadult, an adult female and an adult male were killed along less than 18 months in the same island already in the present century. That suggests a yearly population depletion of at least 5% in that island, most of them no pups. Considering a widest recording of deaths in the region provoked by man in many different areas a yearly estimation of 4,3% and 5,5% has been considered realistic for the viability analysis. The age classes repartition was done according to real recorded proportions obtained through field data embracing 8 years.

Analysis based in these premises revealed that **killing by man alone can drive the Mediterranean populations of the species to extinction in a few decades.** It must be emphasised that viability analysis does not give precise, non questionable accurate values, but the qualitative orientation regarding most probable events and main acting factors in the given circumstances. This essays shows us clearly that the species will vanish soon, if firm actions are non undertaken to avoid it, even if the exact extinction date differs from the above result.

Considering a feasible lower mortality in the bigger Aegean Sea population in relation to the Ionian Sea results, without changing other factors, suggest an even faster vanishing, after just 33 years. The faster extinction of the Ionian population would accelerate also the vanishing of the neighbouring one.

5.2. Entanglement in fishing gear

In relation to the above context, It would be a wrong idea to consider that the only serious human-related drive to extinction for the monk seal in the Mediterranean is intentional killing. Entanglement in nets taken alone is also a main threat in spite that such death cause is 75% lower than direct killing.

Essays considering only human related mortality provoked by entanglement in fishing nets still render values such as 83,5% extinction risk after 122 years.

Entanglement in gill nets and trammel nets alone does not seem to constitute the most serious threat to the species but it plays an additive role, considering the presently spread presence of these gears in the sea. Reduction of entanglement might however be achieved through management actions addressed to keep net settings away from main seal caves, where interactions concentrate. Such issues will be discussed in the next chapter.

6. MANAGEMENT POSSIBILITIES

6.1 Population viability considering translocation of individuals

Considering the highest natural mortality (60% pups; 6% adults) and the different population sizes already mentioned, essays were made to see the effect of doubling the migration rate through translocation:
The chances for the biggest meta-population considered would not be affected by such measures, while survival would be benefited in the essays on the smallest meta-population. However, such an action undertaken in even smaller populations may favour extinction. This paradoxical result is explained by the fact that the population donating more individuals may more easily reach a critical growing rate which would further expose it to extinction in the long term.

A beneficial measure for the meta-population survival would be to interchange equal number of individuals between two populations. That action would benefit both genetic pools without affecting any other factor.

6.2 Population viability under catastrophe risk when reducing mortality not related to man

Management actions able to reduce such mortality might give these results:

A reduction on mortality to half the expected one either for adults or for yearlings would neutralise the extinction risk created by such catastrophic events essayed before. Even a 10% reduction on yearlings mortality would impede extinction.

According to this, **artificial protection of yearlings from natural causes of death might benefit the population chances in areas without human induced deaths**. The same might apply to adults, but the second case is not feasible as it is the case the first one, since it is impossible to protect free ranging adults from natural mortality. On the contrary, a main cause of natural mortality of pups seems to be washing away from the caves and killing inside them by storms. Management actions may reduce this factor since the arrival of storms in monitored breeding caves with high risk for the pups inside them may be predicted.

6.3 Population viability managing the problem of entanglements in nets

If comparative essays are done considering all human related mortality and a situation without mortality in fishing gear, it is verified that the difference in time passed until reaching extinction is less than an additional decade to the forty years obtained under the action of killing.

Extinction risk would not be much reduced by eliminating the presence of static nets. However, **the motivation to kill the seals would not exist in those areas** should other methods (e.g. long lines) be the only ones used, because seals are mainly killed by fishermen who consider them a threat for their nets. In such situation all human induced causes would disappear and the risk of extinction might reach only 0,5%.

A reduction in yearlings natural mortality by 10% without reducing the one produced by fisheries related ones would not preclude extinction risk in a few decades. This means that **yearlings management is not useful as far as fisheries induced mortality has not been first addressed.**

A management measure to consider is **eliminating the setting of static nets in the proximity of areas where seal caves exist**. Research results allow to reduce entanglements by this method at least by 25%, without closing areas too wide around the important caves. That might allow a strong reduction of motivation to kill the seals since damages to nets would be also strongly reduced. Low values of 6% risk of extinction might be reached.

6.4 Population viability considering recovery of pups

More than 10 monk seal pups have been rehabilitated until weaning age in the Mediterranean since 1988. Issues related to the convenience of such measures to help seal populations survival have been raised, not being of minor concern the possibility of diseases transmission to the wild population (Schwarz & Heidemann 1992; Measures 2004). The veterinary rehabilitation of the pups is not usually followed by tracking after release in the wild, to ascertain real recovery of the individuals to their population, although cases exist for monk seals (Reijnders & Ries 1989). Furthermore **an official regional protocol to take into captivity, rehabilitate and release into the wild individuals of this endangered species does not exist.** That could help to solve raised concern on the lack of control of such serious actions (UNEP-MAP RAC/SPA 1998).

Essays considering pup recovery in the wild (not just rehabilitation until release) at twice the recent levels of rehabilitation (an average of one per year) show that the prompt extinction of the species does not change, compared to not releasing again the rehabilitated individuals to the source population.

In view of those results, **it might be more useful for the species chances to attempt the creation of a new colony using rehabilitated seals**. The existence of several populations which will make possible future intermigration strongly enhances the survival possibilities of decimated species, given the stabilising role of this factor in population dynamics as already seen above.

7. CONCLUSIONS

The population viability analysis undertaken shows that the present monk seal status keeps the species at the risk of vanishing from the Mediterranean in a few decades, since even the biggest remaining population, that of the Aegean Sea, is endangered. **Intentional killing is the main drive to extinction**, while entanglement in nets alone would not suffice to provoke it. Whatever management measures are appointed to wildlife managers, positive results are not expected as far as illegal killing is not strongly reduced through an specific strategy to improve related laws enforcement and prosecution of such actions. Measures taken recently on that sense (TMG 2003), with the first prosecution ever done in a Mediterranean country against seals killing are examples to be followed.

Measures to increase natural survival of wild pups would be useful in situations without intentional killing, but not practical to preclude extinction if intentional killings is not sufficiently investigated and restrained by appropriate authorities.

Management measures related to fisheries using static nets should be attempted since the remaining population still may recover if kills stop. Actions on that direction should be initiated in collaboration with bodies playing a role on fisheries and conservation, such as the GFCM of FAO, and in cooperation with other Conventions concerned with this species survival, such as Bern and Bonn Conventions.

Table 1: Mediterranean monk seal populations remaining in the World

Population	Minimum Nº of seals	Last record	Last reproduction data	Source
West Sahara coast	+130	2005	2004	Aguilar pers. com. Gonzalez pers. com.
Canaries	Vanished	1992	1441	Monod 1948; I.R.S.N.B. & S.M.R.U. 1993
Madeira (Desertas)	23	2003	2002	Costa-Neves pers. com
Mediterranean Morocco	Vanished?	2004	1981	RAC/SPA 2004
Chafarinas islands	Vanished?	2001	2000	González 1989; Cebrian pers. com.
Algeria	7	1989	1989	Lefevre et al. 1989
La Galite	Vanished	1986	1983	Gonzalez 1989
Mainland Tunisia	Vanished	1986	1975	Gonzalez 1989; Ktari-Chakroun 1978
Libya	+20	2002	1968	Norris 1972, Boutiba 1993, Mo 2002
Egypt	Vanished	1981	No records	Norris 1972; Marchessaux 1989
Israel	Vanished	1968	around 1928	Bertram 1943; Marchessaux 1989
Lebanon	1 vagrant	1997	No records	Marchessaux 1989, RAC/SPA 2003
Syria	1 vagrant	2003	No records	RAC/SPA 2003
Cyprus	+ 2	2003	1994?	Hadjichristophorou & Dimitropoulos 1994; Ozturk 1994. Cebrian pers. com.
Turkey	42 (overlap with Greece)	2003	1994	Ozturk 1994; Guçu et al 2004
Russia	?	No records	No records	Cebrian 1998
Ukraine	Vanished	No records	No records	Ozturk 1994
Romania	Vanished	1960	No records	Schnapp et al. 1962; Ozturk 1994
Bulgaria	Vanished	1975	1950-60	Schnapp et al. 1962; Avellá 1987; Ozturk 1994
Greece	250 (overlap with Turkey)	2005	2004	Cebrian 1998; Cebrian and Gonzalez, pers. com.
Albania	Vanished?	80's	1944	Lamani pers. com. ; Vaso pers. com.
Serbia & Montenegro	Vanished	No records	No records	Cebrian 1995
Bosnia	Vanished	No records	No records	Cebrian 1995
Croatia	Vanished	1993		Cebrian 1995
Slovenia	Vanished	No records	No records	Cebrian 1995
Mainland Italy	1 Vagrant	2003	1976	Di Turo 1984; Marini 1994; RAC/SPA 2003
Sicily - Pantelleria	1 Vagrant	1998	No records	González 1989; Marini 1994; RAC/SPA 2003
Sardinia	Vagrants	2001	1986	Marchessaux 1989; Marini 1994; Mo pers. com.
Malta	Vanished	No records	No records	
Mainland France	Vanished	1990	1930-35	Duguy y Cheylan 1978; Maigret 1990
Corse	Vanished	1982	1947	Troitzky 1953; Marchessaux 1989
Mainland Spain	Vanished	1984	1950	Avellá 1987; Marchessaux 1989
Balearics	Vanished	1977	1951	Avellá 1987
Mainland Portugal	Vanished	1817	1797	Avellá 1987

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ANNEX I

Mediterranean Monk Seal
Population Viability analysis.
Computerised outputs

VORTEX --

simulation of genetic and demographic stochasticity

VORTES.002

2 population(s) simulated for 200 years, 200 iterations

No inbreeding depression

Minimum age at migration is 1.
Maximum age at migration is 6.
Both females and males migrate.

Migration matrix:

	1	2
1	0.95000	0.05000
2	0.02500	0.97500

First age of reproduction for females: 6 for males: 9
Age of senescence (death): 25
Sex ratio at birth (proportion males): 0.50000

Polygynous mating;
58.00 percent of adult males in the breeding pool.

Reproduction is assumed to be density dependent, according to:
% breeding = (66.60*[1-(N/K)^16.00]+33.30*[(N/K)^16.00]) * N/(1.00+N)
EV in reproduction (% breeding) = 9.00 SD

40.00 (EV = 10.00 SD) percent mortality of females between ages 0 and 1
10.00 (EV = 5.00 SD) percent mortality of females between ages 1 and 2
10.00 (EV = 3.00 SD) percent mortality of females between ages 2 and 3
8.00 (EV = 3.00 SD) percent mortality of females between ages 3 and 4
6.00 (EV = 3.00 SD) percent mortality of females between ages 4 and 5
4.00 (EV = 2.00 SD) percent mortality of females between ages 5 and 6
2.00 (EV = 1.00 SD) percent annual mortality of adult females (6<=age<=25)
40.00 (EV = 10.00 SD) percent mortality of males between ages 0 and 1
10.00 (EV = 5.00 SD) percent mortality of males between ages 1 and 2
10.00 (EV = 3.00 SD) percent mortality of males between ages 2 and 3
8.00 (EV = 3.00 SD) percent mortality of males between ages 3 and 4
6.00 (EV = 3.00 SD) percent mortality of males between ages 4 and 5
6.00 (EV = 3.00 SD) percent mortality of males between ages 5 and 6
6.00 (EV = 3.00 SD) percent mortality of males between ages 6 and 7
4.00 (EV = 2.00 SD) percent mortality of males between ages 7 and 8
2.00 (EV = 1.00 SD) percent mortality of males between ages 8 and 9
2.00 (EV = 1.00 SD) percent annual mortality of adult males (9<=age<=25)
EVs may have been adjusted to closest values possible for binomial distribution.
EV in reproduction and mortality will be correlated.
Frequency of type 1 catastrophes: 0.000 percent
with 1.000 multiplicative effect on reproduction
and 1.000 multiplicative effect on survival

Frequency of type 2 catastrophes: 0.000 percent
with 1.000 multiplicative effect on reproduction
and 1.000 multiplicative effect on survival

Deterministic population growth rate (based on females, with assumptions of no limitation of mates, no density dependence, and no inbreeding depression):

r = 0.058 lambda = 1.059 R0 = 2.233

Stable age distribution:

Ratio of adult (>= 9) males to adult (>= 6) females: 0.677
Initial size of Population 1:
(set to reflect stable age distribution)
133 Males
138 Females

Population 1 carrying capacity = 1355 (EV = 135.50 SD)

Initial size of Population 2:
(set to reflect stable age distribution)
14 Males
15 Females

Population 2 carrying capacity = 450 (EV = 45.00 SD)

In 200 simulations of Population1 for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).
Mean final population for successful cases was 1167.28 (6.78 SE, 95.86 SD)
Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0153 (0.0002 SE, 0.0495 SD)
Final expected heterozygosity was 0.9870 (0.0001 SE, 0.0012 SD)
Final observed heterozygosity was 0.9882 (0.0002 SE, 0.0034 SD)

Final number of alleles was 143.28 (0.64 SE, 8.99 SD)

In 200 simulations of Population2 for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).
Mean final population for successful cases was 438.98 (2.78 SE, 39.28 SD)
Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0937 (0.0004 SE, 0.0803 SD)
Final expected heterozygosity was 0.9862 (0.0001 SE, 0.0014 SD)
Final observed heterozygosity was 0.9882 (0.0004 SE, 0.0054 SD)
Final number of alleles was 130.38 (0.61 SE, 8.56 SD)

In 200 simulations of Meta-population for 200 years:
0 went extinct and 200 survived.
This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).
Mean final population for successful cases was 1606.26 (7.51 SE, 106.15 SD)
Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0376 (0.0002 SE, 0.0422 SD)
Final expected heterozygosity was 0.9873 (0.0001 SE, 0.0012 SD)
Final observed heterozygosity was 0.9882 (0.0002 SE, 0.0032 SD)
Final number of alleles was 147.21 (0.65 SE, 9.26 SD)

****

VORTES.003

Like VORTES.002, with the following changes:

Initial size of Population 1:
(set to reflect stable age distribution)
105 Males
109 Females

Initial size of Population 2:
(set to reflect stable age distribution)
10 Males
10 Females

In 200 simulations of Population 1 for 200 years:
0 went extinct and 200 survived.
This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).
Mean final population for successful cases was 1166.09 (6.60 SE, 93.36 SD)
Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0162 (0.0003 SE, 0.0500 SD)
Final expected heterozygosity was 0.9856 (0.0001 SE, 0.0013 SD)
Final observed heterozygosity was 0.9867 (0.0003 SE, 0.0039 SD)
Final number of alleles was 129.60 (0.52 SE, 7.42 SD)

In 200 simulations of Population 2 for 200 years:
0 went extinct and 200 survived.
This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).
Mean final population for successful cases was 448.26 (2.48 SE, 35.08 SD)
Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0928 (0.0004 SE, 0.0819 SD)
Final expected heterozygosity was 0.9848 (0.0001 SE, 0.0014 SD)
Final observed heterozygosity was 0.9864 (0.0004 SE, 0.0061 SD)
Final number of alleles was 119.50 (0.49 SE, 6.93 SD)

In 200 simulations of Meta-population for 200 years:
0 went extinct and 200 survived.
This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).
Mean final population for successful cases was 1614.35 (7.05 SE, 99.74 SD)
Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0380 (0.0002 SE, 0.0423 SD)
Final expected heterozygosity was 0.9859 (0.0001 SE, 0.0013 SD)
Final observed heterozygosity was 0.9866 (0.0002 SE, 0.0035 SD)
Final number of alleles was 132.90 (0.51 SE, 7.28 SD)

****

VORTES.004

Like VORTES.002, with the following changes:

Initial size of Population 1:

(set to reflect stable age distribution)
52 Males
55 Females

Initial size of Population 2:
(set to reflect stable age distribution)
5 Males
5 Females

In 200 simulations of Population 1 for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 1177.49 (6.99 SE, 98.89 SD)
Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0188 (0.0003 SE, 0.0515 SD)
Final expected heterozygosity was 0.9794 (0.0002 SE, 0.0028 SD)
Final observed heterozygosity was 0.9809 (0.0003 SE, 0.0046 SD)
Final number of alleles was 91.56 (0.52 SE, 7.30 SD)

In 200 simulations of Population 2 for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 443.89 (2.73 SE, 38.65 SD)
Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0902 (0.0004 SE, 0.0829 SD)
Final expected heterozygosity was 0.9786 (0.0002 SE, 0.0027 SD)
Final observed heterozygosity was 0.9816 (0.0004 SE, 0.0063 SD)
Final number of alleles was 86.28 (0.51 SE, 7.23 SD)

In 200 simulations of Meta-population for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 1621.38 (7.47 SE, 105.68 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0396 (0.0002 SE, 0.0426 SD)
Final expected heterozygosity was 0.9797 (0.0002 SE, 0.0027 SD)
Final observed heterozygosity was 0.9811 (0.0003 SE, 0.0041 SD)
Final number of alleles was 93.21 (0.53 SE, 7.56 SD)
****

VORTES.005
Like VORTES.003, with the following changes:

6.00 (EV = 3.00 SD) percent mortality of males between ages 7 and 8
6.00 (EV = 3.00 SD) percent mortality of males between ages 8 and 9
6.00 (EV = 2.00 SD) percent annual mortality of adult males (9<=age<=25)

Initial size of Population 1:
(set to reflect stable age distribution)
107 Males
107 Females

Initial size of Population 2:
(set to reflect stable age distribution)
10 Males
10 Females

Deterministic population growth rate (based on females, with assumptions of
no limitation of mates, no density dependence, and no inbreeding depression):

r = 0.034 lambda = 1.035 R0 = 1.557

Ratio of adult (>= 9) males to adult (>= 6) females: 0.707

In 200 simulations of Population 1 for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 711.81 (13.96 SE, 197.38 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0059 (0.0003 SE, 0.0569 SD)
Final expected heterozygosity was 0.9774 (0.0002 SE, 0.0032 SD)
Final observed heterozygosity was 0.9796 (0.0004 SE, 0.0062 SD)

Final number of alleles was 84.33 (0.57 SE, 8.10 SD)

In 200 simulations of Population2 for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 426.37 (2.48 SE, 35.01 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0509 (0.0004 SE, 0.0777 SD)
Final expected heterozygosity was 0.9773 (0.0002 SE, 0.0031 SD)
Final observed heterozygosity was 0.9804 (0.0005 SE, 0.0072 SD)
Final number of alleles was 82.59 (0.52 SE, 7.38 SD)

In 200 simulations of Meta-population for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 1138.17 (14.59 SE, 206.34 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0229 (0.0002 SE, 0.0446 SD)
Final expected heterozygosity was 0.9783 (0.0002 SE, 0.0030 SD)
Final observed heterozygosity was 0.9799 (0.0004 SE, 0.0050 SD)
Final number of alleles was 88.61 (0.56 SE, 7.92 SD)
****

VORTES.006

Like VORTES.005, with the following changes:

Initial size of Population 1:
(set to reflect stable age distribution)
53 Males
54 Females

Initial size of Population 2:
(set to reflect stable age distribution)
5 Males
5 Females

Deterministic population growth rate (based on females, with assumptions of
no limitation of mates, no density dependence, and no inbreeding depression):

r = 0.034 lambda = 1.035 R0 = 1.557

In 200 simulations of Population 1 for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 696.68 (12.77 SE, 180.62 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0093 (0.0003 SE, 0.0594 SD)
Final expected heterozygosity was 0.9670 (0.0005 SE, 0.0065 SD)
Final observed heterozygosity was 0.9690 (0.0006 SE, 0.0091 SD)
Final number of alleles was 58.74 (0.50 SE, 7.05 SD)

In 200 simulations of Population2 for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 427.58 (2.58 SE, 36.53 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0490 (0.0004 SE, 0.0794 SD)
Final expected heterozygosity was 0.9670 (0.0005 SE, 0.0064 SD)
Final observed heterozygosity was 0.9700 (0.0007 SE, 0.0100 SD)
Final number of alleles was 58.08 (0.47 SE, 6.64 SD)

In 200 simulations of Meta-population for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 1124.27 (13.50 SE, 190.90 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0244 (0.0002 SE, 0.0451 SD)
Final expected heterozygosity was 0.9679 (0.0004 SE, 0.0062 SD)
Final observed heterozygosity was 0.9693 (0.0006 SE, 0.0079 SD)
Final number of alleles was 60.77 (0.50 SE, 7.08 SD)
****

VORTES.007

Like VORTES.005, with the following changes:

60.00 (EV = 20.00 SD) percent mortality of females between ages 0 and 1
4.00 (EV = 2.00 SD) percent mortality of females between ages 5 and 6
2.00 (EV = 1.00 SD) percent annual mortality of adult females (6<=age<=25)
60.00 (EV = 20.00 SD) percent mortality of males between ages 0 and 1
4.00 (EV = 2.00 SD) percent mortality of males between ages 7 and 8
2.00 (EV = 1.00 SD) percent mortality of males between ages 8 and 9
2.00 (EV = 1.00 SD) percent annual mortality of adult males (9<=age<=25)

Deterministic population growth rate (based on females, with assumptions of
no limitation of mates, no density dependence, and no inbreeding depression):

r = 0.028 lambda = 1.028 R0 = 1.489
Ratio of adult (>= 9) males to adult (>= 6) females: 0.720

In 200 simulations of Population1 for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 584.37 (11.94 SE, 168.84 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0048 (0.0003 SE, 0.0677 SD)
Final expected heterozygosity was 0.9789 (0.0002 SE, 0.0029 SD)
Final observed heterozygosity was 0.9812 (0.0005 SE, 0.0068 SD)
Final number of alleles was 89.16 (0.62 SE, 8.82 SD)

In 200 simulations of Population2 for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 418.68 (2.39 SE, 33.80 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0447 (0.0004 SE, 0.0811 SD)
Final expected heterozygosity was 0.9792 (0.0002 SE, 0.0027 SD)
Final observed heterozygosity was 0.9810 (0.0005 SE, 0.0073 SD)
Final number of alleles was 88.80 (0.55 SE, 7.72 SD)

In 200 simulations of Meta-population for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 1003.05 (12.68 SE, 179.29 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0209 (0.0003 SE, 0.0511 SD)
Final expected heterozygosity was 0.9800 (0.0002 SE, 0.0026 SD)
Final observed heterozygosity was 0.9812 (0.0004 SE, 0.0052 SD)
Final number of alleles was 95.22 (0.62 SE, 8.77 SD)
****

VORTES.008

Like VORTES.005, with the following changes:

Migration matrix:

	1	2
1	1.00000	0.00000
2	0.00000	1.00000

In 200 simulations of Population 1 for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 1206.78 (6.81 SE, 96.36 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
 mean growth rate (r) was 0.0236 (0.0003 SE, 0.0593 SD)
Final expected heterozygosity was 0.9819 (0.0002 SE, 0.0025 SD)
Final observed heterozygosity was 0.9830 (0.0003 SE, 0.0041 SD)
Final number of alleles was 103.48 (0.74 SE, 10.49 SD)

In 200 simulations of Population2 for 200 years:
 8 went extinct and 192 survived.

This gives a probability of extinction of 0.0400 (0.0139 SE),
 or a probability of success of 0.9600 (0.0139 SE).

8 simulations went extinct at least once.
Of those going extinct,
 mean time to first extinction was 47.75 years (2.72 SE, 7.70 SD).

No recolonizations.

Mean final population for successful cases was 401.05 (2.88 SE, 39.88 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
 mean growth rate (r) was 0.0247 (0.0004 SE, 0.0707 SD)
Final expected heterozygosity was 0.8484 (0.0052 SE, 0.0718 SD)
Final observed heterozygosity was 0.8542 (0.0052 SE, 0.0725 SD)
Final number of alleles was 12.90 (0.27 SE, 3.74 SD)

In 200 simulations of Meta-population for 200 years:
 0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
 or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 1591.78 (9.26 SE, 130.99 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
 mean growth rate (r) was 0.0240 (0.0003 SE, 0.0507 SD)
Final expected heterozygosity was 0.9805 (0.0003 SE, 0.0038 SD)
Final observed heterozygosity was 0.9526 (0.0011 SE, 0.0160 SD)
Final number of alleles was 115.87 (0.75 SE, 10.64 SD)
****

VORTES.009

Like VORTES.006, with the following changes:

 60.00 (EV = 20.00 SD) percent mortality of females between ages 0 and 1
 60.00 (EV = 20.00 SD) percent mortality of males between ages 0 and 1

Deterministic population growth rate (based on females, with assumptions of
 no limitation of mates, no density dependence, and no inbreeding depression):

 r = 0.003 lambda = 1.003 R0 = 1.038

In 200 simulations of Population1 for 200 years:
 7 went extinct and 193 survived.

This gives a probability of extinction of 0.0350 (0.0130 SE),
 or a probability of success of 0.9650 (0.0130 SE).

14 simulations went extinct at least once.
Of those going extinct,
 mean time to first extinction was 138.57 years (9.37 SE, 35.05 SD).

16 recolonizations occurred.
Mean time to recolonization was 3.44 years (0.88 SE, 3.50 SD).

9 re-extinctions occurred.
Mean time to re-extinction was 4.33 years (1.39 SE, 4.18 SD).

Mean final population for successful cases was 95.36 (5.14 SE, 71.35 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
 mean growth rate (r) was -0.0030 (0.0005 SE, 0.0997 SD)
Final expected heterozygosity was 0.8903 (0.0045 SE, 0.0619 SD)
Final observed heterozygosity was 0.9158 (0.0040 SE, 0.0562 SD)
Final number of alleles was 19.73 (0.66 SE, 9.17 SD)

In 200 simulations of Population2 for 200 years:
 6 went extinct and 194 survived.

This gives a probability of extinction of 0.0300 (0.0121 SE),
or a probability of success of 0.9700 (0.0121 SE).

7 simulations went extinct at least once.
Of those going extinct,
mean time to first extinction was 157.29 years (14.06 SE, 37.21 SD).

2 recolonizations occurred.
Mean time to recolonization was 6.00 years (4.00 SE, 5.66 SD).

1 re-extinctions occurred.
Mean time to re-extinction was 10.00 years (0.00 SE, 0.00 SD).

Mean final population for successful cases was 177.55 (8.81 SE, 122.72 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0126 (0.0005 SE, 0.0970 SD)
Final expected heterozygosity was 0.8954 (0.0046 SE, 0.0634 SD)
Final observed heterozygosity was 0.9095 (0.0043 SE, 0.0605 SD)
Final number of alleles was 21.21 (0.68 SE, 9.51 SD)

In 200 simulations of Meta-population for 200 years:
6 went extinct and 194 survived.

This gives a probability of extinction of 0.0300 (0.0121 SE),
or a probability of success of 0.9700 (0.0121 SE).

6 simulations went extinct at least once.
Of those going extinct,
mean time to first extinction was 155.33 years (13.31 SE, 32.61 SD).

No recolonizations.

Mean final population for successful cases was 272.42 (13.61 SE, 189.55 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0022 (0.0003 SE, 0.0654 SD)
Final expected heterozygosity was 0.9012 (0.0039 SE, 0.0547 SD)
Final observed heterozygosity was 0.9105 (0.0038 SE, 0.0522 SD)
Final number of alleles was 22.03 (0.70 SE, 9.76 SD)
****
VORTES.010

Like VORTES.009, with the following changes:

Migration matrix:

	1	2
1	1.00000	0.00000
2	0.00000	1.00000

Initial size of Population 1:
(set to reflect stable age distribution)
107 Males
107 Females

Initial size of Population 2:
(set to reflect stable age distribution)
10 Males
10 Females

In 200 simulations of Population1 for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 486.93 (24.45 SE, 345.78 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0028 (0.0004 SE, 0.0774 SD)
Final expected heterozygosity was 0.9413 (0.0030 SE, 0.0428 SD)
Final observed heterozygosity was 0.9489 (0.0035 SE, 0.0490 SD)
Final number of alleles was 41.59 (1.48 SE, 20.91 SD)

In 200 simulations of Population2 for 200 years:
113 went extinct and 87 survived.

This gives a probability of extinction of 0.5650 (0.0351 SE),
or a probability of success of 0.4350 (0.0351 SE).

113 simulations went extinct at least once.
Median time to first extinction was 155 years.
Of those going extinct,
mean time to first extinction was 89.49 years (4.34 SE, 46.12 SD).

No recolonizations.

Mean final population for successful cases was 87.92 (9.48 SE, 88.38 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was -0.0060 (0.0007 SE, 0.1196 SD)

Final expected heterozygosity was 0.6353 (0.0185 SE, 0.1728 SD)
Final observed heterozygosity was 0.6691 (0.0218 SE, 0.2035 SD)
Final number of alleles was 5.18 (0.29 SE, 2.69 SD)

In 200 simulations of Meta-population for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 525.17 (25.05 SE, 354.20 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0029 (0.0004 SE, 0.0722 SD)
Final expected heterozygosity was 0.9423 (0.0030 SE, 0.0427 SD)
Final observed heterozygosity was 0.9315 (0.0041 SE, 0.0582 SD)
Final number of alleles was 43.85 (1.49 SE, 21.12 SD)
****

VORTES.011

Like VORTES.010, with the following changes:

Migration matrix:

	1	2
1	0.95000	0.05000
2	0.02500	0.97500

In 200 simulations of Population 1 for 200 years:
1 went extinct and 199 survived.

This gives a probability of extinction of 0.0050 (0.0050 SE),
or a probability of success of 0.9950 (0.0050 SE).

1 simulations went extinct at least once.
Of those going extinct,
mean time to first extinction was 116.00 years (0.00 SE, 0.00 SD).

1 recolonizations occurred.
Mean time to recolonization was 2.00 years (0.00 SE, 0.00 SD).

1 re-extinctions occurred.
Mean time to re-extinction was 17.00 years (0.00 SE, 0.00 SD).

Mean final population for successful cases was 137.03 (4.68 SE, 66.01 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was -0.0031 (0.0004 SE, 0.0845 SD)
Final expected heterozygosity was 0.9442 (0.0017 SE, 0.0244 SD)
Final observed heterozygosity was 0.9548 (0.0022 SE, 0.0311 SD)
Final number of alleles was 35.72 (0.84 SE, 11.90 SD)

In 200 simulations of Population2 for 200 years:
1 went extinct and 199 survived.

This gives a probability of extinction of 0.0050 (0.0050 SE),
or a probability of success of 0.9950 (0.0050 SE).

1 simulations went extinct at least once.
Of those going extinct,
mean time to first extinction was 152.00 years (0.00 SE, 0.00 SD).

No recolonizations.

Mean final population for successful cases was 259.50 (7.62 SE, 107.47 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0135 (0.0004 SE, 0.0878 SD)
Final expected heterozygosity was 0.9482 (0.0016 SE, 0.0231 SD)
Final observed heterozygosity was 0.9539 (0.0018 SE, 0.0256 SD)
Final number of alleles was 39.56 (0.92 SE, 12.94 SD)

In 200 simulations of Meta-population for 200 years:
1 went extinct and 199 survived.

This gives a probability of extinction of 0.0050 (0.0050 SE),
or a probability of success of 0.9950 (0.0050 SE).

1 simulations went extinct at least once.
Of those going extinct,
mean time to first extinction was 152.00 years (0.00 SE, 0.00 SD).

No recolonizations.

Mean final population for successful cases was 396.53 (11.80 SE, 166.48 SD)

Without harvest/supplementation, prior to carrying capacity truncation,

mean growth rate (r) was 0.0028 (0.0003 SE, 0.0591 SD)
Final expected heterozygosity was 0.9502 (0.0015 SE, 0.0215 SD)
Final observed heterozygosity was 0.9541 (0.0018 SE, 0.0253 SD)
Final number of alleles was 41.07 (0.95 SE, 13.38 SD)
****

VORTES.012

Like VORTES.009, with the following changes:

Migration matrix:

	1	2
1	0.90000	0.10000
2	0.05000	0.95000

In 200 simulations of Population 1 for 200 years:
12 went extinct and 188 survived.

This gives a probability of extinction of 0.0600 (0.0168 SE),
or a probability of success of 0.9400 (0.0168 SE).

16 simulations went extinct at least once.
Of those going extinct,
mean time to first extinction was 131.94 years (10.82 SE, 43.28 SD).

29 recolonizations occurred.
Mean time to recolonization was 4.83 years (0.75 SE, 4.02 SD).

25 re-extinctions occurred.
Mean time to re-extinction was 7.76 years (1.72 SE, 8.60 SD).

Mean final population for successful cases was 97.64 (4.69 SE, 64.31 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was -0.0032 (0.0005 SE, 0.1063 SD)
Final expected heterozygosity was 0.8870 (0.0068 SE, 0.0938 SD)
Final observed heterozygosity was 0.9027 (0.0080 SE, 0.1100 SD)
Final number of alleles was 19.99 (0.66 SE, 9.04 SD)

In 200 simulations of Population2 for 200 years:
14 went extinct and 186 survived.

This gives a probability of extinction of 0.0700 (0.0180 SE),
or a probability of success of 0.9300 (0.0180 SE).

14 simulations went extinct at least once.
Of those going extinct,
mean time to first extinction was 150.50 years (11.50 SE, 43.03 SD).

6 recolonizations occurred.
Mean time to recolonization was 3.17 years (1.33 SE, 3.25 SD).

6 re-extinctions occurred.
Mean time to re-extinction was 12.00 years (2.68 SE, 6.57 SD).

Mean final population for successful cases was 192.56 (8.54 SE, 116.47 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0126 (0.0005 SE, 0.1048 SD)
Final expected heterozygosity was 0.9009 (0.0041 SE, 0.0559 SD)
Final observed heterozygosity was 0.9164 (0.0037 SE, 0.0504 SD)
Final number of alleles was 21.84 (0.68 SE, 9.22 SD)

In 200 simulations of Meta-population for 200 years:
12 went extinct and 188 survived.

This gives a probability of extinction of 0.0600 (0.0168 SE),
or a probability of success of 0.9400 (0.0168 SE).

12 simulations went extinct at least once.
Of those going extinct,
mean time to first extinction was 153.00 years (12.05 SE, 41.74 SD).

No recolonizations.

Mean final population for successful cases was 288.16 (13.03 SE, 178.60 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0020 (0.0003 SE, 0.0661 SD)
Final expected heterozygosity was 0.8977 (0.0053 SE, 0.0729 SD)
Final observed heterozygosity was 0.9105 (0.0053 SE, 0.0727 SD)
Final number of alleles was 22.13 (0.69 SE, 9.48 SD)
****

VORTES.013

Like VORTES.010, with the following changes:

Migration matrix:

	1	2
1	0.90000	0.10000

2 0.05000 0.95000

In 200 simulations of Population1 for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 150.31 (4.62 SE, 65.29 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was -0.0025 (0.0004 SE, 0.0869 SD)
Final expected heterozygosity was 0.9458 (0.0020 SE, 0.0280 SD)
Final observed heterozygosity was 0.9567 (0.0023 SE, 0.0325 SD)
Final number of alleles was 37.66 (0.87 SE, 12.35 SD)

In 200 simulations of Population2 for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 275.45 (7.60 SE, 107.46 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0140 (0.0005 SE, 0.0937 SD)
Final expected heterozygosity was 0.9484 (0.0018 SE, 0.0258 SD)
Final observed heterozygosity was 0.9528 (0.0017 SE, 0.0244 SD)
Final number of alleles was 40.63 (0.92 SE, 13.02 SD)

In 200 simulations of Meta-population for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 425.76 (11.86 SE, 167.72 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0034 (0.0003 SE, 0.0589 SD)
Final expected heterozygosity was 0.9498 (0.0018 SE, 0.0248 SD)
Final observed heterozygosity was 0.9541 (0.0017 SE, 0.0242 SD)
Final number of alleles was 41.94 (0.95 SE, 13.49 SD)
****

VORTES.014

Like VORTES.009, with the following changes:

Initial size of Population 1:
(set to reflect stable age distribution)
135 Males
136 Females

Initial size of Population 2:
(set to reflect stable age distribution)
14 Males
15 Females

In 200 simulations of Population 1 for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 168.13 (5.34 SE, 75.46 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was -0.0030 (0.0004 SE, 0.0808 SD)
Final expected heterozygosity was 0.9515 (0.0020 SE, 0.0287 SD)
Final observed heterozygosity was 0.9614 (0.0022 SE, 0.0309 SD)
Final number of alleles was 43.75 (0.96 SE, 13.58 SD)

In 200 simulations of Population2 for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 291.44 (7.19 SE, 101.66 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0134 (0.0004 SE, 0.0846 SD)
Final expected heterozygosity was 0.9563 (0.0016 SE, 0.0228 SD)
Final observed heterozygosity was 0.9627 (0.0016 SE, 0.0231 SD)

Final number of alleles was 48.66 (1.03 SE, 14.61 SD)

In 200 simulations of Meta-population for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 459.57 (11.69 SE, 165.34 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0032 (0.0003 SE, 0.0577 SD)
Final expected heterozygosity was 0.9577 (0.0016 SE, 0.0220 SD)
Final observed heterozygosity was 0.9622 (0.0016 SE, 0.0228 SD)
Final number of alleles was 50.86 (1.06 SE, 15.05 SD)
****

VORTES.015

Like VORTES.014, with the following changes:

Migration matrix:

	1	2
1	0.90000	0.10000
2	0.05000	0.95000

In 200 simulations of Population1 for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 157.42 (4.39 SE, 62.04 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was -0.0032 (0.0004 SE, 0.0829 SD)
Final expected heterozygosity was 0.9573 (0.0015 SE, 0.0215 SD)
Final observed heterozygosity was 0.9640 (0.0025 SE, 0.0356 SD)
Final number of alleles was 45.88 (0.88 SE, 12.50 SD)

In 200 simulations of Population2 for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 296.44 (7.10 SE, 100.37 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0138 (0.0005 SE, 0.0903 SD)
Final expected heterozygosity was 0.9597 (0.0016 SE, 0.0224 SD)
Final observed heterozygosity was 0.9642 (0.0013 SE, 0.0191 SD)
Final number of alleles was 50.13 (0.93 SE, 13.15 SD)

In 200 simulations of Meta-population for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 453.86 (11.02 SE, 155.79 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0034 (0.0003 SE, 0.0578 SD)
Final expected heterozygosity was 0.9609 (0.0015 SE, 0.0206 SD)
Final observed heterozygosity was 0.9641 (0.0015 SE, 0.0214 SD)
Final number of alleles was 51.95 (0.96 SE, 13.52 SD)
****

VORTES.020

Like VORTES.011, with the following changes:

Frequency of type 1 catastrophes: 3.000 percent
with 0.900 multiplicative effect on reproduction
and 0.700 multiplicative effect on survival

Frequency of type 2 catastrophes: 5.000 percent
with 0.950 multiplicative effect on reproduction
and 0.950 multiplicative effect on survival

Deterministic population growth rate (based on females, with assumptions of
no limitation of mates, no density dependence, and no inbreeding depression):

r = -0.009 lambda = 0.991 R0 = 0.885

In 200 simulations of Population1 for 200 years:
74 went extinct and 126 survived.

This gives a probability of extinction of 0.3700 (0.0341 SE),
or a probability of success of 0.6300 (0.0341 SE).

78 simulations went extinct at least once.
Of those going extinct,
mean time to first extinction was 153.00 years (3.45 SE, 30.46 SD).

20 recolonizations occurred.
Mean time to recolonization was 4.15 years (0.60 SE, 2.68 SD).

16 re-extinctions occurred.
Mean time to re-extinction was 8.25 years (1.84 SE, 7.36 SD).

Mean final population for successful cases was 44.63 (4.35 SE, 48.85 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was -0.0165 (0.0006 SE, 0.1133 SD)
Final expected heterozygosity was 0.8028 (0.0125 SE, 0.1402 SD)
Final observed heterozygosity was 0.8547 (0.0147 SE, 0.1647 SD)
Final number of alleles was 12.19 (0.73 SE, 8.24 SD)

In 200 simulations of Population2 for 200 years:
93 went extinct and 107 survived.

This gives a probability of extinction of 0.4650 (0.0353 SE),
or a probability of success of 0.5350 (0.0353 SE).

107 simulations went extinct at least once.
Median time to first extinction was 194 years.
Of those going extinct,
mean time to first extinction was 143.37 years (3.45 SE, 35.68 SD).

102 recolonizations occurred.
Mean time to recolonization was 6.27 years (0.61 SE, 6.15 SD).

88 re-extinctions occurred.
Mean time to re-extinction was 10.25 years (1.28 SE, 12.03 SD).

Mean final population for successful cases was 24.00 (2.25 SE, 23.26 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was -0.0077 (0.0008 SE, 0.1436 SD)
Final expected heterozygosity was 0.8107 (0.0103 SE, 0.1068 SD)
Final observed heterozygosity was 0.8640 (0.0128 SE, 0.1324 SD)
Final number of alleles was 10.92 (0.66 SE, 6.78 SD)

In 200 simulations of Meta-population for 200 years:
73 went extinct and 127 survived.

This gives a probability of extinction of 0.3650 (0.0340 SE),
or a probability of success of 0.6350 (0.0340 SE).

73 simulations went extinct at least once.
Of those going extinct,
mean time to first extinction was 158.08 years (3.55 SE, 30.34 SD).

No recolonizations.

Mean final population for successful cases was 64.72 (6.19 SE, 69.73 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was -0.0155 (0.0005 SE, 0.0883 SD)
Final expected heterozygosity was 0.8192 (0.0116 SE, 0.1310 SD)
Final observed heterozygosity was 0.8553 (0.0126 SE, 0.1424 SD)
Final number of alleles was 13.15 (0.74 SE, 8.30 SD)
****

VORTES.021

Like VORTES.020, with the following changes:

Frequency of type 1 catastrophes: 3.000 percent
with 0.800 multiplicative effect on reproduction
and 0.400 multiplicative effect on survival

Frequency of type 2 catastrophes: 5.000 percent
with 0.900 multiplicative effect on reproduction
and 0.900 multiplicative effect on survival

Deterministic population growth rate (based on females, with assumptions of
no limitation of mates, no density dependence, and no inbreeding depression):

r = -0.021 lambda = 0.979 R0 = 0.757

In 200 simulations of Population 1 for 200 years:
182 went extinct and 18 survived.

This gives a probability of extinction of 0.9100 (0.0202 SE),

or a probability of success of 0.0900 (0.0202 SE).

182 simulations went extinct at least once.
Median time to first extinction was 109 years.
Of those going extinct,
mean time to first extinction was 104.02 years (2.74 SE, 36.95 SD).

42 recolonizations occurred.
Mean time to recolonization was 6.00 years (0.95 SE, 6.14 SD).

42 re-extinctions occurred.
Mean time to re-extinction was 13.71 years (2.22 SE, 14.36 SD).

Mean final population for successful cases was 24.67 (10.15 SE, 43.06 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was -0.0394 (0.0013 SE, 0.2021 SD)
Final expected heterozygosity was 0.7185 (0.0356 SE, 0.1512 SD)
Final observed heterozygosity was 0.8223 (0.0327 SE, 0.1386 SD)
Final number of alleles was 7.28 (1.00 SE, 4.25 SD)

In 200 simulations of Population2 for 200 years:
187 went extinct and 13 survived.

This gives a probability of extinction of 0.9350 (0.0174 SE),
or a probability of success of 0.0650 (0.0174 SE).

192 simulations went extinct at least once.
Median time to first extinction was 89 years.
Of those going extinct,
mean time to first extinction was 89.96 years (2.76 SE, 38.29 SD).

190 recolonizations occurred.
Mean time to recolonization was 6.33 years (0.50 SE, 6.94 SD).

185 re-extinctions occurred.
Mean time to re-extinction was 9.48 years (1.08 SE, 14.72 SD).

Mean final population for successful cases was 15.38 (4.15 SE, 14.95 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was -0.0261 (0.0015 SE, 0.2220 SD)
Final expected heterozygosity was 0.8031 (0.0220 SE, 0.0795 SD)
Final observed heterozygosity was 0.9291 (0.0235 SE, 0.0846 SD)
Final number of alleles was 8.00 (1.03 SE, 3.70 SD)

In 200 simulations of Meta-population for 200 years:
181 went extinct and 19 survived.

This gives a probability of extinction of 0.9050 (0.0207 SE),
or a probability of success of 0.0950 (0.0207 SE).

181 simulations went extinct at least once.
Median time to first extinction was 115 years.
Of those going extinct,
mean time to first extinction was 111.34 years (2.70 SE, 36.35 SD).

No recolonizations.

Mean final population for successful cases was 34.63 (12.31 SE, 53.67 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was -0.0384 (0.0010 SE, 0.1527 SD)
Final expected heterozygosity was 0.7693 (0.0280 SE, 0.1222 SD)
Final observed heterozygosity was 0.8577 (0.0241 SE, 0.1051 SD)
Final number of alleles was 8.16 (1.04 SE, 4.52 SD)
****

VORTES.022

Like VORTES.020, with the following changes:

30.00 (EV = 10.00 SD) percent mortality of females between ages 0 and 1
30.00 (EV = 10.00 SD) percent mortality of males between ages 0 and 1

Deterministic population growth rate (based on females, with assumptions of
no limitation of mates, no density dependence, and no inbreeding depression):

r = 0.035 lambda = 1.035 R0 = 1.549

In 200 simulations of Population1 for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 1175.77 (10.45 SE, 147.76 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0192 (0.0004 SE, 0.0867 SD)
Final expected heterozygosity was 0.9820 (0.0003 SE, 0.0039 SD)
Final observed heterozygosity was 0.9831 (0.0004 SE, 0.0058 SD)
Final number of alleles was 106.88 (1.15 SE, 16.29 SD)

In 200 simulations of Population2 for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 410.08 (2.97 SE, 42.00 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0373 (0.0005 SE, 0.0947 SD)
Final expected heterozygosity was 0.9805 (0.0003 SE, 0.0038 SD)
Final observed heterozygosity was 0.9831 (0.0005 SE, 0.0072 SD)
Final number of alleles was 95.87 (0.97 SE, 13.65 SD)

In 200 simulations of Meta-population for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 1585.86 (11.39 SE, 161.12 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0236 (0.0003 SE, 0.0675 SD)
Final expected heterozygosity was 0.9823 (0.0003 SE, 0.0038 SD)
Final observed heterozygosity was 0.9831 (0.0004 SE, 0.0052 SD)
Final number of alleles was 109.05 (1.19 SE, 16.76 SD)
****

VORTES.023

Like VORTES.020, with the following changes:

3.00 (EV = 1.00 SD) percent annual mortality of adult females (6<=age<=25)

3.00 (EV = 1.00 SD) percent annual mortality of adult males (9<=age<=25)

Deterministic population growth rate (based on females, with assumptions of
no limitation of mates, no density dependence, and no inbreeding depression):

r = 0.008 lambda = 1.008 R0 = 1.124

In 200 simulations of Population 1 for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 679.69 (23.28 SE, 329.17 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0055 (0.0004 SE, 0.0829 SD)
Final expected heterozygosity was 0.9648 (0.0019 SE, 0.0264 SD)
Final observed heterozygosity was 0.9675 (0.0020 SE, 0.0281 SD)
Final number of alleles was 63.15 (1.59 SE, 22.50 SD)

In 200 simulations of Population2 for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 291.49 (8.04 SE, 113.66 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0149 (0.0005 SE, 0.0916 SD)
Final expected heterozygosity was 0.9627 (0.0019 SE, 0.0265 SD)
Final observed heterozygosity was 0.9666 (0.0020 SE, 0.0284 SD)
Final number of alleles was 58.07 (1.45 SE, 20.54 SD)

In 200 simulations of Meta-population for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 971.17 (30.12 SE, 425.96 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0074 (0.0003 SE, 0.0617 SD)
Final expected heterozygosity was 0.9656 (0.0018 SE, 0.0257 SD)
Final observed heterozygosity was 0.9671 (0.0019 SE, 0.0270 SD)
Final number of alleles was 64.54 (1.62 SE, 22.85 SD)
****

VORTES.024

Like VORTES.020, with the following changes:

55.00 (EV = 9.95 SD) percent mortality of females between ages 0 and 1
55.00 (EV = 9.95 SD) percent mortality of males between ages 0 and 1

Deterministic population growth rate (based on females, with assumptions of
no limitation of mates, no density dependence, and no inbreeding depression):

r = -0.000 lambda = 1.000 R0 = 0.996

In 200 simulations of Population1 for 200 years:
8 went extinct and 192 survived.

This gives a probability of extinction of 0.0400 (0.0139 SE),
or a probability of success of 0.9600 (0.0139 SE).

9 simulations went extinct at least once.
Of those going extinct,
mean time to first extinction was 151.33 years (9.50 SE, 28.51 SD).

2 recolonizations occurred.
Mean time to recolonization was 7.00 years (6.00 SE, 8.49 SD).

1 re-extinctions occurred.
Mean time to re-extinction was 10.00 years (0.00 SE, 0.00 SD).

Mean final population for successful cases was 177.72 (12.62 SE, 174.81 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was -0.0041 (0.0005 SE, 0.0939 SD)
Final expected heterozygosity was 0.9049 (0.0056 SE, 0.0781 SD)
Final observed heterozygosity was 0.9194 (0.0064 SE, 0.0884 SD)
Final number of alleles was 28.42 (1.25 SE, 17.29 SD)

In 200 simulations of Population2 for 200 years:
12 went extinct and 188 survived.

This gives a probability of extinction of 0.0600 (0.0168 SE),
or a probability of success of 0.9400 (0.0168 SE).

16 simulations went extinct at least once.
Of those going extinct,
mean time to first extinction was 143.44 years (9.81 SE, 39.23 SD).

20 recolonizations occurred.
Mean time to recolonization was 4.75 years (1.10 SE, 4.90 SD).

16 re-extinctions occurred.
Mean time to re-extinction was 13.12 years (2.87 SE, 11.47 SD).

Mean final population for successful cases was 93.45 (6.28 SE, 86.06 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0042 (0.0006 SE, 0.1119 SD)
Final expected heterozygosity was 0.8986 (0.0054 SE, 0.0745 SD)
Final observed heterozygosity was 0.9291 (0.0054 SE, 0.0740 SD)
Final number of alleles was 25.62 (1.17 SE, 16.03 SD)

In 200 simulations of Meta-population for 200 years:
7 went extinct and 193 survived.

This gives a probability of extinction of 0.0350 (0.0130 SE),
or a probability of success of 0.9650 (0.0130 SE).

7 simulations went extinct at least once.
Of those going extinct,
mean time to first extinction was 144.71 years (6.20 SE, 16.41 SD).

No recolonizations.

Mean final population for successful cases was 267.85 (18.48 SE, 256.74 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was -0.0025 (0.0004 SE, 0.0706 SD)
Final expected heterozygosity was 0.9083 (0.0053 SE, 0.0742 SD)

Final observed heterozygosity was 0.9198 (0.0059 SE, 0.0825 SD)
Final number of alleles was 29.69 (1.29 SE, 17.86 SD)
****

VORTES.025

Like VORTES.020, with the following changes:

50.00 (EV = 10.00 SD) percent mortality of females between ages 0 and 1
50.00 (EV = 10.00 SD) percent mortality of males between ages 0 and 1

Deterministic population growth rate (based on females, with assumptions of
no limitation of mates, no density dependence, and no inbreeding depression):

r = 0.008 lambda = 1.008 R0 = 1.106

In 200 simulations of Population1 for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 574.86 (22.76 SE, 321.88 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0041 (0.0004 SE, 0.0873 SD)
Final expected heterozygosity was 0.9543 (0.0023 SE, 0.0330 SD)
Final observed heterozygosity was 0.9572 (0.0025 SE, 0.0355 SD)
Final number of alleles was 52.48 (1.52 SE, 21.56 SD)

In 200 simulations of Population2 for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

1 simulations went extinct at least once.
Of those going extinct,
mean time to first extinction was 132.00 years (0.00 SE, 0.00 SD).

1 recolonizations occurred.
Mean time to recolonization was 1.00 years (0.00 SE, 0.00 SD).

No Re-extinctions.

Mean final population for successful cases was 265.71 (8.51 SE, 120.38 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0136 (0.0005 SE, 0.0982 SD)
Final expected heterozygosity was 0.9512 (0.0026 SE, 0.0366 SD)
Final observed heterozygosity was 0.9584 (0.0022 SE, 0.0305 SD)
Final number of alleles was 48.77 (1.42 SE, 20.05 SD)

In 200 simulations of Meta-population for 200 years:
0 went extinct and 200 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Mean final population for successful cases was 840.57 (30.41 SE, 430.00 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0061 (0.0003 SE, 0.0653 SD)
Final expected heterozygosity was 0.9556 (0.0022 SE, 0.0313 SD)
Final observed heterozygosity was 0.9576 (0.0022 SE, 0.0307 SD)
Final number of alleles was 53.84 (1.56 SE, 21.99 SD)
****

VORTES.026

Like VORTES.020, with the following changes:

Frequency of type 2 catastrophes: 5.000 percent
with 1.000 multiplicative effect on reproduction
and 1.000 multiplicative effect on survival

Deterministic population growth rate (based on females, with assumptions of
no limitation of mates, no density dependence, and no inbreeding depression):

r = -0.007 lambda = 0.994 R0 = 0.917

In 200 simulations of Population 1 for 200 years:
43 went extinct and 157 survived.

This gives a probability of extinction of 0.2150 (0.0290 SE),
or a probability of success of 0.7850 (0.0290 SE).

44 simulations went extinct at least once.

Of those going extinct,
mean time to first extinction was 159.05 years (5.44 SE, 36.07 SD).

6 recolonizations occurred.
Mean time to recolonization was 4.83 years (1.54 SE, 3.76 SD).

5 re-extinctions occurred.
Mean time to re-extinction was 12.60 years (4.18 SE, 9.34 SD).

Mean final population for successful cases was 68.25 (5.02 SE, 62.87 SD)
Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was -0.0119 (0.0005 SE, 0.1042 SD)
Final expected heterozygosity was 0.8522 (0.0088 SE, 0.1100 SD)
Final observed heterozygosity was 0.8921 (0.0096 SE, 0.1204 SD)
Final number of alleles was 16.08 (0.79 SE, 9.86 SD)

In 200 simulations of Population 2 for 200 years:
56 went extinct and 144 survived.

This gives a probability of extinction of 0.2800 (0.0317 SE),
or a probability of success of 0.7200 (0.0317 SE).

72 simulations went extinct at least once.
Of those going extinct,
mean time to first extinction was 144.32 years (4.35 SE, 36.93 SD).

106 recolonizations occurred.
Mean time to recolonization was 5.62 years (0.51 SE, 5.23 SD).

90 re-extinctions occurred.
Mean time to re-extinction was 9.93 years (1.36 SE, 12.93 SD).

Mean final population for successful cases was 35.12 (2.71 SE, 32.49 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was -0.0039 (0.0007 SE, 0.1319 SD)
Final expected heterozygosity was 0.8281 (0.0110 SE, 0.1325 SD)
Final observed heterozygosity was 0.8755 (0.0107 SE, 0.1284 SD)
Final number of alleles was 14.16 (0.74 SE, 8.94 SD)

In 200 simulations of Meta-population for 200 years:
40 went extinct and 160 survived.

This gives a probability of extinction of 0.2000 (0.0283 SE),
or a probability of success of 0.8000 (0.0283 SE).

40 simulations went extinct at least once.
Of those going extinct,
mean time to first extinction was 163.28 years (5.63 SE, 35.63 SD).

No recolonizations.

Mean final population for successful cases was 98.71 (7.22 SE, 91.35 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was -0.0106 (0.0004 SE, 0.0810 SD)
Final expected heterozygosity was 0.8524 (0.0092 SE, 0.1162 SD)
Final observed heterozygosity was 0.8843 (0.0094 SE, 0.1193 SD)
Final number of alleles was 17.04 (0.83 SE, 10.53 SD)
****

VORTES.027

Like VORTES.020, with the following changes:

Frequency of type 1 catastrophes: 3.000 percent
with 1.000 multiplicative effect on reproduction
and 1.000 multiplicative effect on survival

Deterministic population growth rate (based on females, with assumptions of
no limitation of mates, no density dependence, and no inbreeding depression):

r = 0.000 lambda = 1.000 R0 = 1.001

In 200 simulations of Population1 for 200 years:
1 went extinct and 199 survived.

This gives a probability of extinction of 0.0050 (0.0050 SE),
or a probability of success of 0.9950 (0.0050 SE).

1 simulations went extinct at least once.
Of those going extinct,
mean time to first extinction was 184.00 years (0.00 SE, 0.00 SD).

No recolonizations.
Mean final population for successful cases was 196.09 (11.13 SE, 157.01 SD)

Without harvest/supplementation, prior to carrying capacity truncation,

mean growth rate (r) was -0.0021 (0.0003 SE, 0.0655 SD)
Final expected heterozygosity was 0.9272 (0.0029 SE, 0.0409 SD)
Final observed heterozygosity was 0.9365 (0.0031 SE, 0.0437 SD)
Final number of alleles was 31.22 (1.00 SE, 14.14 SD)

In 200 simulations of Population2 for 200 years:
3 went extinct and 197 survived.

This gives a probability of extinction of 0.0150 (0.0086 SE),
or a probability of success of 0.9850 (0.0086 SE).

5 simulations went extinct at least once.
Of those going extinct,
mean time to first extinction was 160.60 years (10.42 SE, 23.30 SD).

8 recolonizations occurred.
Mean time to recolonization was 7.12 years (3.74 SE, 10.59 SD).

6 re-extinctions occurred.
Mean time to re-extinction was 4.83 years (1.99 SE, 4.88 SD).

Mean final population for successful cases was 99.66 (5.44 SE, 76.39 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0062 (0.0004 SE, 0.0857 SD)
Final expected heterozygosity was 0.9200 (0.0031 SE, 0.0442 SD)
Final observed heterozygosity was 0.9374 (0.0032 SE, 0.0449 SD)
Final number of alleles was 27.65 (0.94 SE, 13.19 SD)

In 200 simulations of Meta-population for 200 years:
1 went extinct and 199 survived.

This gives a probability of extinction of 0.0050 (0.0050 SE),
or a probability of success of 0.9950 (0.0050 SE).

1 simulations went extinct at least once.
Of those going extinct,
mean time to first extinction was 184.00 years (0.00 SE, 0.00 SD).

No recolonizations.

Mean final population for successful cases was 294.76 (16.33 SE, 230.37 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was -0.0005 (0.0003 SE, 0.0501 SD)
Final expected heterozygosity was 0.9302 (0.0027 SE, 0.0385 SD)
Final observed heterozygosity was 0.9367 (0.0028 SE, 0.0392 SD)
Final number of alleles was 32.53 (1.02 SE, 14.34 SD)
****

VORTES.030

Like VORTES.011, with the following changes:

Animals harvested from population 1, year 1 to year 200 at 1 year intervals:
2 females 1 years old
1 females 3 years old
1 females 4 years old
2 female adults (6 <= age <= 25)
2 males 1 years old
1 males 2 years old
1 males 6 years old
1 males 8 years old
1 male adults (9 <= age <= 25)

Animals harvested from population 2, year 1 to year 200 at 2 year intervals:
1 females 5 years old
1 males 8 years old

Deterministic population growth rate (based on females, with assumptions of
no limitation of mates, no density dependence, and no inbreeding depression):

r = 0.003 lambda = 1.003 R0 = 1.038
Generation time for: females = 13.45 males = 15.51

In 200 simulations of Population 1 for 200 years:
200 went extinct and 0 survived.

This gives a probability of extinction of 1.0000 (0.0000 SE),
or a probability of success of 0.0000 (0.0000 SE).

200 simulations went extinct at least once.
Median time to first extinction was 23 years.
Of those going extinct,
mean time to first extinction was 23.45 years (0.27 SE, 3.89 SD).

48 recolonizations occurred.
Mean time to recolonization was 4.94 years (0.79 SE, 5.49 SD).

48 re-extinctions occurred.
Mean time to re-extinction was 1.23 years (0.07 SE, 0.47 SD).

During years of harvest and/or supplementation
mean growth rate (r) was -0.1816 (0.0032 SE, 0.2166 SD)

In 200 simulations of Population2 for 200 years:
200 went extinct and 0 survived.

This gives a probability of extinction of 1.0000 (0.0000 SE),
or a probability of success of 0.0000 (0.0000 SE).

200 simulations went extinct at least once.
Median time to first extinction was 44 years.
Of those going extinct,
mean time to first extinction was 46.52 years (0.83 SE, 11.71 SD).

No recolonizations.

During years of harvest and/or supplementation
mean growth rate (r) was -0.0682 (0.0026 SE, 0.1776 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was -0.0268 (0.0025 SE, 0.1718 SD)

In 200 simulations of Meta-population for 200 years:
200 went extinct and 0 survived.

This gives a probability of extinction of 1.0000 (0.0000 SE),
or a probability of success of 0.0000 (0.0000 SE).

200 simulations went extinct at least once.
Median time to first extinction was 44 years.
Of those going extinct,
mean time to first extinction was 46.58 years (0.82 SE, 11.66 SD).

No recolonizations.

During years of harvest and/or supplementation
mean growth rate (r) was -0.1004 (0.0016 SE, 0.1525 SD)
****

VORTES.031

Like VORTES.011, with the following changes:

Animals harvested from population 1, year 1 to year 200 at 1 year intervals:
2 females 1 years old
1 females 3 years old
1 females 4 years old
2 female adults (6 <= age <= 25)
2 males 1 years old
1 males 2 years old
1 males 6 years old
1 male adults (9 <= age <= 25)

Animals harvested from population 2, year 1 to year 200 at 1 year intervals:
1 females 5 years old
1 males 8 years old
Deterministic population growth rate (based on females, with assumptions of
no limitation of mates, no density dependence, and no inbreeding depression):

r = 0.003 lambda = 1.003 R0 = 1.038

In 200 simulations of Population 1 for 200 years:
200 went extinct and 0 survived.

This gives a probability of extinction of 1.0000 (0.0000 SE),
or a probability of success of 0.0000 (0.0000 SE).

200 simulations went extinct at least once.
Median time to first extinction was 22 years.
Of those going extinct,
mean time to first extinction was 22.46 years (0.22 SE, 3.16 SD).

32 recolonizations occurred.
Mean time to recolonization was 2.69 years (0.38 SE, 2.18 SD).

32 re-extinctions occurred.
Mean time to re-extinction was 1.06 years (0.04 SE, 0.25 SD).

During years of harvest and/or supplementation
mean growth rate (r) was -0.1526 (0.0024 SE, 0.1587 SD)

In 200 simulations of Population2 for 200 years:
200 went extinct and 0 survived.

This gives a probability of extinction of 1.0000 (0.0000 SE),
or a probability of success of 0.0000 (0.0000 SE).

200 simulations went extinct at least once.
Median time to first extinction was 32 years.
Of those going extinct,
mean time to first extinction was 32.94 years (0.50 SE, 7.04 SD).

No recolonizations.

During years of harvest and/or supplementation
mean growth rate (r) was -0.0716 (0.0025 SE, 0.2052 SD)

In 200 simulations of Meta-population for 200 years:
200 went extinct and 0 survived.

This gives a probability of extinction of 1.0000 (0.0000 SE),
or a probability of success of 0.0000 (0.0000 SE).

200 simulations went extinct at least once.
Median time to first extinction was 33 years.
Of those going extinct,
mean time to first extinction was 33.20 years (0.47 SE, 6.63 SD).

No recolonizations.

During years of harvest and/or supplementation
mean growth rate (r) was -0.1427 (0.0021 SE, 0.1708 SD)
****

VORTES.032

Like VORTES.011, with the following changes:

Animals harvested from population 1, year 1 to year 200 at 1 year intervals:
1 females 1 years old
1 females 3 years old
1 females 4 years old
1 female adults (6 <= age <= 25)
2 males 1 years old
1 males 6 years old
1 male adults (9 <= age <= 25)

Animals harvested from population 2, year 1 to year 200 at 1 year intervals:
1 females 5 years old
1 males 8 years old

Deterministic population growth rate (based on females, with assumptions of
no limitation of mates, no density dependence, and no inbreeding depression):

r = 0.003 lambda = 1.003 R0 = 1.038

In 200 simulations of Population1 for 200 years:
200 went extinct and 0 survived.

This gives a probability of extinction of 1.0000 (0.0000 SE),
or a probability of success of 0.0000 (0.0000 SE).
200 simulations went extinct at least once.
Median time to first extinction was 31 years.
Of those going extinct,
mean time to first extinction was 31.70 years (0.41 SE, 5.81 SD).

19 recolonizations occurred.
Mean time to recolonization was 2.42 years (0.35 SE, 1.54 SD).

19 re-extinctions occurred.
Mean time to re-extinction was 1.74 years (0.21 SE, 0.93 SD).

During years of harvest and/or supplementation
mean growth rate (r) was -0.1425 (0.0024 SE, 0.1942 SD)

In 200 simulations of Population2 for 200 years:
200 went extinct and 0 survived.

This gives a probability of extinction of 1.0000 (0.0000 SE),
or a probability of success of 0.0000 (0.0000 SE).

200 simulations went extinct at least once.
Median time to first extinction was 38 years.
Of those going extinct,
mean time to first extinction was 38.89 years (0.65 SE, 9.25 SD).

6 recolonizations occurred.
Mean time to recolonization was 2.17 years (0.65 SE, 1.60 SD).

6 re-extinctions occurred.
Mean time to re-extinction was 7.50 years (1.98 SE, 4.85 SD).

During years of harvest and/or supplementation
mean growth rate (r) was -0.0595 (0.0022 SE, 0.1937 SD)

In 200 simulations of Meta-population for 200 years:
200 went extinct and 0 survived.

This gives a probability of extinction of 1.0000 (0.0000 SE),
or a probability of success of 0.0000 (0.0000 SE).

200 simulations went extinct at least once.
Median time to first extinction was 39 years.
Of those going extinct,
mean time to first extinction was 39.77 years (0.58 SE, 8.24 SD).

No recolonizations.

During years of harvest and/or supplementation
mean growth rate (r) was -0.1205 (0.0019 SE, 0.1668 SD)
****

VORTES.033

Like VORTES.031, with the following changes:

50.00 (EV = 20.41 SD) percent mortality of females between ages 0 and 1
50.00 (EV = 20.41 SD) percent mortality of males between ages 0 and 1

Deterministic population growth rate (based on females, with assumptions of
no limitation of mates, no density dependence, and no inbreeding depression):

r = 0.020 lambda = 1.020 R0 = 1.297

In 200 simulations of Population1 for 200 years:
200 went extinct and 0 survived.

This gives a probability of extinction of 1.0000 (0.0000 SE),
or a probability of success of 0.0000 (0.0000 SE).

200 simulations went extinct at least once.
Median time to first extinction was 27 years.
Of those going extinct,
mean time to first extinction was 27.11 years (0.34 SE, 4.85 SD).

61 recolonizations occurred.
Mean time to recolonization was 3.59 years (0.32 SE, 2.47 SD).

61 re-extinctions occurred.
Mean time to re-extinction was 1.10 years (0.04 SE, 0.30 SD).

During years of harvest and/or supplementation
mean growth rate (r) was -0.1266 (0.0021 SE, 0.1576 SD)

In 200 simulations of Population2 for 200 years:
200 went extinct and 0 survived.

This gives a probability of extinction of 1.0000 (0.0000 SE),
or a probability of success of 0.0000 (0.0000 SE).

200 simulations went extinct at least once.
Median time to first extinction was 40 years.
Of those going extinct,
mean time to first extinction was 41.31 years (0.70 SE, 9.88 SD).

No recolonizations.

During years of harvest and/or supplementation
mean growth rate (r) was -0.0534 (0.0020 SE, 0.1862 SD)

In 200 simulations of Meta-population for 200 years:
200 went extinct and 0 survived.

This gives a probability of extinction of 1.0000 (0.0000 SE),
or a probability of success of 0.0000 (0.0000 SE).

200 simulations went extinct at least once.
Median time to first extinction was 40 years.
Of those going extinct,
mean time to first extinction was 41.52 years (0.68 SE, 9.65 SD).

No recolonizations.

During years of harvest and/or supplementation
mean growth rate (r) was -0.1115 (0.0017 SE, 0.1580 SD)
****

VORTES.034

Like VORTES.011, with the following changes:

Animals harvested from population 1, year 1 to year 200 at 1 year intervals:
1 females 4 years old
1 males 1 years old
1 male adults (9 <= age <= 25)

Animals harvested from population 2, year 1 to year 200 at 4 year intervals:
1 females 5 years old
1 males 8 years old

Deterministic population growth rate (based on females, with assumptions of
no limitation of mates, no density dependence, and no inbreeding depression):

r = 0.003 lambda = 1.003 R0 = 1.038

In 200 simulations of Population1 for 200 years:
176 went extinct and 24 survived.

This gives a probability of extinction of 0.8800 (0.0230 SE),
or a probability of success of 0.1200 (0.0230 SE).

177 simulations went extinct at least once.
Median time to first extinction was 102 years.
Of those going extinct,
mean time to first extinction was 101.04 years (2.72 SE, 36.18 SD).

194 recolonizations occurred.
Mean time to recolonization was 6.01 years (0.45 SE, 6.22 SD).

193 re-extinctions occurred.
Mean time to re-extinction was 4.90 years (0.21 SE, 2.96 SD).

Mean final population for successful cases was 151.46 (33.30 SE, 163.16 SD)

During years of harvest and/or supplementation
mean growth rate (r) was -0.0336 (0.0008 SE, 0.1214 SD)

Final expected heterozygosity was 0.9272 (0.0090 SE, 0.0439 SD)
Final observed heterozygosity was 0.9442 (0.0074 SE, 0.0365 SD)
Final number of alleles was 31.42 (3.35 SE, 16.43 SD)

In 200 simulations of Population2 for 200 years:
169 went extinct and 31 survived.

This gives a probability of extinction of 0.8450 (0.0256 SE),
or a probability of success of 0.1550 (0.0256 SE).

169 simulations went extinct at least once.
Median time to first extinction was 124 years.
Of those going extinct,
mean time to first extinction was 120.02 years (2.54 SE, 33.01 SD).

8 recolonizations occurred.
Mean time to recolonization was 5.00 years (1.18 SE, 3.34 SD).

8 re-extinctions occurred.
Mean time to re-extinction was 6.00 years (1.80 SE, 5.10 SD).

Mean final population for successful cases was 69.81 (14.76 SE, 82.18 SD)

During years of harvest and/or supplementation
mean growth rate (r) was -0.0395 (0.0017 SE, 0.1424 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was -0.0058 (0.0009 SE, 0.1285 SD)

Final expected heterozygosity was 0.8815 (0.0200 SE, 0.1115 SD)
Final observed heterozygosity was 0.9323 (0.0134 SE, 0.0746 SD)
Final number of alleles was 23.00 (2.76 SE, 15.39 SD)

In 200 simulations of Meta-population for 200 years:
167 went extinct and 33 survived.

This gives a probability of extinction of 0.8350 (0.0262 SE),
or a probability of success of 0.1650 (0.0262 SE).

167 simulations went extinct at least once.
Median time to first extinction was 129 years.
Of those going extinct,
mean time to first extinction was 122.38 years (2.44 SE, 31.50 SD).

No recolonizations.

Mean final population for successful cases was 176.67 (40.25 SE, 231.24 SD)

During years of harvest and/or supplementation
mean growth rate (r) was -0.0314 (0.0006 SE, 0.1036 SD)

Final expected heterozygosity was 0.8722 (0.0237 SE, 0.1363 SD)
Final observed heterozygosity was 0.9042 (0.0176 SE, 0.1010 SD)
Final number of alleles was 26.30 (3.19 SE, 18.33 SD)
****

VORTES.035

Like VORTES.011, with the following changes:
Animals harvested from population 1, year 1 to year 200 at 2 year intervals:
1 females 4 years old
1 males 1 years old
1 male adults (9 <= age <= 25)

Animals harvested from population 2, year 1 to year 200 at 8 year intervals:
1 females 5 years old
1 males 8 years old

Deterministic population growth rate (based on females, with assumptions of
no limitation of mates, no density dependence, and no inbreeding depression):

r = 0.003 lambda = 1.003 R0 = 1.038

In 200 simulations of Population1 for 200 years:
70 went extinct and 130 survived.

This gives a probability of extinction of 0.3500 (0.0337 SE),
or a probability of success of 0.6500 (0.0337 SE).

75 simulations went extinct at least once.
Of those going extinct,
mean time to first extinction was 143.28 years (4.17 SE, 36.13 SD).
33 recolonizations occurred.
Mean time to recolonization was 7.73 years (1.37 SE, 7.85 SD).

28 re-extinctions occurred.
Mean time to re-extinction was 5.39 years (0.65 SE, 3.45 SD).

Mean final population for successful cases was 182.56 (18.95 SE, 216.11 SD)

During years of harvest and/or supplementation
mean growth rate (r) was -0.0283 (0.0008 SE, 0.1012 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0050 (0.0007 SE, 0.0925 SD)

Final expected heterozygosity was 0.9083 (0.0059 SE, 0.0671 SD)
Final observed heterozygosity was 0.9314 (0.0066 SE, 0.0754 SD)
Final number of alleles was 28.45 (1.66 SE, 18.97 SD)

In 200 simulations of Population2 for 200 years:
61 went extinct and 139 survived.

This gives a probability of extinction of 0.3050 (0.0326 SE),
or a probability of success of 0.6950 (0.0326 SE).

62 simulations went extinct at least once.
Of those going extinct,
mean time to first extinction was 144.48 years (4.04 SE, 31.83 SD).

16 recolonizations occurred.
Mean time to recolonization was 4.69 years (1.16 SE, 4.64 SD).

15 re-extinctions occurred.
Mean time to re-extinction was 7.93 years (2.51 SE, 9.74 SD).

Mean final population for successful cases was 85.71 (7.15 SE, 84.28 SD)

During years of harvest and/or supplementation
mean growth rate (r) was -0.0234 (0.0017 SE, 0.1184 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0025 (0.0006 SE, 0.1088 SD)

Final expected heterozygosity was 0.8842 (0.0085 SE, 0.1003 SD)
Final observed heterozygosity was 0.9099 (0.0083 SE, 0.0975 SD)
Final number of alleles was 24.56 (1.53 SE, 17.99 SD)

In 200 simulations of Meta-population for 200 years:
60 went extinct and 140 survived.

This gives a probability of extinction of 0.3000 (0.0324 SE),
or a probability of success of 0.7000 (0.0324 SE).

60 simulations went extinct at least once.
Of those going extinct,
mean time to first extinction was 149.33 years (3.98 SE, 30.86 SD).

No recolonizations.

Mean final population for successful cases was 254.80 (24.68 SE, 291.98 SD)

During years of harvest and/or supplementation
mean growth rate (r) was -0.0208 (0.0006 SE, 0.0782 SD)

Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0004 (0.0006 SE, 0.0769 SD)

Final expected heterozygosity was 0.8994 (0.0077 SE, 0.0912 SD)
Final observed heterozygosity was 0.9134 (0.0081 SE, 0.0960 SD)
Final number of alleles was 28.41 (1.64 SE, 19.40 SD)
****

VORTES.036

Like VORTES.011, with the following changes:

Animals harvested from population 1, year 1 to year 200 at 4 year intervals:
1 females 4 years old
1 males 1 years old
1 male adults (9 <= age <= 25)

Animals harvested from population 2, year 1 to year 200 at 16 year intervals:
1 females 5 years old
1 males 8 years old

Deterministic population growth rate (based on females, with assumptions of
no limitation of mates, no density dependence, and no inbreeding depression):
r = 0.003 lambda = 1.003 R0 = 1.038

In 200 simulations of Population 1 for 200 years:
14 went extinct and 186 survived.

This gives a probability of extinction of 0.0700 (0.0180 SE),
or a probability of success of 0.9300 (0.0180 SE).

15 simulations went extinct at least once.

Of those going extinct,
mean time to first extinction was 158.93 years (7.75 SE, 30.02 SD).

9 recolonizations occurred.
Mean time to recolonization was 8.78 years (2.61 SE, 7.82 SD).

8 re-extinctions occurred.
Mean time to re-extinction was 4.75 years (1.78 SE, 5.04 SD).

Mean final population for successful cases was 303.23 (18.10 SE, 246.80 SD)

During years of harvest and/or supplementation
mean growth rate (r) was -0.0203 (0.0009 SE, 0.0878 SD)
Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0038 (0.0005 SE, 0.0839 SD)
Final expected heterozygosity was 0.9315 (0.0039 SE, 0.0530 SD)
Final observed heterozygosity was 0.9452 (0.0032 SE, 0.0443 SD)
Final number of alleles was 36.79 (1.45 SE, 19.79 SD)

In 200 simulations of Population2 for 200 years:
17 went extinct and 183 survived.

This gives a probability of extinction of 0.0850 (0.0197 SE),
or a probability of success of 0.9150 (0.0197 SE).

17 simulations went extinct at least once.
Of those going extinct,
mean time to first extinction was 160.06 years (9.16 SE, 37.77 SD).

15 recolonizations occurred.
Mean time to recolonization was 4.67 years (0.76 SE, 2.94 SD).

15 re-extinctions occurred.
Mean time to re-extinction was 7.27 years (2.45 SE, 9.48 SD).

Mean final population for successful cases was 141.76 (7.97 SE, 107.88 SD)

During years of harvest and/or supplementation
mean growth rate (r) was -0.0105 (0.0021 SE, 0.1041 SD)
Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0076 (0.0005 SE, 0.0968 SD)
Final expected heterozygosity was 0.9239 (0.0045 SE, 0.0615 SD)
Final observed heterozygosity was 0.9394 (0.0049 SE, 0.0662 SD)
Final number of alleles was 33.70 (1.35 SE, 18.22 SD)

In 200 simulations of Meta-population for 200 years:
12 went extinct and 188 survived.

This gives a probability of extinction of 0.0600 (0.0168 SE),
or a probability of success of 0.9400 (0.0168 SE).

12 simulations went extinct at least once.
Of those going extinct,
mean time to first extinction was 166.08 years (8.58 SE, 29.73 SD).

No recolonizations.

Mean final population for successful cases was 438.04 (25.64 SE, 351.57 SD)

During years of harvest and/or supplementation
mean growth rate (r) was -0.0137 (0.0007 SE, 0.0687 SD)
Without harvest/supplementation, prior to carrying capacity truncation,
mean growth rate (r) was 0.0039 (0.0004 SE, 0.0638 SD)
Final expected heterozygosity was 0.9320 (0.0038 SE, 0.0522 SD)
Final observed heterozygosity was 0.9418 (0.0040 SE, 0.0548 SD)
Final number of alleles was 37.71 (1.47 SE, 20.16 SD)
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VORTES.037

Like VORTES.011, with the following changes:

Animals harvested from population 1, year 1 to year 200 at 1 year intervals:
1 females 1 years old
1 females 3 years old
1 females 4 years old
2 female adults (6 <= age <= 25)
1 males 1 years old
1 males 2 years old
1 males 6 years old
1 male adults (9 <= age <= 25)

Animals harvested from population 2, year 1 to year 200 at 1 year intervals:
1 females 5 years old
1 males 8 years old

Deterministic population growth rate (based on females, with assumptions of
no limitation of mates, no density dependence, and no inbreeding depression):

r = 0.003 lambda = 1.003 R0 = 1.038

In 200 simulations of Population1 for 200 years:
200 went extinct and 0 survived.

This gives a probability of extinction of 1.0000 (0.0000 SE),
or a probability of success of 0.0000 (0.0000 SE).

200 simulations went extinct at least once.
Median time to first extinction was 24 years.
Of those going extinct,
mean time to first extinction was 24.69 years (0.28 SE, 3.95 SD).

37 recolonizations occurred.
Mean time to recolonization was 3.38 years (0.51 SE, 3.11 SD).
37 re-extinctions occurred.
Mean time to re-extinction was 1.08 years (0.05 SE, 0.28 SD).

During years of harvest and/or supplementation
mean growth rate (r) was -0.1442 (0.0024 SE, 0.1667 SD)

In 200 simulations of Population2 for 200 years:
200 went extinct and 0 survived.

This gives a probability of extinction of 1.0000 (0.0000 SE),
or a probability of success of 0.0000 (0.0000 SE).

200 simulations went extinct at least once.
Median time to first extinction was 35 years.
Of those going extinct,
mean time to first extinction was 34.24 years (0.56 SE, 7.90 SD).

4 recolonizations occurred.
Mean time to recolonization was 1.25 years (0.25 SE, 0.50 SD).

4 re-extinctions occurred.
Mean time to re-extinction was 4.50 years (0.96 SE, 1.91 SD).

During years of harvest and/or supplementation
mean growth rate (r) was -0.0660 (0.0023 SE, 0.1933 SD)

In 200 simulations of Meta-population for 200 years:
200 went extinct and 0 survived.

This gives a probability of extinction of 1.0000 (0.0000 SE),
or a probability of success of 0.0000 (0.0000 SE).

200 simulations went extinct at least once.
Median time to first extinction was 35 years.
Of those going extinct,
mean time to first extinction was 34.81 years (0.51 SE, 7.20 SD).

No recolonizations.

During years of harvest and/or supplementation
mean growth rate (r) was -0.1334 (0.0019 SE, 0.1617 SD)