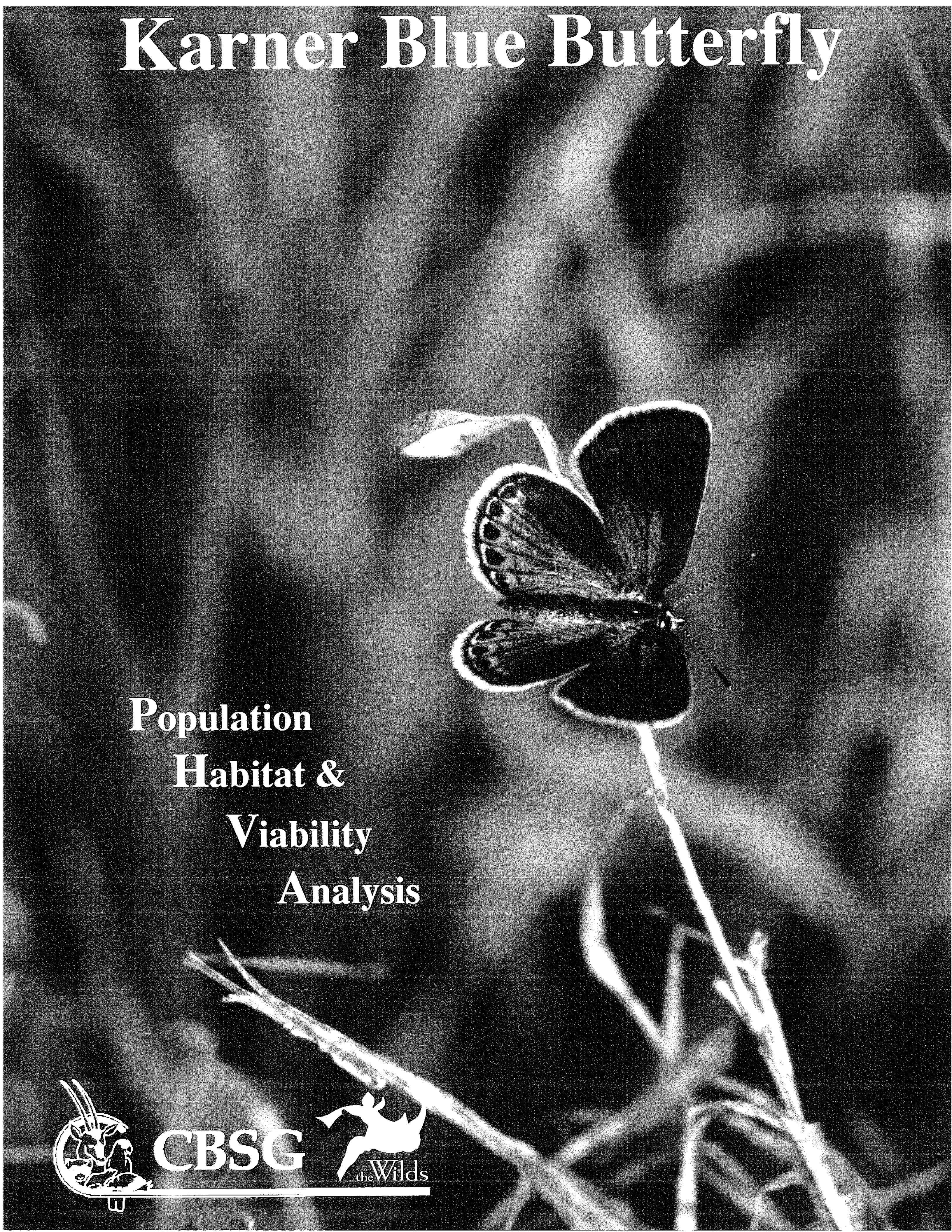
Karner Blue Butterfly



Population Habitat & Viability Analysis

CBSG

the Wilds

KARNER BLUE BUTTERFLY

(Lycaeides melissa samuelis)

POPULATION AND HABITAT VIABILITY ASSESSMENT

DRAFT REPORT FROM WORKSHOP CONDUCTED AT

THE WILDS
Zanesville, Ohio
22-24 April 1992

BY:

U.S. Fish and Wildlife Service
and
Captive Breeding Specialist Group SSC/IUCN

August 1993

KARNER BLUE BUTTERFLY

(Lycaeides melissa samuelis)

POPULATION AND HABITAT

VIABILITY ASSESSMENT

KARNER BLUE BUTTEERFLY AND HABITAT BIOLOGY AND MANAGEMENT

LUPINE PHENOLOGY REPORT

(Working group: Robert Zaremba, Michelle Grigore, Cynthia Lane, Mary Rabe).

Concern: Are there issues in the timing of Lupine life history events that could impact Karner blue butterfly productivity?

Karner Blue Life History Events in Relation to Lupine:

- site of eggs
- first brood food
- pupation sites
- first brood nectar source
- site of eggs
- second brood food
- pupation sites
- site of eggs

Lupine Life History Events:

- lupine sprouts
- leaves fully expanded
- lupine flowers
- lupine begins to senescence
- lupine dormant

Factors Affecting Timing of Lupine Events:

<u>early</u>
- fungi
- drought
- flowering
- southern exposure
- steep slope

<u>late</u>
- browse
- disturbance (results in later flowering)
- shade
- cool spring

Relationship of Microclimate and Topography to Lupine Phenology:

Shade results in fewer leaves but longer leaf life.

Cooler conditions result in later onset of sprouting and later flowering.

Populations on north slopes sprout later and flower later.(?)
Populations on south slopes sprout earlier and flower earlier.

Steeper south-facing slopes are hotter and earlier.

Relationship of Climate to Lupine Phenology:

1. Rainfall

<u>Wet</u>
- No effect on onset of sprouting. (?)
- Probably greater growth and leaf production.
- Delayed onset of fungus.

<u>Dry</u>
- No effect on onset of sprouting. (?)
- Probably less total leaf growth.
- ?Unknown effect on flowering(?)
- Plants probably senescence earlier.
- Advances onset of fungus.
- May kill plants.

2. Temperature

<u>Cool</u>
- Delayed onset of sprouting.
- ?Unknown status of total leaf growth(?)
- ?Delayed onset of flowering(?)
- ?Senescence probably occurs later(?)
- ?Delayed onset of fungus probable(?)

<u>Hot</u>
- May kill plants.
- Earlier onset of sprouting.
- ?May increase total leaf growth(?)
- Advance onset of fungus.
- Advance timing of senescence.

Other catastrophic weather events may affect lupine phenology or success. (e.g. hail or heavy rain)

Research Topics

1. Food value of lupine during second larval feeding, dry vs. wet years. Measure:
   - nitrogen,
   - moisture,
   - secondary plant compounds.

2. Document timing of lupine life history events for shaded and open sites:
   - time of sprouting
   - first fully developed leaf
   - first flowering
   - first seeds ready to collect (shed)
   - first onset of fungus
   - first senescence of leaves

   Each year also record: temperature, rainfall, heating degree days. Gather and compare data from all parts of Karner range.

3. Relationship of soil moisture to timing of senescence.

4. Site characteristics (slope and aspect) in relation to lupine phenology and quality (food value).

5. Effects of fungus on phenology. Eliminate fungus and see if senescence is delayed. Determine whether fungus is a true pathogen and determine effects of fungus on food quality and other plant characteristics.

6. Shade effects on phenology.

7. Choice of oviposition sites relative to senescence of lupine.

8. Examine unoccupied lupine populations for differences in chemical and physical properties.

9. Is hatching of first eggs in growing season in synch with lupine emergence and leaf development?

10. Determine general climatic factors effect on lupine distribution.

TRANSLOCATION SUB-GROUP REPORT

I. What are the mechanics that are involved in rearing? Can we rear KBB? Can we breed KBB? How would it be accomplished--what's the protocol?

Q: Is translocation possible?

* Protocol for these activities should be worked out and practiced on more common but similar species.

* Data on Productivity and Survival should be pulled together and used as a standard to measure individual success and to plan procedures so goals can be met.

On choosing a site for release, defer site selection criteria to decisions made by Habitat Quality Group. **Microclimate factors? Ideal sun/shade ratio in different climates?** Defer parameters (number of individuals and number of demes) needed for a viable population to Metapopulation Group.

Q: When female is probing plant for oviposition, what are they sensing with chemoreceptors? What are they looking for? How do lupine populations and sites vary for that quality?

Q: Could KBB decoys be effective in encouraging released/translocated KBBs to stay in the area?

TRANSLOCATION -- moving directly from one site to another, in any life form, with minimal handling. Used for either supplementation or reintroduction.

Eggs
Translocating eggs is most likely not effective--due to high degree of mortality from egg to adult, would have to do a lot of eggs, and eggs are hard to find.

Larvae
Dolores has moved larvae to a site with historic occurrence. In once instance, 300-400 larvae placed at a site. Dolores did not actually do herself, and she believes that the site was too degraded and poor in lupine availability; also that larvae were placed too densely. Direct follow-up did not occur, and adults were not seen on the site in subsequent years. In the second instance, Dolores placed 50-100 larvae at a site with adequate lupine. Again, the larvae were not monitored for residency, but adults were not seen in that year or subsequent years.

Larvae were not monitored daily to see how they fared; the sites were not under management; the sites were assumed to contain ants; no precautions were taken against predation; larvae are handled with soft forceps, placed securely on the plant and are not left alone until they begin feeding.

Dolores estimates that 1-3 larvae/plant (plant=5 to 8 stems) is an acceptable larvae/plant ratio.

* Consider enclosure to keep the larvae localized and prevent predation; provide both shade and sun.

Q: Lupine contains alkaloids; do lupine respond with production of toxins when heavily predated?

Adults

Dale has said that individuals can effectively be netted across runways and road to promote dispersal.

References on translocation exist: Shuey, Savignano's Saratoga Report on Parcel #45, TNC ESA.

If individuals need to be transported a far distance, put into an iced cooler with no light. Release immediately; if not possible and must hold more than a half day, feed with dilute honey water on cotton (white or orange colored cotton most effective) or wildflowers spiked with droplets of dilute honey water, provide with water on cotton.

Release on a warm sunny day before approximately 4:00 pm or dusk--Dolores thinks the earlier in the day, the better. Place on a nectar plant in the sun, stay with the individual until they warm up, and eat or fly--cooled individuals are vulnerable to predation.

Q: Is a certain time of day better? Would 8:00-9:00 am be better to simulate overnight experience?

* Consider Enclosure to prevent predation and keep individuals localized. Watch the butterflies to ensure that they don't beat themselves up on the enclosure walls or hover in corners--no good. Provide sun and shade.

* Distribute densely so they can mate; put in an area with good lupine and nectar.

* Consider a series of translocations over time for good population numbers and heterozygosity.

Q: **Should young or old females be used?** Will depend upon genetic diversity goals and goal for number of eggs--a higher number of more mature individuals will give greater genetic diversity to new site, leave representative of all genetic material at old site.

Q: **What is the recommended ratio of males to females?** Again, will depend upon goals, but most likely few males than females.

Q: **What number of translocated individuals is needed to establish a population? What are the colonization events?**

REARING AND RELEASING

Dolores is writing up a protocol that will be available soon. We, therefore, will not spend time reviewing that information now. Her past work indicates that residency rate in supplemental releases is good, but **did they reproduce successfully?** The residency rate for reintroductions was nil.

Dolores has done in individual cups, hand feeding lupine leaflets--very time consuming--4+ hours per day for a month. An ideal set up would be in a green house with lupine plants and free-range KBBs or netted enclosures. Have the downside of increased pest numbers.

Releases should be marked for monitoring purposes. Release the adults the same as you would translocations (chill in refrigerator, transport on ice).

Lab mated females lay fewer eggs than wild mated females. Releasing as eggs most likely not practical (requires proper placement) or wise (high mortality in the wild compared to lab). Releasing as larvae is easy, but cannot monitor their progress as adults (cannot mark). Releasing as pupae may be worth considering (it is common practice to transport butterfly species as pupae, but precautions need to be taken to keep from desiccating), but would need to place them appropriately in the duff.

Q: **Should females be mated prior to release?**

Q: **Are Lupinus species other than perennis acceptable to KBB?**

Q: **What causes diapause? What causes break of diapause (most likely temperature or light)? What lab rearing procedures are necessary to provide these requirements or simulate necessary conditions?**

Q: What roles can Zoos play in mass rearing and training in rearing techniques?

* As much as possible, use native plant stock for rearing.

II. What are the Genetic issues?

* Need to pull together information from Laurence Packer.

* Need to consult the literature and researchers on what constitutes a healthy population with good genetic diversity.

Q: Where should each area get its genetic material for releases from?

Q: What genetic strategy should be implemented? ---> Genetic diversity? ---> genetic trueness/similarity/proximity/relatedness?

Q: What genetic information can we research? If we use dry specimens for all populations (current and historic), what are the trade offs (cost, information accessible)? If we use live specimens from current populations, can this information be compared with available information from dry specimens? Can we use the larvae instead of adults--what are the pros and cons?

Whatever the answers, the DNA isolation effort needs to be coordinated (not dictated) and consistent.

Q: Is the transfer of genetic material required for maintaining populations?

III. What role can captive breeding and translocation play in the recovery of the species?

1) Restore extirpated populations.
2) Supplement/Augment marginal (in terms of numbers or genetics) and declining populations.
3) Translocate within metapopulations where genetic dispersal is not possible or where recolonization from nearby deme is desireable.
4) Provide research information and a better understanding of the species biology.
5) Educational to inform the public about KBB. (Not to draw attention to rearing and translocating because of sensitive subject matter for conservation.)

Translocation Group. Updates from previous day:

Metapopulation group integration is not complete, work will be continued today.

Translocation of eggs should not be done. Adults should be translocated, but with adult release, the time of day which is best for release needs to be determined. Factors such as emigration, predation, and feeding need to be examined to determine the best time of day for release. It was suggested that enclosures may be used to keep translocated adults at the new sites.

A systematic approach to translocated techniques is needed to ensure uniformity and best survival success and documentation
of release. Some references exist for this and other species which can be used to determine proper techniques.

The use of common species to "practice" release techniques before attempting to translocate the karner blue was suggested.

Research needs include the investigation of what causes diapause, and what breaks diapause? Lab experimentation will probably be necessary.

To artificially rear the species, either lab rearing on a mass scale or smaller isolated efforts may be employed. Small scale rearing increases the probability of loss through disaster, but the effects would be less, whereas a disaster in a mass rearing situation could potentially be devastating to a large number of KB.

A genetic strategy for "broodstock" acquisition needs to be formulated. Concern was raised over both the removal of genetic material from collection sites and introduction of sufficient genetic diversity into recolonized areas to ensure healthy populations.

To translocate individuals, do you look for fresh adults, who have laid few or no eggs, or use older adults so that some eggs are laid in both the collection site and the translocation site?

HABITAT MANAGEMENT

Working Group (Rex Ennis, Chuck Kjos, Res Ennis - RE, Lisa Stein - LS, Ann Swengel - AS, Chuck Kjos - CK, Scott Swengel - SS, Mike Amaral - MA, Jennifer Windus - JW, Erik Metzler - EM, Lee Casebere - LC, Denis Case - DC, Joe Kelly - JK, Joe Croy - JC, Mitchel Magdich - MM, Tom Mason - TM, Dave Ewert - DE, Krista Helmboldt - KH).

RE: Charge is to develop scenarios to evaluate and test.

AS: Caveat to KB recovery from burn. Absolute size of burn and number and distribution of refugia in and around burn area are critical factors in KB pop recovery, i.e., size, number, and distr of refugia is essential for KB recovery.

JW: Burning never seems to hit every spot in the burn - burns are hard to precisely prescribe.

AS: Within limits we can make some suggestions, i.e., size of burn unit, shape (long, linear burn), etc.

RE: Let's try to capture a range of strategies, incl fire strategies, plot size, etc.

MM: Let's start by listing tools... brush cutting, burning, herbicides.

AS: I have seen ovipositing and larvae in forest shaded lupine.

DE: What happens to lupine before and after treatment? What does fire, logging do to lupine?

LC: IN has little data, but 1st yr flowering is reduced, followed by 2nd yr of good flowering.

RE: What does reduced flowering do? DE: Let's ask Bob Zaremba. TM: Seeds and seedlings are killed on gnd.

JW: Seeds and seedlings that survive the fire are stimulated.

JC: Timing of the fire, even by 2 weeks, makes a diff in its effect on lupine.

RE: Does burning incr or decr lupine?

JW: We have burned 5 yrs in a row, but didn't see diff in subsequent flowering rate. The no. of rosettes did increase by 36% from 1 yr to the next.

DE: What about biomass change?

JW: We don't know.

TM: Fire has to result in at least a temporary reduction in lupine.

AS: Yes, but it may be for a very brief period.

RE: What happens when we mow - quality?

AS: I have no data for comparison with burning.

KH: In Concord, NH, lupine responded positively to mowing.

MA: At an airport, the question is not whether mowing (there will be mowing), but timing, frequency, hgt, etc. of mowing.

AS and KH: Saratoga airport has mowed for years and has lots of lupine, according to DFS.

DE: Mowing hgt of 6-12 in. is recommended to miss the eggs if done when the eggs are on upright vegetation.

AS: Mowing hgt isn't too important if done after lupine senescence.

MA: Mowing must also be done to exclude blueberry, which will invade lupine.

EM: Does mowing equipment make a difference? What does saratoga airport use?

KH: Ordinary bush hog equip.

RE: Hab mgt tools:

Chorus: Mechanical, mowing, ATVs, chemical, misc disturbance, exotic plants/animals, other pops or species levels, nectar source plants for both broods, spatial arr and size of mgt units, mgt for selected other spp, drainage and drainage control, private landholders and pub land mgrs education, hab acquisition, other spp's benefits, contaminants and pesticides protection,

RE: Let's return to fire in hab mgt.

JC: Can we return to wildfire? I don't see unplanned fires getting more than 80 or 90% of a patch because of discontinuities in burnable cover.

AS: Are the temps high in the areas that don't burn, are the patches that don't burn very small? The eggs die at temps much cooler than flame temp and they can get that hot in a small patch that doesn't burn.

JC: In our sites, there are large areas that don't burn or get hot - I could safely stand in them during the fire.

AS: Part of my point is for fire mgrs not to follow up burn the skip areas.

TM: Hot sand in droughts may be killing eggs.

RE: What size areas shall we specify for our fire effects input.

KH: One size class would be <5 ac.

AS: Our (WI) mgrs won't burn areas as little as that.

EM: How shall we provide for wildfires? Firebreaks?

JC: Firebreaks are also good for setting up controlled burns. Maybe a good mgt recommendation for many KB areas.

RE: How big can a burn area be before neg impacts happen? References?

AS: No lit. known.

KH: DS recommends a 20% burn prescription, but this does not necessarily imply 5 burn units in a site.

DE: A unit size prescription based on KB dispersal distance might be a good starting point.

CK: Burn no more than 20% of the KB in a burn.

RE: Let's say burn no more than 20% of the KB occupied area. That should assure that sufficient KBs survive and within dispersal distance for the whole area burned.

AS: What about the other spp. that such a strategy will be bad for?

LC: There may be 1000s of spp that could be badly hurt by optimizing burns for KB.

Consensus: Limit the % of a particular vegetation type burned to ca. 20%.

RE: What's the max burn interval that will maint lupine?

AS: Low qual areas can be managed more intensively than other better areas because they aren't good for other spp.

JC: We still need the max size of ok burn unit.

AS: Max dist fm refugium to burn unit needed.

KH: 500' dist OK?

DE: 100 meters?

DE: How many yrs to reoccupy?

Chorus: 1 year.

KH: What % of before pop returned in 1st yr? 50% 1st yr, 100% 2nd yr (2nd brood figs.)?

TM: We have to remember that burning provides a predation reduction benefit.

KH: In Concord, burning is necessary to maint good habitat.

RE: What about burning to increase KB pops in an area?

RE: Let's tell the model we burn 20%, >4 yr rotation, never burn same area 2 yrs in a row, within 100 meters of refugium, with goal of 50% occupancy 1st yr, 100% return and yr.

RE: How fast will KB repop the burned areas?

DE: In MI, spr brood KB invaded several hundred yds into a new burn area before the summer brood.

MA: In NH, DFS found marked indiv KB moved less than 100 yes fm mark site.

RE: Moving off the fire technique... Let's work on mowing. Timing (AS: we dislike May, June, and July mowing. It disfavors lupine, other nectar flowers, and KB themselves).

KH: Timing will also be a function of purpose for mowing, i.e., blueberry control, grass mowing, shrub control.

KH: Grass mowing in May, June, July can remove all lupine, therefore no KBs. No nectar sources present then either.

RE: Recommended hgt?

KH and AS: >8". <8 starts clipping eggs on stems.

DE: <6" wipes out 50% of the eggs.

Chorus: 100% <8", 6"-8" takes 50%, 50% are<6", i.e., 100% survive if cut is> 8".

RE: What's our brushing prescription and expectation?

AS: What are the brushing methods?

RE: What would we expect if we were hand cutting?

AS: It could result in undesirable root sprouting.

LC: It may be necessary to kill the plant to prevent sprouting.

DE: The desired % open canopy must be maintained - how bout 60-70% open?

AS: Sounds ok.

MM: Cited a paper saying 40-80% open is best for lupine (Packer, 1987).

RE: Accomplishing this by hand cutting should be good?

Chorus: Yup - may need spot herbicide treatment.

LC: Foliar spray would be least desired.

RE: What's our predicted effect?

AS: More flowering.

DE: More rosettes, increase vitality of surviving plants.

LC: More nectar.

LC: Remove slash for aesthetics and reduce fire hazard.

DE: Stack and burn the slash in the winter outside the KB habitat. On a Fri. evening. Make it a party. Pack out your trash.

EM: Do heavy equipment clearing in winter (frozen ground).

AS: Machinery disturbance on highly degraded sites may be good for KB and lupine response.

JW: Esp if done in non-nesting etc seasons so other spp aren't hurt.

RE: Let's move to broadcast chemical biocide tmts.

Chorus recommendation: For known or pot KB areas: Eliminate use where possible. Then no aircraft broadcast biocide use in site or within 1/2-mile, within 100 meters for ground (farm tractor, etc) spraying.

LC: Would those distances work for BT gypsy moth control, too?

RE: Yes.

RE: What are consequences of not following the above prescriptions?

DE: What about exotics like gypsy moth, leafy spurge, Canada thistle, spotted knap weed (KBs use this one). Recommendations: Eliminate leafy spurge at all times at all cost. Tolerate up to 10% knapweed in lupine before treating. Remove autumn olive. Other brushy spp must be controlled to meet habitat objectives (40-80% open) by appropriate means.

Robert Zaremba, RZ: Sweetfern is more invasive of lupine areas than is blueberry. Blue berries are not likely to displace lupine.

RE: We agree that we want lupine to constitute at least 2% gnd cover, based on Lawrence and Cook 1990.

DE: Recommend >1000 plants/site c/ >2% gnd cover in lupine.

RE: Nectar sources.

Chorus: A fairly wide variety of nectar source plants will do and their presence should be assured for both flights. MI, WI, NY, and Ont. have plant spp preference lists. Butterfly weed, horse mint, dewberry, lupine,

RE: How many, how much nectar plant is needed - 2% gnd cover?

DE: 1% cover of ea spp.

CL: Suggest 2 % inflorescence cover.

DE: 60% of the quadrats in Allegan State Game Area had dewberry, let's say 40% coverage.

MODELLING WORKING GROUP MINUTES

Karner blue butterfly PVA; April 22, 1992 FILE: KARBER.KBB
Notes by Anne Hecht

Introduction to the Vortex model (entire group):

Links between effects of events on survival and reproduction

- Fire - surviving eggs/larvae would have high reproductive success (emergence could be staggered affecting mating opportunities)
- Drought - survival and reproduction of survivors could be low

Catastrophes - drought, fire (too large), mowing (wrong time, too low), pesticides (gypsy moth control), temperature variations that may (or may not) differentially affect chronology of lupine and KBB development (may be a catastrophe or environmental variation)

Schweitzer/Savignano: Males are polygamous; females probably monogamous (some info. from Cryan to the contrary); topic may require further research if model is sensitive

Sex ratios even at egg hatching

Age at first breeding=1 (both species); age at death=1

Number of young: most info. from Dolores' lab-reared KBB's (probably optimize egg production); nectar availability may affect egg-laying; Spoor data - 79 eggs +/- 47 laid -- 26 eggs hatching; variance on productivity will be huge (especially for populations in decline!)

What percent of adult females reproduce? 75% - large variance

Mortality from egg hatch to breeding age - mortality from Savignano (must assume constant mortality across all in-stars (she only sampled 2)) - 80%

Catastrophe (probability; effects on survival and recovery)

- Fire - at Albany historically about 1 fire/ten years -probability=.1; effect on survival - 90% (actually may be up to 100%); surviving females will have normal productivity (Schweitzer - should be enhanced survival)

- Drought - probability = 2%; survival = 10% (90% reduction); no effect on reproduction

- Cold wet spring - probability = 20%, 50% effect on reproduction; no effect on survival; first brood only

Initial size of first brood pop. = 100

Carrying capacity of habitat - data suggests relationship between numbers of plants and KBB's; carrying capacity of 500

No harvest.

Summer brood is 3-4X spring brood; adjust egg mortality

Migration - 1% between two pops.

Population 1 became extinct in year 1 in all 10 runs
Population 2 became extinct in year 1 in 8 runs, all runs by year 4

Since pop. became extinct, no estimate of heterozygosity; % remaining alleles

Schweitzer: request for run for 5 deme metapopulation, 100 KBB's per deme, 1% exchange in both directions

Breaking up into Working Group

Working Groups: modeling (life history parameters, catastrophes), habitat quality and variance, management, metapopulations (goals), lupine phenology (impacts of environmental events on KBB's), disease and parasites

Metapopulation Working Group

Participants: Bleser, Wilsmann, Baker, Hecht, Andow

Subtopics: migration among pops; research populations; metapopulations across range; how do components of metapopulations interact (is there a core of pop. or more co-equal pops?; is recolonization a problem?); what should be recovery goal? numbers of metapopulations, distribution of metapopulations

Habitat variation as an indicator of potential variation within species; no current information on genetic diversity

In absence of information to the contrary, do not assume that this is a homogenous species

Goals should consider range in Canada, and other areas where KBB's are currently extirpated

Habitat limitations in some subregions should not artificially limit goals in areas where more habitat (or restorable habitat) still exists

Tentative recovery regions:

- NH - MA - NY - habitat is superficially similar
- PA - Southern NY
- Ont.
- OH - southeast MI
- Western MI
- Indiana
- Central WI - southeast MN
- Northwest WI - east central MN
- western NY ????? - records are questionable in terms of what they represent

Scenarios - def. of a metapopulation that can be tested by the model: (all assume, for now, relatively low levels of management - burning to set back succession, but no other extraordinary population support)

- 5 subpopulations of 1000 second brood adults each; 0.25% migration per generation in both directions among all subpops. What is fecundityX mortality for this population to be sustainable?

- 5 subpops of 100 each

- 10 subpops of 1000 each

- 10 subpops of 100 each

Are migrating females fertile?
Dolores and Dale's observations suggest yes. Implies that each migrating female contributes genotype of two individuals.

Need information on migration distances? Migration rates?

Laura Sommers (NYDEC): She has little info. about KBB's except along Hudson River sandplain

Western NY, PA - possiblity of reintroduction should not be precluded at these sites, but it is lower priority than recovery elsewhere and should not be attempted until reintroduction has been successful at a site where much more is known about KBB's

FILE: DPOPBIO2.WG

Notes of Karner Blue Population Modelling Subgroup 22 April 1992

participants: Dolores Savignano, Scott Swengel, Laura Sommers, Mike DeCapita, Mark Clough, Dave Andow, Susan Walker, Ann Swengel

Number of Demes: One. More accurate models should include several populations with some communications. The Metapopulation folks suggested four model runs: 5 and 10 demes respectively, running it with both 100 spring Karners and 1000 spring KB's to test for sensitivity of the population to both number of demes and to deme size. Dispersal rate would be 0.25% for each pair of demes.

Mean Lifespan: We chose 4.5 days; this is the midpoint of reported mean lifespans in the wild of 4-5 days.

Eggs Laid: The number of eggs laid by 34 captive females kept by Dr. Savignano was linearly related to the number of days they lived. The mean number of eggs laid per day was 9.94 +/- 6.01. The range was 0.25-32.33 egg/day. This gave us a maximum of 145 eggs laid by a female in its life. We entered the distribution of egg numbers for each female in our sample as the experimental model. The mean was 45 eggs per female, and the minimum 1. The distribution of the 34 sample points approached normal (see graph). We don't know whether the July-hatched females would lay the same number of eggs as the May-June hatched ones kept by Dr. Savignanao, but our model assumes this.

Egg Hatchability: Savignano's captive females had an unweighted mean egg hatching rate of 91.74%. We also estimated 28% additional loss by predation and other causes for the eggs laid in late May-June. This is based on Spoor's 22% "average egg-opened predation" rate of late summer eggs with a little (6%) mortality added for other causes (vanishing eggs). For the July-laid eggs that must overwinter, we estimated a flat mortality rate of 75% to account for the large number found missing by Spoor (he could only find 22% of eggs by late Fall; he also could find only 18% of eggs marked in late Fall during searches the following spring) without assuming that all missing eggs died. During 9 months of diapause, the summer-laid eggs may be exposed to more mortality factors than the eggs laid earlier in the summer by spring brood females. The latter eggs are in the environment only 3-7 days before they hatch. We believe our June egg hatching rate is moderately well substantiated but the overwinter mortality is practically a guess (overwinter mortality could be much higher).

Eggs hatched: Summer brood eggs hatching in April: 0-36/female, mean 11; spring brood eggs hatching in June: 1-90/female, mean 30 (see data sheet). The accuracy of the June hatching egg estimate is probably better, for the reasons in the preceding paragraph, than that of the April hatched eggs.

Larval Mortality: We estimated 80% mortality for June larvae using Savignano's filed observations. A later estimate using Savignano's data more precisely--but ignoring pupal mortality--suggested a slightly lower mortality rate. These larvae hatch on a lupine plant, and needn't search for food. We estimated 25% mortality of larvae in April before finding a lupine plant, leaving only 75% of larvae at the beginning of feeding; of those 75%, we estimate 80% die (as in June) before becoming adults. Therefore, 20% of the 75% live, or there is 15% overall survival (85% mortality) of spring-feeding larvae resulting from summer brood eggs. Our June larval mortality is well-based, but our April-May larval mortality is poorly substantiated--especially mortality of larvae before finding a lupine.

Karner blues survived too well using this model, so we raised the mortalityy to 85% for the June larvae and to 97, 95, 93, and 91.5%, respectively for April-May larvae for future model runs. **NOTE**: we did not estimate standard deviation. Any suggestions?

Catastrophes: 1. There is a 10% annual probability of a fire causing 50% mortality as discussed in the general meeting by Schweitzer and Zaremba. We estimate that fire results in 1.5 times normal reproduction by survivors. This would be optimistic reproduction for really small populations and perhaps pessimistic for populations reduced byy moderate amounts by fire. That fire reduces KB numbers is known, but we don't have solid evidence on the magnitude of this drop (it's close to 100% in complete burns, but we're modelling mostly incomplete burns). The breeding response of KB's in a fire unit appears above normal, but we can't tell how many of the summer KB's are the result of immigrant females laying eggs in the burn unit in June, as opposed to fire survivors laying eggs in June. Work on fire mortality and post-fire breeding success would have great conservation value.
2. We chose not to guess at the effects of cold rainy springs on eastern spring brood Karners or the effects of drought on midwestern summer and spring brood Karners (drought may have a lag time affecting the following spring brood of butterflies). We felt we lacked any evidence on which to base the effect of these weather disasters, and wanted input from other subgroups before modelling this.

Model Run: 1. Summer brood starts at 1000, K=2000. The summer-spring population was stable, and the spring-summer population tripled. We believe we had too high survivorship for overwintering eggs and for April larvae than is realistic. Note again, we did not use a standard deviation.

Model Run Results

Model Runs 2-5. All populations start at 200 spring brood, K=500.
2. With 85% June larval mortality and 97% April-May larval mortality, all populations went extinct within 5 years.
3. With 85%/95% larval mortality, all populations went extinct within 20 years, and r was about -0.4.
4. With 85%/93% larval mortality, 9 of 20 populations went extinct in 20 years, but average surviving populations increased slightly.
5. With 85%/91.5% larval mortality, only 1 of 20 populations went extinct in 20 years and most populations increased in size, with a mean end population of 420 indivduals. R was >1.0.

Ideas for Refining the Model:

- use standard deviations for mortality
- start with different population sizes
- explore metapopulation interactions
- sensitivity analysis for major variables
- lowest mortality factors allowing populations to maintain themselves
- more rigorous catastrophe analyses

FILE: DKBREPOR.2

Metapopulation Working Group

Members: Rich Baker, Anne Hecht, Leni Wilsmann, David Andow, Cathy Bleser

Tasks: We decided to charge ourselves with four tasks:

1) Develop descriptions of existing metapopulations
2) Develop loose recovery goals in terms of metapopulations
3) Develop descriptions of theoretical metapopulations for testing by model.
4) Develop a description of coordinated genetics research.
5) Identify research questions.

1) **Develop descriptions of existing metapopulations across range.**

We decided to use available distribution maps to determine where existing metapopulations are. Using the deliberately vague definition of a metapopulation as "a cluster of bunches of butterflies", we determined that there are currently ten metapopulations in existence, consisting of various numbers of subpopulations and population numbers, and operating at various degrees of connectivity. We assigned to each of these a rough indication of degree of threat, using the terms "endangered", "vulnerable", and "secure".

2) **Develop loose recovery goals in terms of metapopulations and number of subpopulations per metapopulation.**

We began by assuming that, in the absence of genetic information, the species must be presumed not homogenous across the range. We decided to use habitat variation as a proxy for whatever genetic variation may exist, and to subdivide the species' range into regions based on "ecoregions". We also decided to include all historic occurrences within this subdivision. This implies that we are not precluding the possibility of habitat restoration and/or reintroduction into sites where no habitat and/or butterflies currently exist. We agreed that habitat limitations in some subdivisions should not artificially limit goals in areas where more habitat (or restorable habitat) still exists. Based on these criteria, we came up with ten tentative "ecological groupings" (see map).

As a first cut, we added three additional columns to our table of existing metapopulations. These are:

* a guestimate of the potential number of metapopulations within each ecological grouping, given a 100 year time frame and unlimited funds and personnel. The only restriction was that we would not consider the restoration of totally altered former habitat (ag land, concrete, etc.).
* the number and status of metapopulations per ecological grouping necessary to reclassify the butterfly from endangered to threatened.

* the number and status of metapopulations per ecological grouping necessary to delist the butterfly.

See our table for these numbers and threat values.

Before we can go further with assigning number of metapopulations or subpopulations per metapopulation to these groupings, we need to get a better feel from the model what the persistence is of various combinations of number of subpopulations, population size per subpopulation, and migration rate among subpopulations. (See task 3.)

Once we are able to complete the assignment of metapopulations to groupings, we will try to prioritize them, probably in terms of "high", "medium", and "low".

3) **Develop descriptions of theoretical metapopulations for testing by model.**

For the purposes of objective 2, we decided that we need to know how various metapopulation definitions survive within the model parameters. For this purpose we decided to assume, for now, relatively low levels of management (e.g. burning to set back succession, but no other extraordinary population support). The parameters we would like to test are:

Number of subpopulations: 5; 10
Number of second brood adults per subpopulation: 50; 100; 1000
Migration rate per generation: 0.25%; 1.0%; 2.0%
Connectivity model: Core/satellite; all satellites

We have run one test, using 5 subpopulations, 50 per subpopulation (250 total), migration rate of 1.0%, and an "all satellite" model. Using parameters resulting in an r= -0.1589, the metapopulation had a 62% probability of extinction after 20 years (40 generations). More runs, using subpopulation sizes of 100 and all three migration rates will be run next.

4) **Develop a general description of coordinated genetics research.**

We began by identifying the goals of coordinated genetics research. They are:

* to provide information useful in identifying the best source populations for future reintroductions or supplementations.
* to determine the distribution of genetic variation within and among populations and ecological groupings, both to better understand the relative uniqueness of various subdivisions of the species, and to validate the ecological groupings we have assigned.
* to resolve taxonomic questions.

We attempted to then develop a general description of coordinated research, but didn't get far, because of the difficulty of serving the best interests of the species protection and recovery while avoiding creating unrealistic constraints on independent researchers. The discussion was confounded by a recognition that change and development in genetic techniques is very rapid. Possible recommendations include:

* requiring the use of "state of the art" genetic techniques in order to get the maximum amount of information from collected specimens.
* requiring the use of multiple genetic techniques in order to increase the liklihood of being able to compare results across studies.
* requiring that future work should use at least the same techniques as preceeding studies in order to allow comparison across studies.

Other possible approaches include:

* collecting samples from all populations as soon as possible, but holding them in storage until a single project is developed that is appropriately designed and uses the appropriate techniques.
* not collecting right away from small, vulnerable populations, but beginning with a comparison of the larger, widespread populations to see if further work is called for.
* putting out an RFP for a single study, and thus retaining more control over the research design and implementation.

5) Research Questions

* More quantitative information is needed on dispersal rates and distances.
* More quantitative information is needed on migration rates and distances (i.e. dispersers that contribute to the gene pool of the receiving population).

KARNER BLUE BUTTERFLY

(Lycaeides melissa samuelis)

POPULATION AND HABITAT

VIABILITY ASSESSMENT

POPULATION BIOLOGY AND SIMULATION MODELS

FORWORD

When a species, such as the Karner Blue Butterfly, is reduced several small populations, its demise can be the result of random events. The events leading to extinction can be varied and they interact in complex and compounding ways. A team of biologists (Appendix 1) from a variety of fields connected with the recovery of Karner Blue Butterfly recently reviewed the species' extinction risks in a Population and Habitat Viability Assessment (PVHA) workshop. The workshop was held from 22-24 April 1992 in Zanesville, Ohio. The PVHA provided a frame-work for asking difficult questions about prioritizing research and managing habitat for the butterfly's future. The Karner Blue may be one of the most well-researched butterflies in North America, but many questions concerning its biology and management remain. The workshop was a cooperative venture between the Division of Endangered Species, Region 3, and Dr. Ulysses Seal, Chair of the Captive Breeding Specialist Group of the International Union for the Conservation of Nature and Natural Resources.

Based on information accumulated from both field and laboratory experience, workshop participants used their expertise to distill their data into numbers that could be incorporated into the computer model, KARNER (Appendix 2). Minutes from the general workshop sessions are available in Appendix 3. Discussions from specific working groups are also available in Appendix 3, except the minutes from the modeling group which have been incorporated into this report.

KARNER, the population model used for the analysis, was developed by Dr. Robert Lacy of the Conservation Biology Department of the Chicago Zoological Park. The model was set up to act like a population of Karner Blue Butterflies. The simulated population had the same life history parameters, such as brood size and mortality rate, that were calculated for real Karner Blue Butterfly populations. The population was run through a gauntlet of risks, like increased fire and drought, for 50 years.

The PVHA environment allowed workshop participants to integrate their experience and research results to analyze the projected future of the Karner Blue Butterfly. After repeated runs, participants could view the extinction probabilities and population trajectories of a number of simulations. The model is a well-developed thought experiment allowing participants to explore "what-if" scenarios within various management strategies. It is possible, through modeling, to determine which management strategies may be most effective in reducing the species risk of extinction. The process is never complete; the workshop was only an introduction to the technique of modeling butterfly populations and the continued use of modeling as a conservation tool is encouraged.

KARNER BLUE BUTTERFLY OVERVIEW

SEE APPENDIX 4

The Nature Conservancy has kindly furnished a draft of the Element Stewardship Abstract (ESA) they are developing for the Karner Blue Butterfly. The ESA was broadly reviewed in 1990 and modified based on that review. Information obtained and work occurring since the 1990 review has not been incorporated the draft ESA included in this report (Appendix 4). The ESA covers species information that is traditionally included in PVHA final reports: species description, ecology and distribution, taxonomy, habitat type, major threats. Additionally, the ESA complies current research and management strategies by population and provides a thorough bibliography for the Karner Blue Butterfly.

POPULATION MODELING

Fecundity and Mortality Rates Derived at the Workshop

During the PVHA workshop, participants agreed upon demographic and catastrophic parameters that, to the best of their knowledge, reflect the biology of the Karner Blue Butterfly. The values entered into the population model were based on field and laboratory data. Explanations of how some of the values were calculated are listed below:

Mean Lifespan: 4.5 days is the midpoint of reported mean lifespans in the wild of 4-5 days.

Eggs Laid: The mean number of eggs laid per day was calculated as 9.94 +/- 6.01, from 34 females held in captivity by Dolores Savignano. The range was 0.25-34.33 egg/day. Thus, a maximum of 145 eggs laid by a female in its reproductive life of 4.5 days. We entered the distribution of egg numbers for each female in our sample as the experimental model. The mean was **45 eggs per female**, and the minimum 1. The distribution of the 34 sample points approached normal.

Egg Hatchability: Savignano's captive females had an unweighted mean egg hatching rate of **91.74%. For the spring-laid eggs, an additional 28% loss was added.** This is based on Spoor's 22% "average egg-opened predation" rate of late summer eggs with a little (6%) mortality added for other causes (vanishing eggs). **For the July-laid eggs that must overwinter, a flat egg failure rate of 75% was estimated** to account for the large number found missing by Spoor (he could only find 22% of eggs by late Fall; he also could find only 18% of eggs marked in late Fall during searches the following spring) without assuming that all missing eggs died. During nine months of diapause, the July-laid eggs may be exposed to more mortality factors than June eggs which diapause for only 3-7 days.

Eggs hatched: Based on the numbers discussed above, the **spring-hatching cohort produces between 1-90 larvae per female with a mean of 30 larvae. The summer-hatching cohort produces 0-36 larvae per female with a mean of 11 larvae.**

Larval Mortality: Based on Savignano's field observations, **mortality of larvae emerging in June was estimated as 80%.** June larvae hatch on lupine plants, and needn't search for food. April larvae, however, must find lupine plants after emerging. Therefore, experts estimated a 25% mortality before larvae find food and 80% mortality thereafter. This results in an overall **larval mortality rate of 85% for spring-feeding larvae.**

NOTE: Karner Blues survived "too well" using the calculated mortality rates, so **larval mortality rates were raised slightly to 93% and 85% for April and June-hatching broods, respectively.** Standard deviations for the mortality values were not calculated.

Post-Workshop Modifications

The input parameters generated at the PVHA Workshop were slightly modified after the workshop ended. The major problem with all the files that were developed at the workshop is that the percentage of larvae produced per female did not add up to 100% in either the first (spring: 96.6%) or second (summer: 99.3%) broods. This caused the model to automatically place the missing larvae into the maximum brood size (104). Thus, productivity was overestimated. We realized the problem but not its consequences at the PHVA. The error has been corrected as shown in Table 1.

After changing the productivity values, all simulated populations went extinct rapidly. To correct the "extinction phenomena" and work with populations that at least approximate true Karner Blue Butterfly behavior, the mortality values for both broods was adjusted as follows:

1) Brood A (April hatch) mortality FROM 93.0 TO 92.0
2) Brood B (June hatch) mortality FROM 85.0 TO 80.0

Table 1. Changes made to model input since PVHA Workshop.

PARAMETER	ORIGINAL	REVISED	RATIONAL
POP A, % LAYING 8 EGGS	8.8	11.8	Missed larvae in original
POP A, % LAYING 10 EGGS	8.8	8.9	
POP A, % LAYING 11 EGGS	11.8	11.9	

POP A, % LAYING 12 EGGS	8.8	8.9	
POP A, % LAYING 13 EGGS	8.8	8.9	
POP B, % LAYING 24 EGGS	2.9	3.0	Distribute extra 0.7% around approximate mean
POP B, % LAYING 25 EGGS	5.9	6.0	
POP B, % LAYING 26 EGGS	8.8	8.9	
POP B, % LAYING 27 EGGS	2.9	3.0	
POP B, % LAYING 28 EGGS	2.9	3.0	
POP B, % LAYING 29 EGGS	2.9	3.0	
POP B, % LAYING 30 EGGS	5.9	6.0	

The proportions by which the mortality rates were adjusted are unequal but the changes do not challenge what is known about Karner Blue Butterfly biology. In fact, the revised mortality rates are more in keeping with observations that the population size of the summer brood is three to four times larger than the spring brood. Additionally, the revised mortality rate for the larvae emerging in spring (80%) is identical to the original calculation of the population working group! (see "Larval Mortality" above).

Although it was not changed, the input for environmental variation (EV) in reproduction warrants discussion. In Population A (spring hatching cohort), 11% was entered for "EV in Reproduction"; the program adjusted this number to conform to the data and used an EV = 11.87%. In Population B, the input value was 30%; the program used an EV = 0.00%. The software's inability to use the EV input stems from the input data stating that all adult females produce at least one larvae. EV in reproduction is used to add variance to the number of females producing NO young, not to the overall reproductive variance. This means that there is no environmental variability in reproduction for the summer cohort of butterflies (30% of 0 is 0) and very little environmental variability in reproduction for the spring cohort (11.87% of 2.900 is 0.344).

Basic Model and Sensitivity to Mortality

The values derived at the PVHA and the subsequent modifications discussed above were used to examine the sensitivity of a simulated Karner Blue Butterfly population to changes in demographic values. The most basic scenario consisted of a single population of 100 April-hatched butterflies. The population was free of catastrophic events. Carrying capacity was set at 1000 individuals. One hundred iterations of the model were run for 100 years. All results are based on the spring-hatching cohort.

The BASIC model resulted in a population trajectory that approached the habitat's carrying capacity within an average of 25 years (Fig. 1). The persistence and growth of the population was supported by the summer cohort which had a high deterministic growth rate of $lambda_{det}B$ = 2.756 (r=1.014). The spring-hatching cohort displayed a strongly negative growth rate of $lambda_{det}A$ = 0.442 (r=-0.817). The stochastic mean growth rate is a more instructive indicator of population behavior however since populations rarely function in a deterministic fashion. The population had a stochastic growth rate of r = 0.179 ± 0.207. The difference between the deterministic and stochastic growth rates is due to demographic and environmental variation. Eight percent of the simulations went extinct in a mean time of 23.75 ± 22.35 years. Final observed heterozygosity of the was 0.6545 ± 0.1326. The mean population size for those simulations that persisted for 100 years was 975.45 ± 93.91 (Fig 1).

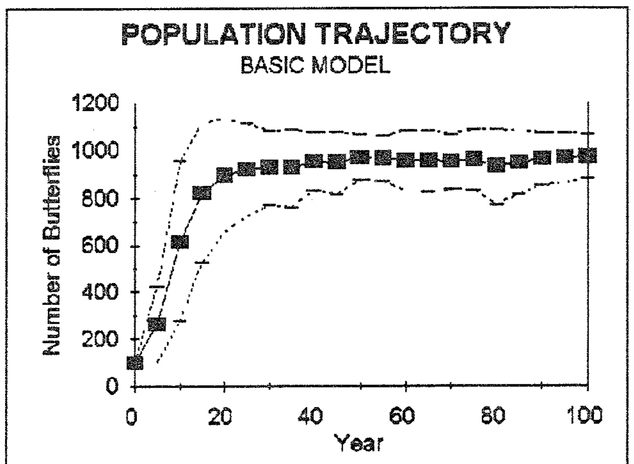


Figure 1. Mean population trajectory with standard deviations for the 92 simulations that did not go extinct.

Four files were developed to assess the effect that a change or miscalculation of the mortality rate for either the spring or summer cohort could have on population persistence (Table 2). With the exception the mortality rate of pre-breeding individuals, all parameters are identical to those used in the basic scenario discussed above .

Table 2. Model sensitivity to mortality. A = mortality of spring-hatching larvae; B = mortality of summer-hatching larvae. E = extinction rate. ET = time to extinction.

MORTALITY	E	ET ± SD	N ± SD	r ± SD
BASIC A=92%, B=80%	8%	23.75 ± 22.35	975.45 ± 93.91	0.179 ± 0.207
A=90%	6%	59.50 ± 29.84	983.15 ± 69.74	0.407 ± 0.186
A=94%	100%	15.40 ± 9.73	0	-0.170 ± 0.528
B=78%	12%	31.58 ± 25.23	964.70 ± 94.77	0.277 ± 0.201
B=82%	28%	34.79 ± 31.67	881.87 ± 208.48	0.068 ± 0.254

As the model indicates and logic suggests, the mortality rate of the spring brood has the greatest impact on population persistence (Fig 2). One surprising result is the higher extinction rate of B=78% despite a higher growth rate in comparison to BASIC (Table 2). The stochastic nature of the model accounts this anomaly.

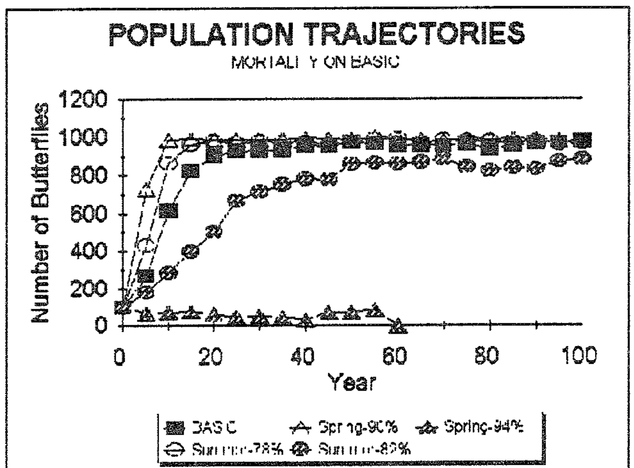


Figure 2. Population trajectories of BASIC model under different mortality regimes for larvae in both the spring and summer broods.

Fire as a Catastrophe

During the general meeting, participants calculated that fire had a 10% annual probability of occurring on butterfly habitat before the April brood lays eggs. Assuming lupine plants and larvae and/or eggs are burned, fire was thought to raise mortality by an estimated 50%. Surviving butterflies, however, were estimated to reproduce at 1.5 times their normal rate because of the higher quality habitat available after a fire. Experts criticized KARNER's treatment of fire as a "random" event since litter build-up is required for fires in some areas. Never-the-less, the above values were incorporated into the BASIC scenario as a catastrophic event that affected teh spring-hatching cohort.

Table 3. Effects of adding fire as a catastrophe on a Karner Blue Butterfly population. E = extinction rate. ET = time to extinction.

CHANGE	E	ET ± SD	N ± SD	r ± SD
Fire Base	21%	29.24 ± 25.32	822.19 ± 274.34	0.109 ± 0.311
fecundity = 2	29%	23.31 ± 25.63	839.41± 247.73	0.110 ± 0.306
fecundity = 1	32%	24.91 ± 23.56	797.49 ± 272.04	0.106 ± 0.318
survival =.75	12%	28.25 ± 22.88	937.42 ± 136.37	0.153 ± 0.220
survival=.25	74%	36.03 ±27.92	524.15 ± 330.29	0.024 ± 0.515
probability = 5%	17%	38.94 ± 30.31	929.16 ± 153.06	0.141 ± 0.266
probability = 15%	36%	27.06 ± 26.28	620.34 ± 338.07	0.077 ± 0.362

The values agreed upon for the frequency and impact of fire greatly increase the standard deviations associated with population size and "r". Fire also more than doubles the probability of extinction (Table 3).

Changes up to a 50% reduction or addition to fecundity after a fire have little effect on the resulting population (note "r" in Table 3). If fire occurs in a colony more often than an average of 15 times in 100 years, the population may be in significant danger of extinction (Table 3). A change in the probability of a fire effects the resulting population trajectory but not as profoundly as changes in survival do (Table 3, Fig. 3). A 25% increase or decrease in survival has the

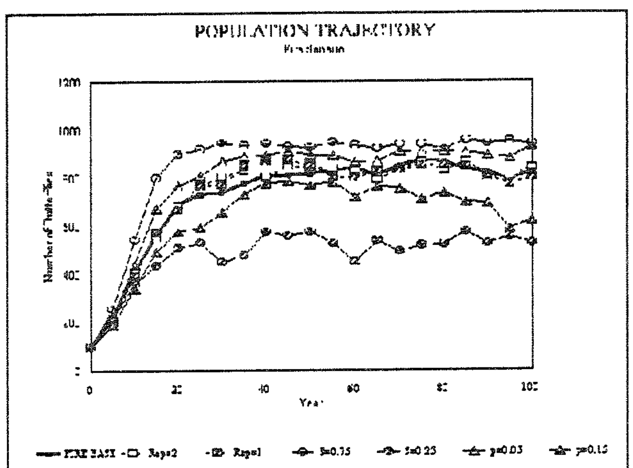


Figure 3. BASIC model with fire added as a catastrophe. Note the dramatic effect changes in survival rate have on population behavior.

most dramatic impact on the probability of extinction (Table 3).

Drought as a Catastrophe

The PVHA participants ideally would like drought to occur in cycles rather than as independent random events. They suggested that drought increases the chances of fire and the two catastrophes are correlated. Given the limitations of the model, they agreed upon a catastrophic drought occurring with an annual probability of 5% before the April brood lays eggs. Such a drought would halve both survival (0.5) and reproduction (0.5). These values were incorporated into the BASIC scenario as a catastrophic event.

Like the impact of fire, adding drought lowers the population's growth rate while increasing the standard deviations associated with population size and the intrinsic rate of increase (r) (Table 4). Because drought happens more often and it's impact is more severe, extinction rates are higher and population sizes are lower after 100 years as compared to the effects of fire.

Table 4. Catastrophe 2 (drought) effects on a Karner Blue Butterfly population. E = extinction rate. ET = time to extinction.

CHANGE	E	ET ± SD	N ± SD	r ± SD
DROUGHT BASE	37%	40.49 ± 34.11	744.92 ± 324.51	0.0925 ± 0.4129
fecundity = .75	33%	22.97 ± 26.99	883.21 ± 199.75	0.1203 ± 0.3315
fecundity = .25	72%	36.85 ± 27.86	542.18 ± 403.11	0.0682 ± 0.5285
survival = .75	26%	28.73 ± 29.58	860.38 ± 233.25	0.1236 ± 0.3244
survival = .25	62%	37.84 ± 31.69	658.13 ± 396.16	0.0749 ± 0.5260
probability =2.5%	21%	17.14 ± 16.52	773.41 ± 296.64	0.1330 ± 0.3315
probability =7.5%	58%	27.79 ± 26.48	704.40 ± 361.59	0.0698 ± 0.4667

Unlike fire as a catastrophe, drought negatively impacts both fecundity and mortality. The effects of changes in reproduction, survivorship, and probability of occurrence were tested. Superficially, DROUGHT appears to be most sensitive to changes in reproduction (Fig. 4). Such a large variance is associated with the growth rates for extant populations, however, that it is difficult to judge which of the three parameters actually has the greatest impact (Table 4). More iterations of each scenario need to done in order to assess sensitivity more accurately.

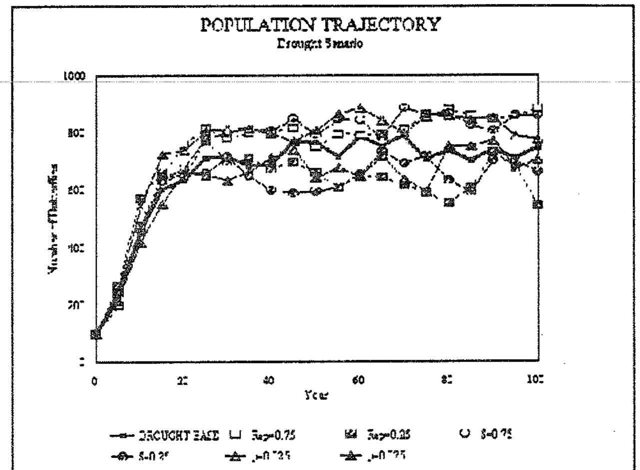


Figure 4. Effects of drought as a catastrophe on population behavior.

Combined Catastrophes

Both fire and drought were added as catastrophes to the BASIC scenario. This double catastrophe model, TEMPLET, served as the format for all other simulations (Appendix 5). TEMPLET produces the "marginal" population that the experts thought would be the most interesting and appropriate type of population to explore further (Fig. 5).

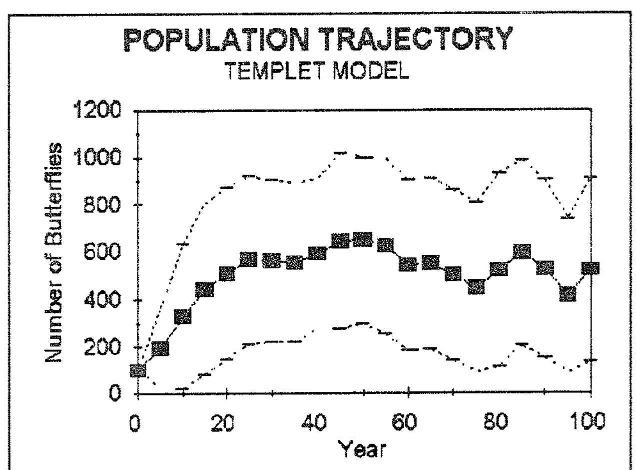


Figure 5. Population trajectory of EXTANT butterfly populations modeled by TEMPLET.

Seventy-two percent of the 100 iterations of TEMPLET were extinct in a mean time of 34.06 ± 28.71 SD years. Starting with 100 individuals, the mean final population size for successful cases was 523.93 ± 389.68 SD at the end of 100 years (about half of the carrying capacity, which was set at 1000). The stochastic intrinsic growth rate (r) was 0.0245 ± 0.4784 SD.

Management Issues

TEMPLET was used to explore the extinction rates of single populations of different sizes (Table 5). We do not suggest interpreting these results in the context of arguing for "minimum viable populations". The variance associated with the population growth rate and the rather large difference in results between identical sets of input precludes such faith in the numbers shown below. Rather, the test does suggest that even populations with 350 individuals in the spring cohort have a sizable (37%) probability of becoming extinct within 50 years. It is also clear that smaller populations are much more likely to go extinct than ones that begin with over 200 individuals in the spring-hatching cohort.

Table 5. Starting size effect on simulated Karner Blue Butterfly populations. The simulations were run for 50 years for 100 iterations. E = extinction rate. ET = time to extinction.

INITIAL SIZE	E	ET ± SD	N ± SD	r ± SD
350	37%	23.43 ± 11.27	582.71 ± 372.00	0.0305 ± 0.4710
200	37%	18.78 ± 13.04	574.10 ± 358.79	0.0421 ± 0.4580
150	45%	15.73 ± 9.73	535.67 ± 379.61	0.0194 ± 0.4687
125	43%	17.84 ± 12.15	558.37 ± 361.72	0.0220 ± 0.5020
100	53%	17.11 ± 13.85	658.15± 376.62	0.0167 ± 0.5036
50	72%	12.40 ± 11.65	524.79 ± 393.22	-0.001 ± 0.5621
25	82%	7.22 ± 7.84	587.29 ± 297.61	0.0065 ± 0.5820
12	94%	4.94 ± 8.22	658.17 ± 351.34	0.0098 ± 0.6305

If most of the existing populations of Karner Blue Butterflies have a high probability of becoming extinct, should they be supplemented? Simulated results support the intuitive conclusion that populations will persist longer if as many butterflies are added as possible for as long as possible (Table 6). The results, however, do not include the detrimental effects of disease and assume released butterflies have the same rigor as resident Karner Blues. The simulations seem to indicate that supplementing the spring-hatching cohort would be more beneficial than summer releases (Table 6).

Table 6. Supplementation effect on Karner Blue Butterfly populations. Simulations were run for 50 years, 100 runs, 100 individuals at start. Scenarios 1a-d supplemented the spring-hatching cohort; scenarios 2a-d supplemented the summer-hatching cohort. Equal number of males and females added. E = extinction rate. ET = time to extinction.

NUMBER ADDED	YEARS ADDED	E	ET ± SD	r ± SD
TEMPLET = 100	0	53%	17.11 ± 13.85	0.0167 ± 0.5036
1a = 20	10	27%	29.19 ± 10.60	0.0278 ± 0.4600
1b = 20	5	40%	26.88 ± 12.22	0.0283 ± 0.4569
1c = 10	10	35%	31.80 ± 12.88	0.0983 ± 0.4666
1d = 10	5	45%	22.33 ± 11.51	0.0199 ± 0.4896
2a = 20	10	26%	35.35 ± 10.13	0.0768 ± 0.4511
2b = 20	5	36%	30.00 ± 11.04	0.0635 ± 0.4642
2c = 10	10	32%	29.62 ± 10.58	0.0623 ± 0.4588
2d = 10	5	30%	26.23 ± 12.08	0.0572 ± 0.4567

METAPOPULATION DYNAMICS

The PVHA participants thought it would be instructive to model the dynamics of five populations that exchange individuals. The 108 files requested were created based on the TEMPLET scenario (see above and Appendix 5) to explore metapopulation dynamics. Of those "Meta" and "Control" files set up, 26 are analyzed for this report. Presenting the results of 108 files of the magnitude that a five-way "metapopulation" scenario produces would be cumbersome. More importantly, little information of value is lost if, for every batch of similar runs, we present "worst case scenarios".

We present results for simulations that started with a metapopulation size of 250 butterflies in the spring hatching cohort. Migration occurred between populations during both the spring and summer flight periods at a low (0.0025), moderate (0.01) or high (0.02) frequency. Migrating individuals had the same fecundity and mortality rates as non-migrating individuals and lay eggs in the population to which they migrated. A table of the scenarios requested and addressed is available in Appendix 6.

The "FIVE WIMPY DEME" model allowed five populations of 50 individuals to mix at a moderate rate (Fig. 6). The outcome for such a metapopulation structure was grim. All populations within the metapopulation were extinct by the 20th year. Belonging to a "wimpy" metapopulation was worse for an individual population than being autonomous (Table 7, see Table 5 for individual results).

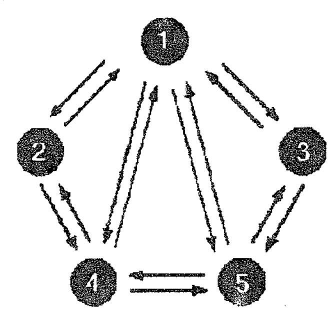


Figure 6. The "FIVE WIMPY DEME" model.

Emigration effectively increases the population's mortality rate while immigration decreases it. The impact of migration is magnified when the population is small. When four percent of the individuals in a small population leave, like the "FIVE WIMPY DEME" model (0.01 emigration rate x 4 other populations), to other equally small or smaller populations mortality effectively rises and extinction comes more suddenly.

Table 7. Results of "FIVE WIMPY DEMES". E = number of iterations that went extinct at least once. ET = time to FIRST extinction. ReCol = number of recolonization attempts. ReE = number of reextinctions.

POPULATION	E	ET (SD)	ReCol	ReE	r (SD)
1	100	10.00 (3.11)	3	3	-0.4892 (0.6457)
2	100	7.12 (3.21)	27	27	-0.3961 (0.7726)
3	100	7.07 (3.03)	21	21	-0.3987 (0.7410)
4	100	7.18 (3.26)	15	15	-0.3926 (0.7653)
5	100	7.18 (2.79)	23	23	-0.4009 (0.7842)
Meta	100	11.65 (2.94)			-0.4326 (0.5166)

Core Models

Four types of "CORE" models were developed as input for KARNER: CORE, BIGGER CORE (META6), BETTER CORE (META7), VISCOUS CORE (META8). "Core" refers to a population within the metapopulation that is more robust than the others. The core population always starts off with a larger population size (198 adults for most simulations) than the other four populations (13 adults for most simulations).

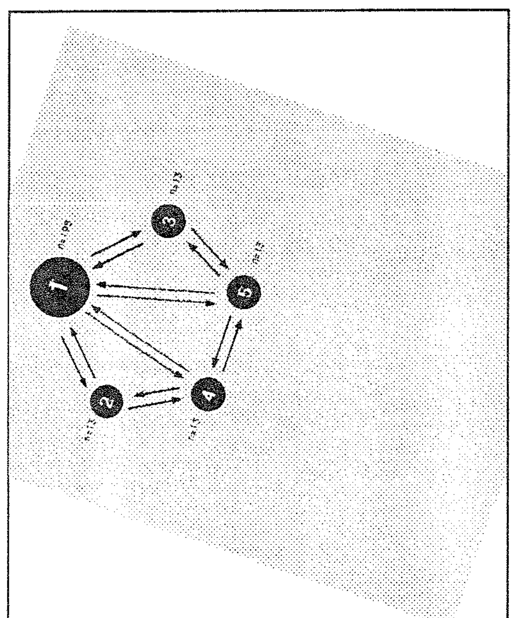


Figure 7. CORE model set-up.

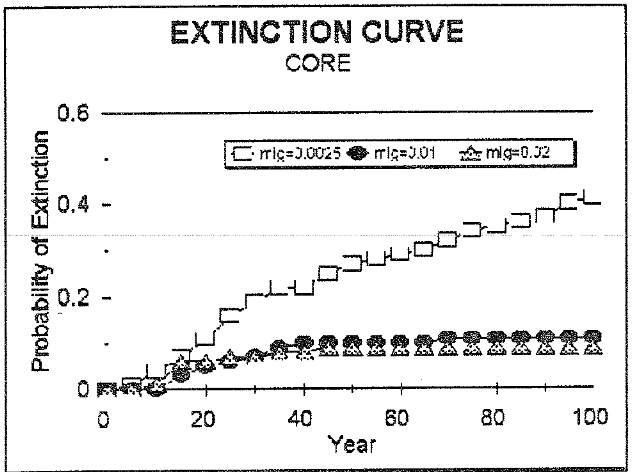


Figure 8. CORE model population trajectories.

he most basic set-up of the core model is depicted in Figure 7 (see also Appendix 6).

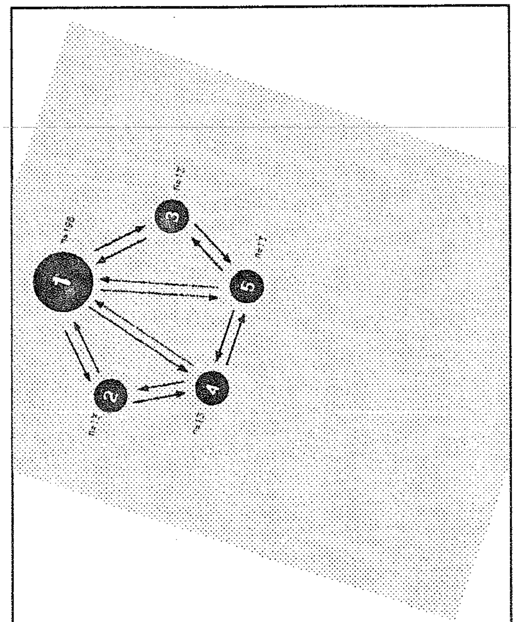


Figure 9. CORE model set-up.

Migration among all populations were run at low, medium, and high rates. Model results indicate that increasing the rate of migration increases metapopulation persistence and the intrinsic growth rate of the metapopulation (Table 8, Fig. 8, Fig. 9). As migration increases, the core population fares worse relative to the non-core populations. This can be explained because more individuals are leaving the core at faster rates while fewer are coming in. The faster migration rates greatly increase the growth rate and probability of persistence of non-core populations since more butterflies are coming in to supplement a frighteningly small population.

Table 8. Result of CORE model at three levels of migration. Population 1 is the core; 2-5 are the non-core populations. "CORE*" presents the dynamics of the metapopulation. E = percent of iterations becoming extinct at least once. ET = time to first extinction in years. ReCol = number of recolonization attempts. ReE = number of recolonization events that failed. "r" = intrinsic growth rate.

POPULATION	E	ET (SD)	ReCol	ReE	r (SD)
1	74	41.42(29.16)	127	102	0.0193 (0.5432)
2	91	8.57(13.55)	376	332	-0.0037(00.6904)
3	82	10.27(17.90)	299	263	0.0247 (0.6417)
4	92	9.10(18.05)	387	344	0.0145 (0.6718)
5	87	10.22(18.18)	360	319	0.0188 (0.6854)
COREa	41	42.61(28.69)			0.0561 (0.3322)
1	21	18.81(16.05)	32	22	0.0517 (0.4424)
2	40	7.80(10.66)	90	61	0.0767 (0.4854)
3	50	8.40(12.53)	98	59	0.0762 (0.4884)
4	45	8.76(13.64)	80	46	0.0753 (0.4847)
5	45	6.38(7.08)	87	53	0.0761 (0.4898)
COREb	11	27.18(15.94)			0.0874 (0.2088)
1	9	7.67(4.36)	11	11	0.0647 (0.3828)
2	14	5.86(4.72)	17	12	0.0920 (0.3913)
3	13	4.08(3.28)	13	9	0.0956 (0.4020)
4	16	5.94(6.21)	18	11	0.0932 (0.3992)
5	17	5.94(4.84)	24	16	0.0930 (0.4036)
COREc	9	19.33(10.99)			0.0933 (0.1804)

BIGGER CORE

The core population was given a higher carrying capacity (K = 1980) in the "BIGGER CORE" model while the carrying capacities of non-core populations were reduced to K = 130 (Appendix 6). The model was run at low, moderate, and high migration rates between all populations. At first the population trajectories seem to defy the extinction curves (Fig. 10 and 11). How can a larger population have a higher probability of extinction given the preceding discussion? The key is to keep METApopulation dynamics in mind and remember "population size" is calculated only for EXTANT populations.

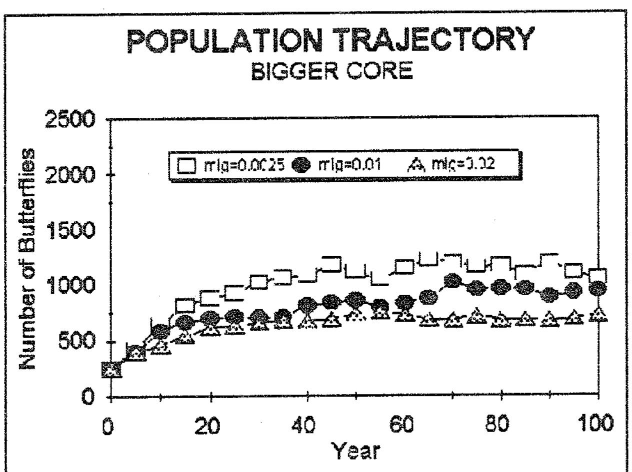


Figure 10. BIGGER CORE population trajectory.

When migration is low, a few individuals (about 2 in the first year of the simulation) leave the more robust population, but virtually none come in. During the 100 simulations with low migration, 94% of inferior populations went extinct at least once and, once extinct, were recolonized an average of 245 times each! Reextinction occurred about 85% of the time (Table 9). The larger population went extinct 55% of the time and none of the 34 recolonizations persisted.

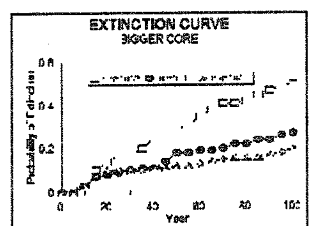


Figure 11. BIGGER CORE extinction curves.

Under a regime of moderate and high migration, the larger population (1) fares worse than when migration is low (more individuals leave); the average growth rate of the large population actually becomes negative! The smaller non-core populations fare better, however, making the METApopulation growth rate higher (Table 9) than that of a single population of similar size (Table 5). When migration rates are moderate or high, population and metapopulation extinctions still occur but generally at lower frequencies. Recolonizations are more successful since more colonizers are coming into an empty population.

Table 9. Results of BIGGER CORE model. "POPULATION" 1 = core population whereas 2-5 are non-core populations. "Meta**" refers to the metapopulation as an entity and corresponds with the input information in Appendix 6. E = percent of populations that went extinct at least once. ET = time to first extinction. ReCol = number of times a population was recolonized. ReE = number of times reextinction occurred. r = intrinsic growth rate.

POPULATION	E	ET (SD)	ReCol	ReE	r (SD)
1	55	34.80 (24.64)	34	34	0.0083 (0.4701)
2	94	11.21 (17.43)	246	207	0.0626 (0.6583)
3	93	13.52 (22.57)	248	214	0.0649 (0.6668)
4	92	15.17 (24.29)	224	189	0.0676 (0.6403)
5	98	11.86 (20.38)	263	222	0.0594 (0.6811)
Meta6A	50	44.76 (27.37)			0.0486 (0.3610)
1	55	35.87 (27.02)	118	93	-0.0128 (0.5569)
2	67	23.94 (26.19)	161	124	0.1027 (0.5811)
3	69	24.78 (28.00)	180	141	0.1126 (0.5894)
4	73	23.89 (26.94)	175	131	0.1040 (0.5988)
5	69	16.58 (21.30)	161	121	0.1125 (0.5931)
Meta6B	27	44.89 (29.06)			0.0711 (0.2799)
1	27	33.59 (27.76)	28	21	-0.0102 (0.4855)
2	36	32.97 (32.98)	36	21	0.1194 (0.4952)
3	33	27.97 (28.30)	45	32	0.1214 (0.5047)
4	38	30.82 (30.96)	40	22	0.1222 (0.5061)
5	40	28.95 (33.00)	52	33	0.1193 (0.5034)
Meta6C	20	41.75 (34.28)			0.0814 (0.2426)

The results of BIGGER CORE can be summarized in three general statements. Firstly, when population sizes are relatively small, higher migration rates allow the metapopulation to persist longer than lower migration rates; the relationship is not linear, however. Secondly, the variance in growth rate is lower when individuals are partitioned into a metapopulation rather than lumped into the same population but a metapopulation is not necessarily more likely to succeed than the same number of individuals in a single population. Thirdly, recolonization of extinct populations is more successful when migration is higher.

BETTER CORE

The core population in the BETTER CORE model (META7) had a lower mortality rate for both broods (92% and 84% for spring and summer-hatching cohorts, respectively). BETTER CORE was run at low, moderate, and high migration rates between all populations. The runs resulted in similar population trajectories as those resulting from the CORE model (Fig. 12). Extinction rates for the metapopulation

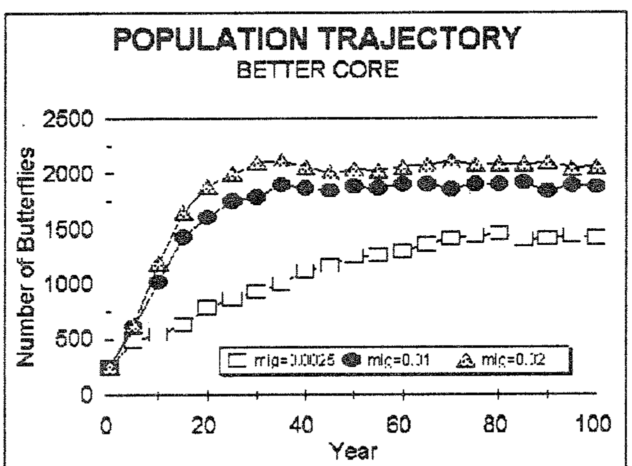


Figure 12. Population trajectories for BETTER CORE.

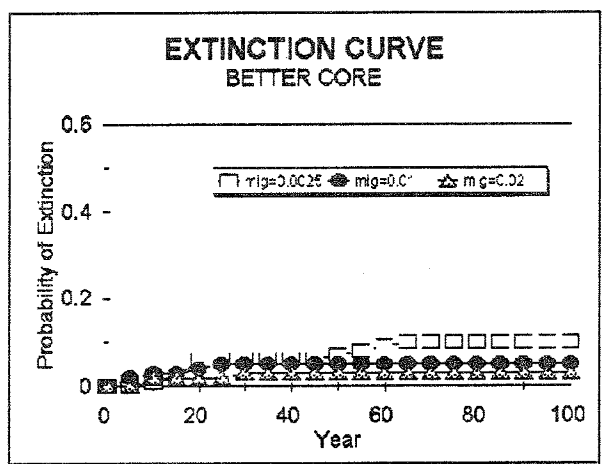


Figure 13. Extinction curves for BETTER CORE

were much lower in this set of simulations compared with BIGGER CORE (Fig. 13). Since the modeled butterfly populations are most sensitive to changes in mortality, the lower extinction rates were predictable. Raising the carrying capacity (K) from 130 to 500 for the four smaller populations may have also assisted in lowering the extinction rate since larger populations are more likely to persist through the stochastic and catastrophic events that act upon the modeled butterflies.

Table 10. Results of BETTER CORE. See Table 9 for column descriptions.

POPULATION	E	ET (SD)	ReCol	ReE	r (SD)
1	25	35.16 (29.14)	59	45	0.1808 (0.4828)
2	81	10.01 (16.88)	354	286	0.0424 (0.6231)
3	88	10.12 (14.96)	350	276	0.0460 (0.6147)
4	80	8.85 (17.15)	381	316	0.0400 (0.6269)
5	86	12.80 (19.40)	335	262	0.0409 (0.6359)
Meta7A	10	32.00 (21.80)			0.1459 (0.2645)
1	6	11.00 (10.14)	4	3	0.1919 (0.4204)
2	24	6.75 (14.30)	31	12	0.0949 (0.4372)
3	21	3.48 (3.52)	26	10	0.0902 (0.4401)
4	21	2.95 (2.16)	30	14	0.0942 (0.4443)
5	24	3.96 (4.44)	30	11	0.0938 (0.4398)
Meta7B	5	12.20 (9.58)			0.1418 (0.1885)
1	3	8.67 (0.58)	3	3	0.1891 (0.3702)
2	10	4.30 (7.12)	8	1	0.1049 (0.3802)
3	11	3.45 (3.14)	11	3	0.1074 (0.3853)
4	5	4.40 (2.41)	5	3	0.1059 (0.3815)
5	7	4.00 (2.71)	9	5	0.1081 (0.3753)
Meta7C	3	14.67 (9.87)			0.1375 (0.1725)

Recolonizations are more successful in BETTER CORE than in the other scenarios, especially as migration rates increase (Table 10). As expected, the growth rate for the core population is much higher in BETTER CORE. This much higher growth rate in the core carries over to the non-core populations, through immigration, making their growth rates higher also.

VISCOUS CORE

The VISCOUS CORE model (META8) allowed one of the five populations to have a lower emigration rate than the smaller populations. The "moderate out, fast in(8E)" scenario fared much better than the "slow out, moderate in "(8A) and "slow out, fast in"(8C) arrangements, which produced similar results. When butterflies move into the core population more quickly, the time to the first extinction of the core is delayed in the core while rising in the non-core populations (Table 11).

Results suggest that emigration from the core population controls metapopulation dynamics more than immigration to the core. The populations trajectories (Fig 14) of the VISCOUS CORE model are similar to those of the CORE at the same level of emigration from the core population. Additionally, moderate immigration into the core (8A) and high immigration into the core (8C) produce similar metapopulation parameters, suggesting that migration out of the core is more important to population growth and persistence than migration into the core or among non-core populations (Fig 14, 15, Table 11).

Table 11. Results for VISCOUS CORE. See Table 9 for column descriptions.

POPULATION	E	ET (SD)	ReCo l	ReE	r (SD)
1	38	26.68 (21.34)	23	16	0.0681 (0.4725)
2	77	6.64 (8.23)	200	156	0.0417 (0.5741)
3	86	6.70 (9.02)	245	190	0.0346 (0.5830)
4	74	5.64 (5.66)	213	172	0.0376 (0.5891)
5	82	5.28 (7.19)	246	196	0.0402 (0.5765)
Meta8A	31	30.10 (24.97)			0.0686 (0.2895)
1	34	32.21 (16.13)	4	3	0.1015 (0.4410)
2	81	5.57 (6.93)	241	194	0.0337 (0.5593)
3	79	5.48 (6.56)	254	208	0.0282 (0.5645)
4	72	4.83 (4.70)	238	200	0.0336 (0.5573)
5	77	4.99 (6.32)	242	200	0.0317 (0.5549)
Meta8C	33	33.94 (16.42)			0.0703 (0.2960)
1	16	15.38 (10.70)	10	7	0.1096 (0.3924)
2	31	6.19 (6.58)	36	18	0.0762 (0.4373)
3	33	5.42 (5.03)	52	32	0.0726 (0.4299)
4	32	5.31 (6.50)	37	18	0.0764 (0.4257)
5	29	6.28 (5.87)	35	19	0.0748 (0.4311)
Meta8E	13	20.23 (12.19)			0.0918 (0.1926)

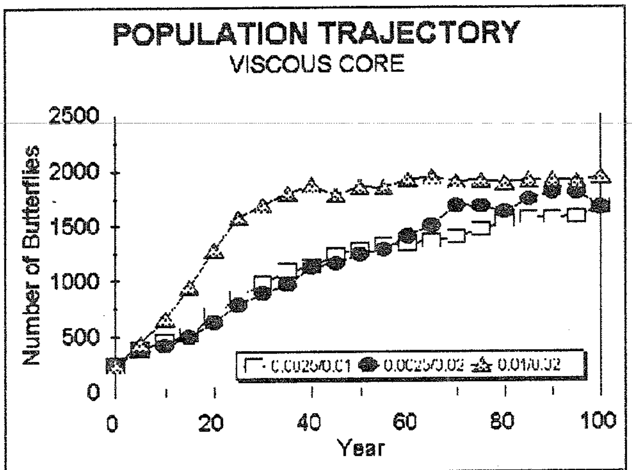


Figure 14. Population trajectories of VISCOUS CORE at three levels of migration.

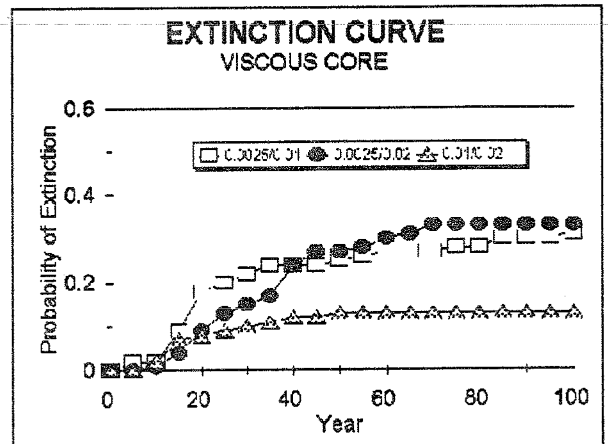


Figure 15. Extinction curves for VISCOUS CORE at three levels of migration.

VISCOUS CORE yields some curious results when compared against CORE. When CORE was given a migration rate of 0.0025 the 74% of the core populations went extinct at least once. When VISCOUS CORE was given a 0.0025 migration rate out of the core, the core fared much better (as expected) and so did the non-core populations (not expected) (Table 11). When migration occurred at rate of "0.01 out of core/0.02 all others" (8E) in VISCOUS CORE, the average growth rate of the core population doubled (as expected) compared with CORE run at migration of 0.01. The growth rate of non-core populations was virtually identical to the CORE scenario, however (not expected).

Combined Cores

The three variations of CORE (BIGGER, BETTER, and VISCOUS) into three more scenarios:

1) BIGGER, BETTER (META9),

2) BETTER, VISCOUS (META10),

3) BIGGER, VISCOUS (META11).

Of the files setup (Appendix 6), only the results for the combined "worst cases" are presented in this report. These are:

1) BIGGER, BETTER META9A (META6a + Meta 7b),

2) BIGGER, VISCOUS META10B (META6a + META8b),

3) BETTER, VISCOUS META11C (META7a + META8b).

A BIGGER, BETTER core within a metapopulation is better than a BETTER or BIGGER core only. For the metapopulation, it produces the highest growth rate of all the pairwise core combinations (Table 12). Growth rates tend to be high for non-core populations yet an average of 73% of the non-core populations went extinct at least once. Recolonizations are common and relatively successful. The results tend to be more similar to the BETTER scenario than to the BIGGER one.

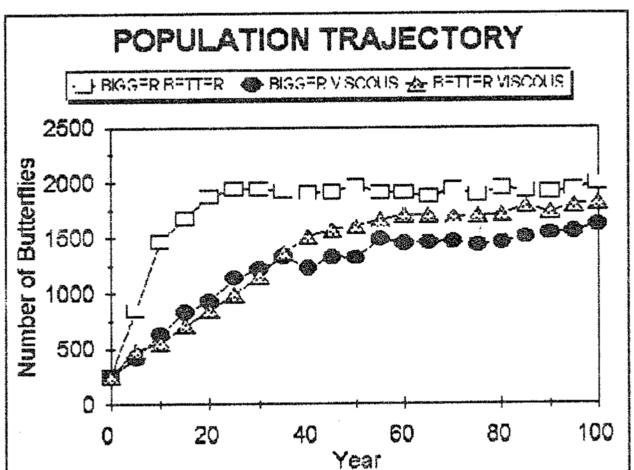


Figure 16. Population trajectories for combined core models.

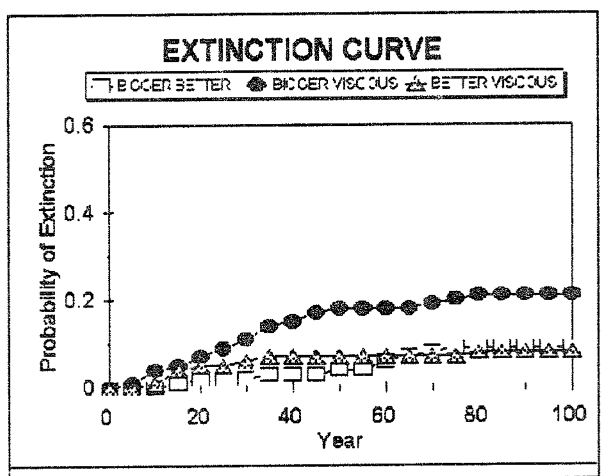


Figure 17. Extinction curves for combined core models.

BIGGER, VISCOUS performs the

most poorly of the combined core models (Table 12, Fig. 16, Fig. 17). Although the core population fares better than either the BIGGER or the VISCOUS models, the metapopulation has about the same growth rate the VISCOUS metapopulation model alone. The probability of extinction of the BIGGER, VISCOUS metapopulation is lower than either BIGGER or VISCOUS. The results tend to be more similar to BIGGER than to VISCOUS.

A BETTER, VISCOUS core has a much higher growth rate and chance of persistence than a BETTER or VISCOUS alone (Table 12). This carries over to the non-core populations and allows them to also persist for longer despite moderate growth rates. Using population growth and extinction curves as indicators, BETTER appears to be the dominant scenario in this combined core file.

Table 12. Results of combined core models. See Table 9 for column descriptions.

POPULATION	E	ET (SD)	ReC	ReE	r (SD)
1	14	39.57 (21.64)	13	11	0.1896 (0.4429)
2	70	9.20 (18.71)	127	70	0.1255 (0.5710)
3	76	8.58 (16.49)	155	89	0.1253 (0.5806)
4	70	13.76 (25.32)	131	73	0.1248 (0.5752)
5	76	10.63 (19.48)	146	82	0.1216 (0.5793)
Meta9A	9	48.67 (22.05)			0.1936 (0.3236)
1	24	31.50 (22.67)	10	7	0.0453 (0.4513)
2	77	8.69 (17.07)	184	130	0.0637 (0.5678)
3	78	11.64 (22.33)	186	135	0.0632 (0.5743)
4	76	7.95 (16.03)	180	127	0.0701 (0.5774)
5	81	7.48 (13.27)	160	104	0.0711 (0.5717)
meta10B	21	31.52 (20.95)			0.0661 (0.3117)
1	9	22.00 (21.82)	3	2	0.2660 (0.4124)
2	66	5.65 (10.35)	184	127	0.0524 (0.5079)
3	61	5.33 (6.39)	191	139	0.0469 (0.5204)
4	65	4.42 (4.26)	206	149	0.0465 (0.5069)
5	57	4.60 (4.04)	163	114	0.0516 (0.5146)
Meta11C	8	25.50 (22.90)			0.1564 (0.2401)

BIGGER, BETTER, VISCOUS

Lastly, files were combined to produce a BIGGER, BETTER, VISCOUS core. Nine versions of this model were set-up (Appendix 6) and a summary of the results from all nine versions are presented (Table 13). Extinctions of the core population and the metapopulation were rare regardless of the migration rates in or out of the core. Non-core populations fared much better when immigration was moderate from the core and high from other non-core populations (12C, 12F, 12I). Never-the-less, the growth rate for the metapopulation in all the versions was similar. The results are most similar to the BETTER model although even the BETTER model performed poorly compared to "BIGGER, BETTER, VISCOUS"

Increasing the starting population sizes does little to enhance the success of this model (Table 13).

Table 13. Results of BIGGER, BETTER, VISCOUS model. See Table 9 for column descriptions.

POPULATION	E	ET (SD)	ReCol	ReE	r (SD)
1	8	47.00 (27.95)	10	4	0.1949 (0.4565)
2	59	6.80 (13.62)	111	54	0.1194 (0.5359)
3	61	12.16 (22.95)	128	70	0.1243 (0.5306)
4	58	10.07 (21.63)	122	67	0.1255 (0.5261)
5	74	4.82 (7.72)	143	71	0.1150 (0.5616)
Meta12A	2	12.50 (3.54)			0.1997 (0.3057)
Meta12D	2	62.50 (40.31)			0.2046 (0.3026)
Meta12G	1	92.00 (0.00)			0.1971 (0.3065)
1	5	6.20 (2.59)	3	1	0.2027 (0.4303)
2	60	3.35 (3.37)	95	38	0.1141 (0.4878)
3	57	5.12 (9.98)	86	32	0.1094 (0.4959)

4	53	4.02 (4.80)	78	28	0.1112 (0.4873)
5	58	4.91 (10.52)	95	40	0.1095 (0.4940)
Meta12B	3	8.67 (1.53)			0.2012 (0.3049)
Meta12E	1	11.00 (0.00)			0.2077 (0.2965)
Meta12H	0				0.2025 (0.3000)
1	8	17.50 (17.94)	10	6	0.1504 (0.4192)
2	20	3.30 (3.11)	36	20	0.2683 (0.4112)
3	27	7.67 (14.72)	40	17	0.2739 (0.4081)
4	21	7.05 (14.80)	32	15	0.2684 (0.4078)
5	23	8.83 (19.43)	32	13	0.2696 (0.4191)
Meta12C	4	23.50 (6.03)			0.1949 (0.2874)
Meta12F	0				0.1972 (0.2806)
Meta12I	0				0.2012 (0.2786)

Controls

Each of the above metapopulation models had a companion control file that focused on the core population. These were constructed to assess the effects of emigration. Instead of five populations, two were created. The non-core population was a "death patch" to which individuals from the core migrated at a rate of four times a single emigration event in each of the metapopulation scenarios.

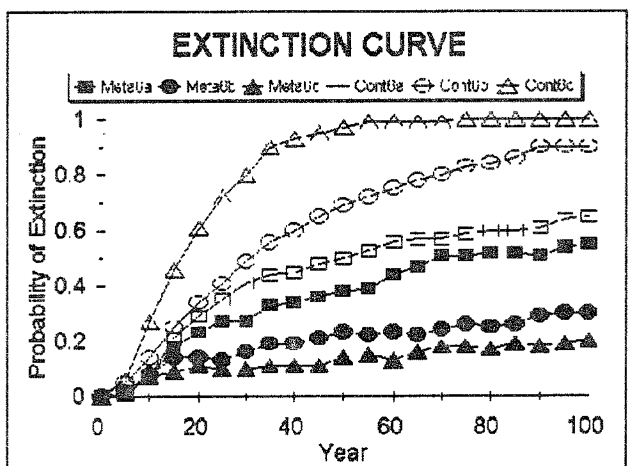


Figure 18. Extinction curves for the BIGGER model and it's corresponding control file.

As stated earlier, the modeled Karner Blue Butterflies that emigrate do not reproduce in their natal population. Therefore, although emigration does not actually raise mortality, it effectively does. The modeled populations are sensitive to changes in the mortality rates so as migration rates increased these control populations performed more poorly compared to single populations with no emigration of the same size and populations associated with a metapopulation. As an example, we present the results of the "control" versions of the BIGGER CORE model (Table 14, Fig. 18).

Table 14. Comparison of the core population in the BIGGER model and it's associated control model. See Table 9 for column descriptions.

POPULATION	E	ET (SD)	r (SD)
META6a	55	34.80 (24.64)	0.0083 (0.4701)
CONT6a	65	32.91 (25.26)	0.0083 (0.4656)
META6b	55	35.87 (27.02)	-0.0128 (0.5567)
CONT6b	90	33.78 (23.70)	-0.0605 (0.5283)
META6c	27	33.59 (27.76)	-0.0102 (0.4855)
CONT6c	100	19.80 (13.11)	-0.1685 (0.5925)

APPENDIX 5

TEMPLET SCENARIO INPUT FILE FOR "KARNER"

INPUT FILE FOR BASIC METAPOPULATION SCENARIOS - APPENDIX 5
TWO CATASTROPHES

TEMPLET.OUT ***OutputFilename***
N ***PlotterFiles?***
100 ***Simulations***
100 ***Years***
5 ***ReportingInterval***
1 ***Populations***
N ***InbreedingDepression?***
Y ***EVcorrelation?***
2 ***TypesOfCatastrophes***
P ***MonogamousOrPolygynous***
1 ***FemaleBreedingAge***
1 ***MaleBreedingAge***
1 ***MaximumAge***
0.500000 ***SexRatio***
104 ***MaximumLitterSize***
N ***DensityDependentBreeding?***
2.900000 ***Population 1a: PercentLitterSize0***
5.900000 ***Population 1a: PercentLitterSize1***
0.000000 ***Population 1a: PercentLitterSize2***
0.000000 ***Population 1a: PercentLitterSize3***
2.900000 ***Population 1a: PercentLitterSize4***
2.900000 ***Population 1a: PercentLitterSize5***
5.900000 ***Population 1a: PercentLitterSize6***
2.900000 ***Population 1a: PercentLitterSize7***
11.80000 ***Population 1a: PercentLitterSize8***
2.900000 ***Population 1a: PercentLitterSize9***
8.900000 ***Population 1a: PercentLitterSize10***
11.90000 ***Population 1a: PercentLitterSize11***
8.900000 ***Population 1a: PercentLitterSize12***
8.900000 ***Population 1a: PercentLitterSize13***
2.900000 ***Population 1a: PercentLitterSize14***
8.800000 ***Population 1a: PercentLitterSize15***
0.000000 ***Population 1a: PercentLitterSize16***
2.900000 ***Population 1a: PercentLitterSize17***
2.900000 ***Population 1a: PercentLitterSize18***
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2.900000 ***Population 1a: PercentLitterSize26***
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0.000000	***Population 1a: PercentLitterSize34***
0.000000	***Population 1a: PercentLitterSize35***
2.900000	***Population 1a: PercentLitterSize36***
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0.000000	***Population 1a: PercentLitterSize71***
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0.000000 ***Population 1a: PercentLitterSize101***
0.000000 ***Population 1a: PercentLitterSize102***
0.000000 ***Population 1a: PercentLitterSize103***
0.000000 ***Population 1a: PercentLitterSize104***
11.000000 ***EV--Reproduction***
92.000000 ***FemaleMortalityAtAge0***
0.00000 ***EV--FemaleMortality***
100.000000 ***AdultFemaleMortality***
0.000000 ***EV--AdultFemaleMortality***
92.000000 ***MaleMortalityAtAge0***
0.000000 ***EV--MaleMortality***
100.000000 ***AdultMaleMortality***
0.000000 ***EV--AdultMaleMortality***
10.00000 ***ProbabilityOfCatastrophe1***
1.5 ***Severity in Ref to Repro***
0.5 ***Severity in Ref to Survival***
5.0000 ***ProbabilityOfCatastrophe2***
0.5
0.5
Y ***AllMalesBreeders?***
Y ***StartAtStableAgeDistribution?***

100 ***InitialPopulationSize***
1000 ***K***
0.000000 ***EV--K***
N ***TrendInK?***
N ***Harvest?***
N ***Supplement?***
0.000000 ***Population 1b: PercentLitterSize0***
8.800000 ***Population 1b: PercentLitterSize1***
0.000000 ***Population 1b: PercentLitterSize2***
0.000000 ***Population 1b: PercentLitterSize3***
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2.900000 ***Population 1b: PercentLitterSize21***
0.000000 ***Population 1b: PercentLitterSize22***
0.000000 ***Population 1b: PercentLitterSize23***
3.000000 ***Population 1b: PercentLitterSize24***
6.000000 ***Population 1b: PercentLitterSize25***
8.900000 ***Population 1b: PercentLitterSize26***
3.000000 ***Population 1b: PercentLitterSize27***
3.000000 ***Population 1b: PercentLitterSize28***
3.000000 ***Population 1b: PercentLitterSize29***
6.000000 ***Population 1b: PercentLitterSize30***
0.000000 ***Population 1b: PercentLitterSize31***
5.900000 ***Population 1b: PercentLitterSize32***
2.900000 ***Population 1b: PercentLitterSize33***
2.900000 ***Population 1b: PercentLitterSize34***
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0.000000 ***Population 1b: PercentLitterSize102***
0.000000 ***Population 1b: PercentLitterSize103***
0.000000 ***Population 1b: PercentLitterSize104***
30.000000 ***EV--Reproduction***
80.000000 ***FemaleMortalityAtAge0***
0.000000 ***EV--FemaleMortality***
100.000000 ***AdultFemaleMortality***
0.000000 ***EV--AdultFemaleMortality***
80.000000 ***MaleMortalityAtAge0***
0.000000 ***EV--MaleMortality***
100.000000 ***AdultMaleMortality***
0.000000 ***EV--AdultMaleMortality***
0.000000 ***ProbabilityOfCatastrophe1***
0.000000 ***ProbabilityOfCatastrophe2***
Y ***AllMalesBreeders?***
Y ***StartAtStableAgeDistribution?***
0 ***InitialPopulationSize***
1000 ***K***
0.000000 ***EV--K***
N ***TrendInK?***
N ***Harvest?***
N ***Supplement?***
N

<u>APPENDIX 6</u>

CORE MODEL INPUT SCENARIOS

Table . Core and Metapopulation Input Scenarios. (Appendix 6).

RUN	MIGRATION		CORE				NON-CORE			
	from core	to core	size	mort-a	mort-b	K	size	mort-a	mort-b	K
meta5a	0.01	0.01	50	93	85	500	50	93	85	500
COREa	0.0025	0.0025	198	93	85	500	13	93	85	500
COREb	0.01	0.01	198	93	85	500	13	93	85	500
COREc	0.02	0.02	198	93	85	500	13	93	85	500
meta6a	0.0025	0.0025	198	93	85	1980	13	93	85	130
meta6b	0.01	0.01	198	93	85	1980	13	93	85	130
meta6c	0.02	0.02	198	93	85	1980	13	93	85	130
meta6d	0.0025	0.0025	396	93	85	1980	26	93	85	130
meta6e	0.01	0.01	396	93	85	1980	26	93	85	130
meta6f	0.02	0.02	396	93	85	1980	26	93	85	130
meta6g	0.0025	0.0025	792	93	85	1980	52	93	85	130
meta6h	0.01	0.01	792	93	85	1980	52	93	85	130
meta6i	0.02	0.02	792	93	85	1980	52	93	85	130
meta7a	0.0025	0.0025	198	0.92	0.84	500	13	93	85	500
meta7b	0.01	0.01	198	0.92	0.84	500	13	93	85	500
meta7c	0.02	0.02	198	0.92	0.84	500	13	93	85	500
meta7d	0.0025	0.0025	398	0.92	0.84	500	26	93	85	500
meta7e	0.01	0.01	398	0.92	0.84	500	26	93	85	500

meta7f	0.02	0.02	398	0.92	0.84	500	26	93	85	500
meta8a	0.0025	0.01	198	93	85	500	13	93	85	500
meta8b	0.0025	0.01	394	93	85	500	26	93	85	500
meta8c	0.0025	0.02	198	93	85	500	13	93	85	500
meta8d	0.0025	0.02	394	93	85	500	26	93	85	500
meta8e	0.01	0.02	198	93	85	500	13	93	85	500
meta8f	0.01	0.02	394	93	85	500	26	93	85	500
meta9a	0.0025	0.0025	198	92	84	1980	13	93	85	130
meta9b	0.01	0.01	198	92	84	1980	13	93	85	130
meta9c	0.02	0.02	198	92	84	1980	13	93	85	130
meta9d	0.0025	0.0025	396	92	84	1980	26	93	85	130
meta9e	0.01	0.01	396	92	84	1980	26	93	85	130
meta9f	0.02	0.02	396	92	84	1980	26	93	85	130
meta9g	0.0025	0.0025	792	92	84	1980	52	93	85	130
meta9h	0.01	0.01	792	92	84	1980	52	93	85	130
meta9i	0.02	0.02	792	92	84	1980	52	93	85	130
meta10a	0.0025	0.01	198	93	85	1980	13	93	85	130
meta10b	0.0025	0.02	198	93	85	1980	13	93	85	130
meta10c	0.01	0.02	198	93	85	1980	13	93	85	130
meta10d	0.0025	0.01	396	93	85	1980	26	93	85	130
meta10e	0.0025	0.02	396	93	85	1980	26	93	85	130
meta10f	0.01	0.02	396	93	85	1980	26	93	85	130

meta10g	0.0025	0.01	792	93	85	1980	52	93	85	130
meta10h	0.0025	0.02	792	93	85	1980	52	93	85	130
meta10i	0.01	0.02	792	93	85	1980	52	93	85	130
meta11a	0.0025	0.01	198	92	84	500	13	93	85	500
meta11b	0.0025	0.01	394	92	84	500	26	93	85	500
meta11c	0.0025	0.02	198	92	84	500	13	93	85	500
meta11d	0.0025	0.02	394	92	84	500	26	93	85	500
meta11e	0.01	0.02	198	92	84	500	13	93	85	500
meta11f	0.01	0.02	394	92	84	500	26	93	85	500
meta12a	0.0025	0.01	198	92	84	1980	13	93	85	130
meta12b	0.0025	0.02	198	92	84	1980	13	93	85	130
meta12c	0.01	0.02	198	92	84	1980	13	93	85	130
meta12d	0.0025	0.01	396	92	84	1980	26	93	85	130
meta12e	0.0025	0.02	396	92	84	1980	26	93	85	130
meta12f	0.01	0.02	396	92	84	1980	26	93	85	130
meta12g	0.0025	0.01	792	92	84	1980	52	93	85	130
meta12h	0.0025	0.02	792	92	84	1980	52	93	85	130
meta12i	0.01	0.02	792	92	84	1980	52	93	85	130

APPENDIX 9

KARNER BLUE BUTTERFLY PHVA REPORT FIGURES

APPENDIX 3

KARNER BLUE BUTTERFLY PHVA WORKSHOP MINUTES

KARNER BLUE BUTTERFLY PHVA WORKSHOP

MINUTES Filename: KB0422.CGK

Karner Blue Butterfly PVA, The Wilds, Zanesville, OH. 04/22/92

Notes by Chuck Kjos

Dale F. Schweitzer, DFS: (quoted by US): KB will prob. need intensive intervention mgt in perpetuity.

Ulie Seal, US: Political factors and uncertainties are at least as important as biol factors in the survival of spp., incl KB.

Disease may be a significant catastrophic event for KB.

US: mig rate item for model: pop 1%, 0%,

DFS: Quick rebound of pops following fire suggests density-dependant increased survival and breeding of the remnant pop that survived the fire.

US: It may be good to model both for a KB-managed pop and for an unmanaged pop (subj only to unplanned stochastic events).

The data (DS's data?) suggests KB has naturally relatively stable pops that vary subj to catastrophic crash events.

DFS, DS et al: Males are polygamous, females are less certain, but probably mostly monogamous.

US: What is max no/litter, i.e., no. getting to age of repro?

ANSWERS: Dolores Savignano, DS: SEE SMoen's sheets of DS's captive KB data.

DFS: Let,s assume a 4-day egg laying granting that lab condx probably result in max capability production;

DS: "ok."

Dave Andow, DA, et al: the variance in these data are as great as the means - great variability in egg-laying and survivorship, hatching.

Scott Swengel, SS: Quoting Ryk Spoor's data: Only 18% of laid eggs could be subsequently found. Some "lost" eggs may have hatched elsewhere and contributed to subsequent adult counts.

US: What proportion of females produce eggs?

ANS: DFS: ca. 25% females lay no eggs; could be a lot higher in a spr brood facing bad weather. Then agreement on 26 eggs/laying female, subj to wild variability (doubtful utility in model).

DS: Let's try my data, then use a sanity check.

Chorus: ok.

Cynthia Lane, CL: Let's try min and max possible assumed mortality (fm hatching to adulthood) runs.

Chorus: ok. 80% mort selected. NOTE: This is close to Spoor's 18% eggs found data - was all the mort in the egg, little in the larvae?!

SM c/ Bob Dirig, RD's info: Fire hit albany KB sites ca every 8-11 yrs.

Robert Zaremba, RZ: Historically fire every 8-10 yrs, but is different today (suppression). Not all of the site need be burned, there were survivors in fire areas, mort was high, but <100%

Ann Swengel, AS: No larvae found in 4 days of looking in an area after a fire thus mort close to 100% - in the areas actually burned, not in parts the fire missed.

US: Let's use 10%.

US: The fire notion is being used c/ ambiguity; there seems to be agreement not to use 100% mort c/ ea. fire. Remember yesterday's thought that 50% mort via fire might not be devastating.

DFS: Better to assume closer to 90% mort.

SM: None of the responses to the dataform indicated 100% fire mort at any site.

US: We'll stick c/ 10% survivorship for this run. Other %% can, and should be, be used in subsequent runs.

US: Instruction to gru: Descr drought effects in terms of % pop reduction.

DA: Let's put in a 50-yr drought (2% prob of occurrence).

DFS: That would be 90% mort.

RZ: Every 5 yrs there can be a wet spring that cuts the 1st brood by 50%. Half of the females sit out the breeding season. No affect on survival.

US: Let's start c/ a spring pop of 100. Let's enter 400 as the carrying capacity fig for this 1st trial run.

Sharon Moen, SM: Many insects aren't habitat carrying capacity dependent.

DFS: There is a near 1:1 linear relationship between number of KBs and number of lupine plants. [when?]

SM: Since summer brood is ca. 3x spr brood, we should decrease mort to....

SS: Do a run c/ summer brood (o/wintering) egg mort 3x greater than egg mort of spr brood's eggs. This egg survivorship is based on info fm RDirig.

DFS: Pls make 5 runs, ea gene exchanging 1% c/ one other pop in both directions between both broods - I'm looking for increased stability. What happens c/ 5 metapops c/ wimpy demes?

US: OK - give me your cond c/ what you want.

US: Suggested grus:
- Modelling gru - SM facilitator;
- Lupine phenology - RZ facilitator;
- Habitat variation - CK facilitator;
- Management - Rex Ennis, RE, facilitator;
- Metapops - ;
- Parasites and disease - DA facilitator.

DA: The model appears to be set up to incorporate exogenous events, not for endogenous or density-dependent factors. Right?

US: Right.

END

04/23/92 - KBPVA AM session Filename: 0423AM.CGK

Robert Zaremba - RZ, Michelle Grigore - MG, Dolores Savignano - DS, Ann Swengel - AS, Krista Helmboldt - KH, Dave Andow - DA, Cathy Bleser - CB, Ulie Seal - US, Rex Ennis - RE, Erik Metzler - EM, Dave Ewert - DE, Rich Baker - RB, Leni Wilsmann - LW, Scott Swengel - SS, Anne Hecht - AH, Chuck Kjos - CK, Tom Mason - TM Sharon Moen - SM

RZ Non-sync events' effects on KB repro, i.e., plant phenology/KB phenology.

MG Carrying cap concept for KB is problematic. What component of the hab is the determinant?

DS Poorer sites have fewer KB and it seems related to amount of lupine.

AS KB emergence shifts in response to plant phenology - 2-wk shift ea way is possible (summer brood ad flights).

KH KB in NH, spr brood will shift emergence to match weather/phenology.

DA In MN every year sets some sort of weather extreme record. These extremes are poss greater than on e. coast and may be limiting to KB in MN.

Carrying cap can poss be usefully thought of as fluctuating tremendously throughout the season and fm yr to yr.

CB Last July 4th's KB emergence occurred when there were very few nectar sources and the adults (ads) were actively srching for nectar sources - probed me, the collecting net handle, etc.

US Habitat management group next.

RE There are many unanswered questions. We focused on hab mgt strategies, i.e., what if... We discussed fire (incompletely), mowing, other mech, and chem vege control. Also exotics, herbivores, unit size and spatial arr, etc.

We might need to look at means to enhance lupine for 2nd brood, i.e., irrigation.

Our fire discussion addressed spatial and temporal burning strategies. We agreed that 20% of an area burned once in a 5 yr time period, never burned 2 yrs in a row. Also, doubt about burning small patches, i.e., don't burn patches c/ <1000 KB.

RZ In a functional metapop case, it may not be bad to totally burn a small site. Long-term viability of lupine without burning is doubtful - burning may be essential. RE: We could use your data and info on that. RZ: This is my judgement, no data available.

EM We were concerned to assure prompt repopulation.

DS An albany site, KB came back quickly, but lupine didn't respond quickly.

KH We agreed that site specific management prescriptions (much or little burning, etc) will be necessary for ea site.

RE Agreement was on use of best practices to keep out woody stems on a site by site basis.

RZ We just don't have the pop sizes at our sites that the midwest does. Do any of the midwesterners know what is limiting KB? Do you know for sure that it is lupine limited? Is there something else that you should be managing for?

DE We found that nectar source availability is important in midwest.

RB In MN the microhab (canopy cover) is freq wrong, i.e., too heavy canopy. We freq need to open the canopy.

RE We don't recommend for removal of every tree, but 40-80% open, based on Packer, 1987.

RB A fig like that needs a scale to relate the prescribed openess to surrounding tree cover.

RE We hoped to address size and openess prescriptions, but we didn't have good data to work from.

KH It would be helpful to know pros/cons of mowing vs burning for lupine and nectar source plants.

DS Packer's 40-80% fig came from the study of a pop that subsequently crashed. We may want to study the question elsewhere.

RZ Re chem tmts, in NY, 12 KB sites are on chem treated power line routes. We will analyze ROW mgt practices that may give us some info on various practices vs. KB.

MG Do the MI KBs actually travel between sites - is movement documented?

LW No exch of marked individuals. Openings surrounded by lots of trees may not repop quickly.

CB We have info on KB flying through/over 50 feet of dense trees to repop sites.

SS Mowing clearly keeps sites useful to some degree.

AS There is a diff between broadcast and spot tmt. I endorse spot tmt wherever possible.

RZ Our burn units are small, ca. 1/4-ac, etc.

RE On mowing: We identified the circumstances where mowing was appropriate, also chem tmts, and aerial and ground broadcast spraying guidelines. Spot tmt to kill indiv trees in a site.

US Some group is going to have to address translocation, reintroduction, etc.

AS Was the 100 meter repop dist based on someone's data? RE Yup.

DA Disease/parasite gru. ....

DS I have noted very low levels of parasitism. A small diff in larval mort can make a big diff in whether or not and how quickly a pop reaches carrying cap.

SS Modeling gru. We sought life his traits for a life table. Lifespan was ca. 4 days, sometimes 5 days. We picked 4.5 for the model.

Eggs laid: DS had a good set of data. Eggs laid linearly related to how long the females lived. 9-10 eggs/day laid - 4.5 day life = ca 45 eggs. Ergo 45 eggs/female/season = mean, c/ sd = +- 27 eggs. DS eggs had ca 97% hatch, we dropped that for wild pops based on RPS's data and assumed 67% june eggs hatching.

Jul/aug brood - based on RPS data. We didn't apply as large egg loss as Ryk Peter Spoor's used because lost eggs might have been ok and hatched, not necessarily dead or eaten. We used 75% egg mort as a fig for winter survival.

Hatch rate X eggs laid = .25 X 30 eggs, L. summer....

Larvae mort: L May e Jun mort is fairly well known by DS data fm the wild. Ca 80% mort of larvae..... Get these figs fm SS.

KH Does dispersal/repop during flt require time that may detract fm repro time? Ans: unkn.

Is it likely that spr and summer females have ca = no. eggs? Ans: Unkn. MA: Nectar availability can influence this.

TM: Size of female also related.

DA: There is a larvae size diff between hatches for some spp.

EM Re catastrophes, did modelling include accident and/or mis-mgt?

Could a spr brood actually be the preceding yrs spr brood offspring, i.e., circumstances pvt a summer hatch and the eggs hang on until the next spr? DS: Doubtful. DA: Might be poss for summer broods eggs to hatch c/ summer broods hatch.

US Are we closed on models? SS: SM has more info ... get SM's part.

AH The short time to inflection pt on extinction curve is troublesome because the longer tail part of the point looks like a long time to extinction, but doesn't show the much greater difficulty in recovering the spp after the inflection pt compared to recovering it before the inflection pt. Managers might just see the long time to extinction, not the greatly increasing cost of recovery. US: Right on.

CK Superimpose a rising cost of recovery curve (hyperbolic or parabolic?) on the (SM's) declining time to extinction curve - let managers see both conditions in one picture.

AH Use the true horror stories to show people what actually has (and thus can) happen.

RE USFS also needs effective presentation before changes are made.

portion missed .....

RB 3rd goal of gru: Needed: further testing of the model in metapop context.

We suggesting testing on metapops that need low-level intervention, 100 and 1000 pop 2nd brood adults, c/ mig rate of .25% mig/sub-pop/yr. We need a descr of a persistent metapop, like 99% prob of surviv for 500 yrs.

US We must discuss the % survival/time goals. It's an important part of the recommendations we need to develop (understanding that they may not be accepted or met by mgt agencies).

RB The model must provide for survival of the metapop given the occasional winking out (or in) of the metapop's component pops.

US Right on. Try to provide for this.

DS The eff of dispersal rate will depend on pop size because we are dealing c/ % dispersal, not abs numbers.

EM Historically this was a dispersing, opportunistic spp. Now we are faced c/ managing for maint of fixed site areas and fixed site pops.

RB The topography of the MN sites (valley sites separated by impassible ridges) necessitates EM's point. Translocation will be a necessary tool. US: Zoo folks and others c/ experience work c/ RB on this. Chorus: ok.

US One of the products of the gru should be a list of rsch recommendations.

END

Filename: 0423PM.CGK

04/23/92 PM Session. KBPVA, Habitat gru and subgrus.

Mary Rabe - MR
Jennifer Windus - JW
Eric Metzler - EM
Chuck Kjos - CK
Rex Ennis - RE
Lee Casebere - LC

RE We need to focus on hab qual items and egg, larval, pupal, and adult stages - qual hab for ea of the stages. Then discuss creating qual hab for ea of the stages.

We break into 2 sub-grus for ca 1 hr, ok?

RE What questions must we ans for ea of the 4 stages?

EGG
- Substrate
- Litter
- Predation
- Temp

PUPAE
- Same as above for eggs

LARVAE
- Same as above
- Amt and distr of lupine
- Movement distances
- Qual of lupine
- Moisture
- Ants
- % cover

ADULTS
- Nectar sources
- Predators
- Catastrophes
- Size of habitat
- When is size inadequate to support the pop, forcing srch for new hab?

Notes from RE's sub-gru

RE Lets try for good quant values for ea of the above categories/stages. It's difficult.

LC We have a problem of inadequate data for much of the above.

CK I hope that future rsch will consider 1st the elements that this PVA indicates are most influential in affecting pops, irrespective of the qual of our data that illustrates the influence of the element.

LC Some ground vege is necessary, even if KB don't always lay eggs on lupine, but on other plant spp. Some litter and canopy may be desirable to avoid desiccation and heat killing of eggs and larvae. Airports have large areas without any canopy and they have good KB pops.

RSCH NEED: ASK LARGER GROUP FOR THE ANSWER TO THIS OR PROPOSE IT AS A RSCH PROJ.

RE What about predation?

DS's data indicated light, but some, parasitism and disease (in lab larvae) of larvae with moderate to heavy predation the norm. RPSpoor mentioned predation and eggs being presumably carried off. SM's simulation data this AM indicated that survivorship is a sensitive item in the extinction curve.

RSCH NEED: QUANTIFY RATE OF PARASITISM, PREDATION, AND DISEASE AT HIGH AND LOW KB POPS AND IN A VAR OF HABITATS. I.E., WHAT ARE GOOD HAB CHARACTERISTICS FOR EGG AND LARVAE SURVIVAL?

CK Consider managing ground cover and canopy to avoid excessively high temps. Are excessive temps a pot prob rangewide? Rsch item?

Gru questions:

What do larvae select as pupation site?

What sites have good survival?

Are there vulnerable diapauses?

Do larvae pupate on the last plant that they were feeding on, or do they seek a plant just for pupating?

Pupae are rarely encountered in the field. In good egg-laying and larvae hab, is a special/different pupae hab needed, or is it covered by good egg and good larvae hab? Should these be sch items?

RE How much lupine do we want in a given area and how best distributed for KB?

JW The 2%, 1000 plant fig we used yesterday isn't really a very good descr of what is needed. We need to express it in a more meaningful way. The 1:1 KB:lupine plant fig is very uncertain as a good prescription.

THIS IS AN IMPORTANT RSCH ITEM: QUANTIFICATION OF GOOD LUPINE ABUND AND DISTR FOR KB. KB SURVEYORS, IF COUNTING LUPINE AT ALL, MAY NOT BE COUNTING LUPINE IN A WAY COMPARABLE AMONG KB SITES.

Let's ask for a plant count protocol. Ask CL for count or lupine abund description protocol.

What % of lupine coverage of a site is needed and what is should be the density of the lupine be in the lupine covered part of a site? CL suggests using % cover estimates to describe lupine abundance.

EM Will the prescription be the same regardless of size of the site?

LC The shape of the site needs to be considered, too, i.e., long, thin sites with fairly continuous lupine vs blocks of land c/ small patches of lupine.

MR What about lupine age struct?

JW: It will probably be diverse because of the early successional place of lupine.

MR Did someone say that larvae will travel ca 1 meter?

EM We know that they have to find a plant, but we don't know if they stay on the 1st plant they find or travel to other plants.

EM Larvae can be marked and followed c/ radioisotopes. It has been done c/ noctuid and pest spp larvae. I don't know if it is a destructive technique. Very few larvae might be needed to ans the question.

JW The ans to this would help with lupine patchiness recommendations.

RE What is a qual lupine plant? Big c/ lots of moisture? Small and stressed? Big plant gives a big larvae that gives a big adult that gives more eggs, right?

EM Does road dust settling on lupine degrade the lupine for KB?

ASK DE IF LUPINE QUAL IS A FACTOR FOR KB EGGS, LARVAE, PUPAE, OR ADULTS.

IS LUPINE QUAL BETTER IN PARTIAL SHADE THAN IN FULL SUN OR FULL COVER? WHAT'S BEST FOR KB?

MR In hot, dry sites lupine senesces sooner than in cooler, moister sites, so cooler moister may be better for KB.

The following is a draft of calculations and recommendations. Not to be taken as consensus recommendations and info.

Model:

Start c/ 1000 KB July adults, panmictic unit.
1. Assume 1:1 sex ratio.
2. Assume 75% of females lay ave of 45 eggs ea. (n=375).

Thus, 375 x 45 = 16,875 July eggs.

Assume 75% mort of July eggs: 16,875 x .75 = 4,219 Jul larvae

Assume 91.5% mort of the 4,219 larvae: 359 May adults or 180 May females.

Then, 75% of 180 May females produce 45 eggs ea = 6,050 eggs. 30 of 45 eggs hatch = 4,840 Jul larvae.

Then, 4,840 Jul larvae x .80 mort of larvae = 968 Jul adults, or 484 Jul adult females.

Then, (.75) [484 Jul females x 11 eggs/female] that hatch in May = 3,999 May larvae.

If, assume 88.4 plants/ac, and 1:1 larvae:lupine, then = 54 ac has 4774 lupine plants = 349 May adults.

* * * *REX - HELP. LOOK AT THE YELLOW SHEET YOU SENT ME AND TYPE THIS IN THE WAY IT SHOULD BE - I CAN'T READ ALL THE WORDS ON THE NOTE. THANKS! CK.

Draft/provisional recommendations, acknowledging possibility of stochastic events:

1. Maint ca 60 ac mgt units when creating new habitat and configure these units to be w/in 100 m of known KB pops.

2. Burn no more than 20% of known KB site and only after 4 surrounding units have been burned.

3. Burn rotation to be ca 10 yrs. Monitor to determine
   a. lupine pop trend since last burn,
   b, Nectar pop trend since last burn,
   c. KB pop trend since last burn, and
   d. Determine colonization rate.

4. Maint landscape units of at least 1,500 ac to allow for wildfire, other species of concern, varying amts of lupine

nectar density, and for dispersion.

Dave Ewert's addendum to afternoon's deliberations:

Adnl application of Cryan's numbers gave following results. Note that we made an error yesterday, and that the ave is only 100 adults/ac, instead of 1,000 adults/ac. That erases 1 order of magnitude, anyway.

Also, I threw out 2 of the sites we used in yesterday's calculations; the two 1-ac sites. They are real outliers and don't contribute much to a gen understanding (although it's of interest to note that you can pack >1,000 adults on 1 ac if you've got enough lupine, i.e., >1,200 plants/ac).

1. N = 20; the ave size of a site to accommodate at least 1,000 summer adults (ads) is 73 ac, +- 142.

2. The 73 ac should have an ave of 6,350 lupine plants +- 17,800.

3. This will result in 7,200 ads +- 14,360, on ave.

If you calc per acre data, you get:

1. Ave plants/ac = 87 (86.8). Range c/ 1 s.d. = 0-112.

2. Ave ads.ac = 100 (78). Range c/1 s.d. = 0-100.

3. Ave plants/ad = 1 (.9). Range c/ 1 s.d. = 0-1.1.

This indicates need for 10 ac, c/ a min of 8,700 lupine plants to support to support 1,000 summer KB adults.

The following is a session later in the afternoon c/ the following people joining the above gru.

Dave Ewert - DE
Dolores Savignano - DS
Cynthia Lane - CL
Ken Multerer - KM
Michelle Grigore - MG
Joe Croy - JC
Denis Case - DC
Mitchell Magdich - MM

3:30 PM Meeting c/ Dave Ewert's hab qual and mgt gru.

DE A series of calculations using avail, but differing data indicates 1 to 210 ac needed to support 1000 KBs. Cryan's and Schweitzer's data were used. .88 plants/adult; .0099 ac/ad; 88.4 plants/ac. Cryan's data.

DS Sites I know are highly fragmented - the Givnish rpt may be helpful in dealing c/ the lupine density need.

RE You have a range of size of ac of lupine to support 1000 KB based on differing assumptions of lupine/ac and on number of KB observed/ac in lupine? Yes.

DS There may well be east vs midwest diffs in KB and lupine/ac occurrences.

DS John Cryan indicates that his NY pop size data is rough because of low recapture rates, etc. We don't have solid pop data for most sites.

DE ....
We need to consider acid rain, deer browse, ants, ground litter...

RE Nectar sources remain unanswered. How important, what effect on egg-laying, etc? Is 1% coverage c/ nectar source plants adequate? If not, what is needed?

DE: Lawrence and Cook had nectar info.

DS and CL: Distribution and timing of nectar sources may be very important.

DW L and C found dewberry to be important for 1st brood in Allegan State Game Area, butterfly weed for 2nd brood. Other nectar sources plus rel abundance and use by 1st and 2nd brood are listed.

DS Do KB use lupine as a nectar source in midwest? Unknown.

CL: KB may well have a shortage of nectar sources for 1st brood.

DE Euphorbia corollata is a common food for 2nd brood.

RE What about differences under high, med, and poor nectar availability for the ads? Would it make a diff to repro/egg laying?

DS Well fed butterflies lay more eggs, based on studies c/ other spp.

RE Lifespan and egg prod being related to nectar sources, can we make predictions? Will they survive to breed a bit even without feeding? DS: Will they disperse in search of food, instead? RE Can we say even that poor to none is bad?

CL: Yes.

RE In a lg pop of ok hab, would dispersal probably be increased?

CL: It would depend upon whether dispersal was initiated in response to adversity or programmed behavior.

RE Why does a female disperse: to find food or to lay eggs? Unkn.

CL Our guess is that adversity drives the dispersal for KB.

DE How many rosettes needed to support a larva?
Survivorship of lupine during larvae feeding per?
How far will a larvae go to reach lupine?
What proportion of the lupine is usable to the larvae?
What proportion of lupines will support caterpillars?

Gru questions:

Within an area, define the size of the opening as delineated by its natural boundaries, then how big is that opening that is occupied to some extent by KB?

Where in that opening is the lupine growing?

How big an area is the lupine area in the opening?

What is the lupine density there?

DS It's unlikely that pupae would survive and subsequently emerge beyond their normal cohort.

DE What is relat of sm rodent pop to larvae survival?

DS Of 4 observed larvae, one pupated on a lupine, 3 pupated on the ground.

RE What are the KB adult resting sites?

CL: Mostly on grasses and nectar plants, incl lupine (roosting, not necessarily feeding).

DE: 22,500 structures needed for egg laying.

RE Do ant-tended larvae survive 2x [subsequent discussion c/ SV indicated it was 2x better survival/day for ea day] better than untended larvae?

MG: Depends on the ant sp.

DS: Data fm 2 sites for 2 yrs: ca daily mort at .1199 for tended larvae; untended = .4377. Tended = .18; untended = .38. Tended = .16; untended = .26. These figs are for diff sites in diff yrs. The average daily mortality for ant tended larvae was 0.15 and for untended larvae was 0.36. Multiplied out over 14 days (rough estimate of time in instar 3 & 4 = ca 10% increase when ant tended) = See KBPVA briefing book for complete descr of DS's study results.

Group questions:

How many ant hills are there within the opening?

How close are they to the lupine areas c/ KB?

What activities affect the ant population?

What other things are there for the ants to feed on?

What are the spp of ants in the opening?

How much nectar is needed for various pop levels of KB?

Group point: When nectar sources are high, they contribute to max egg-laying potential. When nectar sources are moderate we don't know eff on egg production. Same goes for poor abundance of nectar plants.

How does a late frost affect KB larvae?

What are the important resting sites for daylight and night time?

What protection do these resting sites provide?

RE Does 2x [per day] increased survival affect population? Yes. The 2x ant question thus becomes important.

DE Do the ant spp that DS studied occur in the midwest? Unkn.

DS Is there great variability in larvae being tended or not tended.

DE: I have seen larvae c/ and w/o ant larvae.

DE More questions.
Is frost a catastrophic event for KB caterpillars in midwest?

Unkn.

What's the threat from collectors? Prob not too big a problem.

Global warming.

Acid rain/pollution deposition, esp dnwind fm Chicago-Gary.

Need to ident pot hab/pot reintro hab, poss by soil type.

RE Irrigation is a poss for some sites, esp in say MI where gnd water is abund. Would this be a help in areas?

CL Over time in might favor woody plant invasion.

RE In drought years might it be a good measure between 1st and 2nd broods?

DE: It's a poss in some sites near Manistee, MI.

RE: But would it help?

DS: Careful choice of drought conds for irrig might prevent a local pop crash.

MG: Would that draw in predators, as to an oasis? Birds especially? Unkn.

RE I would think of ceasing the irrigations soon as the ads emerged - just to provide a lush vege food source for ads and larvae. Gru sense was that it would probably help.

END

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Ulie Seal - US

Critical Habitat Topic

Robert Zaremba - RZ

We didn't do 2 areas in the repro cycle that affect success. We don't know when the eggs hatch or when the plants 1st emerge. The timing of these events may be crit for KB survival.

2nd brood larvae vs the stage of lupine and its food value, incl the fungus question will need to be looked into.

Rex Ennis - RE We have an improved idea of how to locate the habitat size, location, configuration, mgt, etc. we're well on our way to asking the key questions.

Krista Helmboldt - KH: we discussed direct transloc - do not do it c/ eggs. Consider time of day to minimize shock to released ads. Use ads use enclosures, pick KB from good qual sites, Must be further developed on a systematic basis. Canada will be involved. Use surrogates for testing. Investigate what causes and breaks diapause so it won't be inadvertently broken. Investigation propagation tech. Genetics must be considered - source, diversity, RZ: consider unintended rearing selection effects. No. of founders, release strategies (no. released, spacing of releases, etc.),

Tom Mason - TM When watching a pop decline, do we wait for them to be extirpated, or do we supplement. Also, think of translocation of a rel long process not as a quick event.

Dave Andow - DA Biocontrol specialists (at Univ of MN) and in each state have developed good techs for release of lots of types of organisms. "The Frass" is a newsletter of people involved in rearing insects.

Dolores Savignano - DS - and NH TNC are involved in rearing KBs.

Ann Swengel - AS: mentioned published work by British on a var of butterfly spp. The lit is fairly good there. Vane-wright, a primary editor of "Biol of Butterflies." AS will snd her printout to US.

DS Several zoos rear butterflies and have staff entomologists.
KH How much should we get involved in planting non-native plant spp for 2nd brood nectar sources? Chorus: There are plenty

of suitable native plants; no need for exotics.

US Let's do the modelling gru.

Rich Baker - RE: We discussed genetics, no of metapops/region. On genetics, we put bounds around a coord genetics rsch endeavor. We needed to determine why to do it. 4 goals emerged: to ident sources for xlocs and supplementation, 2 to eval distr of genetic var across the spp' range and among pops (partly to eval groupings of KB), and 3 to resolve ssp or synonymy question.

To coord the effort we had to balance the interest of KB recovery against needs for info fm collecting vs our own limits to do the work and given emerging techniques. Recommendations: Use state of art techs, use multiple techs, use techs that are comp, insofar as poss, c/ work already done. To maximize our work: FWS put out an RFP for a KB genetics rsch effort.

US: Write the RFP after talking c/ a known high qual investigator, and considering that in writing the RFP.

Perhaps we should collect fm the rapidly disappearing eastern areas to bank the genetic material. Also compare range wide genetics - there may be little or no var.

We gave out a map out in yesterdays minutes that held 10 groups of KB. We tried to ident the no. of clusters of bunches in ea of the 10 ecol grus as a way to quant metapops. The projected overhead shows our results [get it for the final book]. We rated them V - vulnerable, s - secure, e - endangered, o - no pops. Recovery pot was listed in another column and given a numerical probability. For some sites we had poor info or felt recovery was doubtful. Tentative reclassify and delist goals were also put in columns. We understand that this table is a starting point - a working document. Further, we recognize that recovery may result in the reconnection of some of the separate populations.

AS It's almost certain that lots more demes will occur c/ recovery.

DS The metapop gru might want to work on defs of them for metapop, deme, pop, etc that we will all use in common and have common understanding of.

Rich Baker - RB: We did come simulations using assumed 50 indiv pop sizes. Some extirpations and loss of heterozygosity were predicted. The results were better with 100 and 200 indiv pops and assuming a bit more genetic transfer.

US Groups will need to get their info and get it to SM.

Anne Hecht - AH

Fed Permit topic addressed by Anne Hecht:

C/ listing there will be need for permit for whole range of take. Applies to state cons agency for mark and release permits - covered by our state-FWS sect 6 agreements. Apply now to your ROs for permit, so you will be covered the day the KB is listed. FWS will do some qual control and coord of rsch oversight. Get permits for burning of areas, for collecting for genetics work.

For states of IA, IL, IN, MI, MN, MO, OH, and WI, write or phone permit questions to:

Craig Johnson, Chief, Div. of Endangered Species, US FWS, or Ron Refsnider, US FWS, Div. of Endangered Species, Fed. Bldg., 1 Fed. Dr., Ft. Snelling, MN 55111.
Telephone 612/725-3276.

For CT, DE, MA, MD, ME, NJ, NH, NY, PA, RI, WV, VA, VT, contact:

Paul Nickerson, Chief, Div. of Endangered Species, US FWS, One Gateway Center, Ste. 700, Newton Corner, MA 02158. Telephone 617/965-1000

Critical Habitat means areas c/ biol and physical features essential to conservation of the sp in question. It may incl areal not currently occupied, if essential to cons. It may incl temporarily occupied, i.e., migration or wintering areas.

See the Karner Blur Proposed Rule copy in the KBPVA briefing book. It's pp 2244-2245 of the Federal Register -in the briefing book.

Crit hab designation. The product isn't just the designation, it's a process that does a lot for recovery beyond lines on maps. We will have to desig areas crit to KB conservation as driven by the recovery goal. We have to desig enough hab to provide for recovery of the spp. Desig does not guarantee proper mgt for KB. Crit hab applies only to the actions of Fed agencies - not state, local, or pvt groups. This incls funding by HUD, FmHA, FAA, etc. Despite this Fed-only aspect of crit hab, the Crit Hab has great recognition value in keeping areas safe by means other than Fed end. spp. prohibitions. It causes other interested parties to pay more attention to the crit hab areas and to be more reluctant to harm them - despite the absence of Fed hammer. The term"essential hab" is used by FWS, but it has no legal meaning under the Endangered Species Act. Crit hab can be desig even where the KB aren't - to provide for poss of eventual reintro. Land for rotational treatment and occupancy are included in crit hab desig. Applies to transiently occupied habitat, i.e., migratory hab.

How we desig crit hab: FWS has done 4 crit habs in last 6 yrs, only one has been finalized. We will try to do KB by doing the sure parts first and those most important to KB first. The econ analysis will be the hard and time consuming part. We need to ident essential components (lupine, savannah, sizes and shapes, etc) plus site selection criteria, i.e., not every lupine patch is going to be crit hab. We will ask states for assistance c/ drawing the lines, etc. incl those for restoring areas.

We will work c/ fed agencies to develop strategies to avoid adverse modifications c/ other Fed agencies and fm that we will have more info for the econ analysis. This has the spin-off effect of generating enthusiasm for an and spp among fed land managers who probably aren't biologists.

Maps will be prepared and they will be published with a proposed crit hab rule in the Federal Regis, and there will be pub input, poss pub hrngs. Then the final crit hab rule will be published.

* * * * Post-break session.

Evolut and pop genetics discussion.

US The question of founding vs. pop supplementing. Guidelines from pop genetics view vs demography view. Pop genetics says 20-30 functional founders will capt >99% of source pop genetic variability. Even where there is quasi cloning at work in establishing a pop, the 20-30 fig does a good job of capturing the var. Clearly, rare alleles will be under represented by this strategy. This may or may not be highly important. Statistics may help determine appropriate effective founder size if rare alleles are critical.

Mike Amaral - MA: Does this usu imply = sex ratio of effective founders? US: Yes.

US Known dispersion or contact between pops can be of help in keeping/establishing genetic var.

When a founder pop size has been estab, monitoring will follow success. Few intros gave been genetically monitored over time, but they should be. SM: Peregrine falcons are one [rare] example of reintros being genetically monitored.

Only recently has genetic modelling of reintros been done. Think about deliberate additions of genetic var over time, esp if initial intro didn't do too well. The data are extremely scant in this area.

DA I caution us against taking general genetic findings as prescriptions, i.e., the 20-4- indiv. finding. We should study the KB and derive the founder size to capture the var from the KB itself.

DS Annual vagaries of weather, etc will also affect reintro success, apart fm size of the founding pop.

US Most successful reintros have used repeated infusions of rel lg numbers, this goes for inverts, too. One thinks of the low hundreds. The demographic, rather than genetic, process seems to drive the reintro success.

In most cases, the more the better for genetic diversity.

RB Remember that much of pop genetics is based on theory that looks cookbook, but, in real life is not as certain as it may look in a pop genetics theory derived formula.

US On the FL panther, the genetic problem has proved to be very difficult and is not at all a crisp clear problem of following a prescription. Our thinking about pop genetics is also changing rapidly.

DA SIZE OF REINTRO FOUNDER POP MUST BE RATIONALLY ARRIVED AT FOR THE KB, AND NOT JUST IN ACCORDING TO A GEN RULE OF THUMB OF NUMBERS TO USE.

US Demographic concerns usu req a larger release gru than is needed to capt the genetic var (but the founders of the rel gru must capture the genetic var).

Gru eval:

Symp c/ PVA together was v good. Learned lots.

V good attitude of participants - no neg attitudes. Would have liked more trained entomologists to be present.

Good process. Will apply to other spp. A "map," not a prescription. Good spending of the $$.

We have lots to learn ca the KB.

Wasn't the way I would have done it - I like being forced to do it different.

Tuesday's info session was esp helpful. All was good.

1 meeting is better than 0 or 2. Geog area incl is good. I'll wait and see how the pva is used.

Good to see faces of diverse researchers and workers - we're together now.

Learned a lot more.

Excellent, but get the briefing book out before the meeting.

Great inter gru sharing of info

Worth the $$. May need to get together again for KB some day.

Have the next PVA in a cheaper place.

Pick a remote and less expensive place. V good process. The diversity of experineces was good.

The inter gru info sharing is v good.

Back-to-back symp and pva is good. Appreciation for what has been done. Good basis for unified work in future.

V. positive. Learned a lot. V. diff ways of viewing problem. V diff habitats of KB

Bring more entomologists. Good that zoo experts came.

5 yrs will tell worth of workshop.

Useful to compare rangewide notes. Should have more advance info on the process and have more pop genetics expertise.

Symp/pva good for quick study of a sp. Also bring in other expertise, not just spp experts. How bout an ant biologist?

Interaction of workers a good thing. Relied too heavily on expertise, but didn't tap everyone's experience here. Perhaps nominal gru process would bring all into the process better.

Having the symp 1st, just before the PVA was good. Made new contacts.

The PVA meeting process is as important as the pva model. Therefore, pay a bit more attention to the process. Modelling not well explained to participants, i.e., limits, assumptions, and constraints.

Networking and surfacing of rsch needs v. good. Unclr when people were speculating or expressing solid opinion. Ask future participants to identify which they're expressing.

Symp 1st good. Good for networking. Good surfacing of rsch needs. Could have used briefing doc 1st. Needed prior knowledge of model limitations, assumptions, etc.

Will focus our allocation of resources better. Lots of very valuable info in that area. Gray lit surfaced well here. I I look forward to the final pva doc. I think of the model c/ my observations and views - useful to compare. Weak on where we go from here part.

It was fun and the qual of the thinkers was impressive. People participated v well. Little contention or turf stuff. People very forthcoming c/ their info.

At 1st I had a prob c/ the idea of applying a vert model to an invert. I still have the prob c/ the idea.

FWS needs to ident a single person as KB coordinator.

END

Rex-habitat
Krista-translocation

Dave A.-resources for issues
Biocontrol experts -- make contact because techniques are developed, many resources
Frass newsletter -- people interested in insect rearing

Ann - scant literature on reintroduction by British
Florida--Atala hairstreak
Gorgone checkerspot
Vane-wright & Akery reference??
Dolores's references

Thomas, J. A. 1984. The conservation of butterflies in temperate conutries: past efforts and lessons for the future. Page 333-353 in R. I. Vane-wright and P. R. Ackery, ed. THE BIOLOGY OF BUTTERFLIES. Princeton University Press, Princeton, New Jersey, Usa (published in NJ in 1989)

Krista--planting non-native spp for nectar source for second breed

Rich--metapopulation
genetics--use "state of the art" techniques and multiple techniques for large output and future comparisions
Ulie-High rate of investigative failure for genetics research

Rich-importance of collecting dwindling pops before extinction but start with comparitive info first from larger pops

Rich showed map--broke range into ten groupings
get transparency--E=endangered
V=vulnerable
S=secure
recovery planning ideas--certainly not set in stone

DS--meta,mega ,sub, colony, deme,...create definitions

Disscussion of metapop data file
31% prob of extinction (n=50)
migration of 1% between each population (.5,1,2 migration rate) run at different pop sizes

Ann H--Federal permits
with federal listing comes need for permits (catching, harrassing, ...)
MRR-get permit from state (no killing, no holding for over 45 days or transport over state lines
make sure permits are in place before listing
As stakes are raised, CYA (cover your ass)

Ann s-is burning a "take"
Ann H--probably, talk to Ron Rufsnider
Ann S- timetable
Ann H- final probably August, if hearing final rule probably in Jan
DS--incidental killing
Ann h--state permit should coming
Chuck--if you have a permit and accidental mortality occurs, ok, it happens

Michell g--if crossing state lines, how many permits
Ann H--both states and a fed.
Dave a--suppose moving eggs and larvae
Ann-state, if holding for over 45 days need a fed permit
Ann S--if you are a butterfly collector, what to do with specimens collected prior to listing
Ann H--keep records but ok to keep the specimen

DS--always got a state permit in NY

Chuck--phone your regional FWS office
Ann H--just hearing her views
HABITAT REQUIREMENTS
Act says "conservation"
FWS will define critical habitat
Look at proposed rule
critical habitat for KB not determinable (yet), legally bound to

define it however within 2 yrs of proposed rule (Jan 1994 deadline)

keep momentum of workshop up to work up critical habitat
critical habitat--rather like PVA
product is actually prosses of defining it
critical habitat driven by recovery goal
enough to recover spp
recognize lines on a map don't necessarily mean management will be correct
what lines mean---fed agency legally constrained from adversely affecting critical habitat---if state agency wants to pave CH, feds can't stop them.

REx-broad umbrella

???--fed loan to by a house will not be given if on CH
Leni--how bout farming

Ann H--CH has enormous recognition value
makes land managers and owners pay attention to area
drawing of lines should include areas of biological importance (but some disagree)

Rex--essential? KB habitat moves in a large landscape (critical and essential have difference legally). See KW plan.

Ann H--Essential habitat has no legal value but in vogue.

???-could CH occur in states with extripated pops?
Ann H-yes

Ann s- management ideas must be incorporated

Ds--temporal variation and occupation of sites
Ann H--area must be biologially important but not necessarily at every point in time.

Michelle g--who determines this
Ann--that's comming
Rex--if CH succeed into forest but KB habitat is close by, what then.

Krista--can this happen faster than 2 years?
Ann--theoretically yes, physically no

ann--process
4 packages in last year
economic analysis important for KB
ID essential components (ie lupine, soil, size, shapes,...things important for recovery goal, managable units,

selection criteria),
Asked states to make first cuts on Piping Plover
Fed land owners should talk alot with FWS--think through carefully the economic impacts, in discussion process developed lots of ideas, frustrating, time consumming, productive
Balance cost an balances of CH
Maps prepared
rule prepared and published in fed register
Public hearings with comments
Review rule
Re-publish rule
Process should advance conservation of spp

ULIE--founders, genetics

clonal founding events--larger size of event allow selection to opperate on whatever genetic material is avialialbe

20-30 effective founders--underrepresent rare allelles very rare alleles may make a difference in those types of events if it a consern--no limit to size of founding population

Tom--breeding females?
U--equal sex ratio is better
in general, don't start with a singel gravid female migration rates--of say 1% per generation when genetically effective will allow genetic mixing (guideline number)

Demographically--rare for single reintroduction event to be successful

monitoring
few genetic studies
Orxy--pedigrees being monitored

Deliberate additions through time especially if small numbers of founders initially successful

Source of founders--butterfly "ecotypes" a continuing theme, local adaptation--molecular data would be instructive: maybe choose from a variety of populations

dave--concern over "perscription" theme of discussion

DS--habitat is very variable over time

Ulie--repeated efforts over time, more individuals the better, highly stochastic; nothing cast in stone, methods still developing
Increased genetic diversity allows selection

Models are still developing
Reinforces species specificity

release programs for vertebrates driven by demography

Chuck--wants to hear what's good and bad about experience...

-symposium good, workshop oberserver--lots of unknowns, good way to bring it out
-positive attitude
-more trained entomologists needed
-process applicalbe to other spp & to KBs, view alternatives,good
-expenditure
-lot more to learn about KB
-broadened thoughts
-observer--tues info helpful
-size good once but not more--now break down to smaller groups
-need to see results first
-faces with names, synthesis and discussions
-all aspects excellent, breifing book needed early
-landscape
-worth the money
missed
-symposium & PVA back to back good idea
-very positive
-thanks for inviting zoo people
-know in 5 years after evaluating status of butterfly
-useful to know before hand what to expect
-invaluable tool for info exchange, need more broad expertise (entomologists, ant biologists, plant biologists)
-interaction good, need to have process, to heavily on expertise, not tapped personal experience enough
-symposium good start
-process is more important than model outputs, no way to demonstrate process in terms of building concensus and network, product suffers from lack of demonstration of that
-concerned that some may leave not knowing limits of model, need more discussion at begining about model
-networking really valuable & research needs
-speculation vrs data--make it clear
-symp/PVA good, networking, esp formulate future research
-breifing document prior to meeting
-assumption and constraints of model needed in handbook
-focus of time & money, grey literature, management
model good for thinking
-where to go from here--lack of coordination
-fun, process, quality of thinkers excellent, productive and coopperative, renewed perspective, thinking processes--impressive
-problem with plugging model for verts to inverts

TRANSLOCATION SUB-GROUP REPORT

I. What are the mechanics that are involved in rearing? Can we rear KBB? Can we breed KBB? How would it be accomplished--what's the protocol?

Q: Is translocation possible?

* Protocol for these activities should be worked out and practiced on more common but similar species.

* Data on Productivity and Survival should be pulled together and used as a standard to measure individual success and to plan procedures so goals can be met.

On choosing a site for release, defer site selection criteria to decisions made by Habitat Quality Group. **Microclimate factors? Ideal sun/shade ratio in different climates?** Defer parameters (number of individuals and number of demes) needed for a viable population to Metapopulation Group.

Q: When female is probing plant for oviposition, what are they sensing with chemoreceptors? What are they looking for? How do lupine populations and sites vary for that quality?

Q: Could KBB decoys be effective in encouraging released/translocated KBBs to stay in the area?

TRANSLOCATION -- moving directly from one site to another, in any life form, with minimal handling. Used for either supplementation or reintroduction.

<u>Eggs</u>
Translocating eggs is most likely not effective--due to high degree of mortality from egg to adult, would have to do a <u>lot</u> of eggs, and eggs are hard to find.

<u>Larvae</u>
Dolores has moved larvae to a site with historic occurrence. In once instance, 300-400 larvae placed at a site. Dolores did not actually do herself, and she believes that the site was too degraded and poor in lupine availability; also that larvae were placed too densely. Direct follow-up did not occur, and adults were not seen on the site in subsequent years. In the second instance, Dolores placed 50-100 larvae at a site with adequate lupine. Again, the larvae were not monitored for residency, but adults were not seen in that year or subsequent years.

Larvae were not monitored daily to see how they fared; the sites were not under management; the sites were assumed to contain ants; no precautions were taken against predation; larvae are handled with soft forceps, placed securely on the plant and are not left alone until they begin feeding.

Dolores estimates that 1-3 larvae/plant (plant=5 to 8 stems) is an acceptable larvae/plant ratio.

* Consider enclosure to keep the larvae localized and prevent predation; provide both shade and sun.

Q: Lupine contains alkaloids; do lupine respond with production of toxins when heavily predated?

Adults

Dale has said that individuals can effectively be netted across runways and road to promote dispersal.

References on translocation exist: Shuey, Savignano's Saratoga Report on Parcel #45, TNC ESA.

If individuals need to be transported a far distance, put into an iced cooler with no light. Release immediately; if not possible and must hold more than a half day, feed with dilute honey water on cotton (white or orange colored cotton most effective) or wildflowers spiked with droplets of dilute honey water, provide with water on cotton.

Release on a warm sunny day before approximately 4:00 pm or dusk--Dolores thinks the earlier in the day, the better. Place on a nectar plant in the sun, stay with the individual until they warm up, and eat or fly--cooled individuals are vulnerable to predation.

Q: Is a certain time of day better? Would 8:00-9:00 am be better to simulate overnight experience?

* Consider Enclosure to prevent predation and keep individuals localized. Watch the butterflies to ensure that they don't beat themselves up on the enclosure walls or hover in corners--no good. Provide sun and shade.

* Distribute densely so they can mate; put in an area with good lupine and nectar.

* Consider a series of translocations over time for good population numbers and heterozygosity.

Q: **Should young or old females be used?** Will depend upon genetic diversity goals and goal for number of eggs--a higher number of more mature individuals will give greater genetic diversity to new site, leave representative of all genetic material at old site.

Q: **What is the recommended ratio of males to females?** Again, will depend upon goals, but most likely few males than females.

Q: **What number of translocated individuals is needed to establish a population? What are the colonization events?**

REARING AND RELEASING

Dolores is writing up a protocol that will be available soon. We, therefore, will not spend time reviewing that information now. Her past work indicates that residency rate in supplemental releases is good, but **did they reproduce successfully?** The residency rate for reintroductions was nil.

Dolores has done in individual cups, hand feeding lupine leaflets--very time consuming--4+ hours per day for a month. An ideal set up would be in a green house with lupine plants and free-range KBBs or netted enclosures. Have the downside of increased pest numbers.

Releases should be marked for monitoring purposes. Release the adults the same as you would translocations (chill in refrigerator, transport on ice).

Lab mated females lay fewer eggs than wild mated females. Releasing as eggs most likely not practical (requires proper placement) or wise (high mortality in the wild compared to lab). Releasing as larvae is easy, but cannot monitor their progress as adults (cannot mark). Releasing as pupae may be worth considering (it is common practice to transport butterfly species as pupae, but precautions need to be taken to keep from desiccating), but would need to place them appropriately in the duff.

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Q: What roles can Zoos play in mass rearing and training in rearing techniques?

* As much as possible, use native plant stock for rearing.

II. What are the Genetic issues?

* Need to pull together information from Laurence Packer.

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Q: Where should each area get its genetic material for releases from?

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Whatever the answers, the DNA isolation effort needs to be coordinated (not dictated) and consistent.

Q: Is the transfer of genetic material required for maintaining populations?

III. What role can captive breeding and translocation play in the recovery of the species?

1) Restore extirpated populations.
2) Supplement/Augment marginal (in terms of numbers or genetics) and declining populations.
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4) Provide research information and a better understanding of the species biology.
5) Educational to inform the public about KBB. (Not to draw attention to rearing and translocating because of sensitive subject matter for conservation.)

Translocation Group. Updates from previous day:

Metapopulation group integration is not complete, work will be continued today.

Translocation of eggs should not be done. Adults should be translocated, but with adult release, the time of day which is best for release needs to be determined. Factors such as emigration, predation, and feeding need to be examined to determine the best time of day for release. It was suggested that enclosures may be used to keep translocated adults at the new sites.

A systematic approach to translocated techniques is needed to ensure uniformity and best survival success and documentation
of release. Some references exist for this and other species which can be used to determine proper techniques.

The use of common species to "practice" release techniques before attempting to translocate the karner blue was suggested.

Research needs include the investigation of what causes diapause, and what breaks diapause? Lab experimentation will probably be necessary.

To artificially rear the species, either lab rearing on a mass scale or smaller isolated efforts may be employed. Small scale rearing increases the probability of loss through disaster, but the effects would be less, whereas a disaster in a mass rearing situation could potentially be devastating to a large number of KB.

A genetic strategy for "broodstock" acquisition needs to be formulated. Concern was raised over both the removal of genetic material from collection sites and introduction of sufficient genetic diversity into recolonized areas to ensure healthy populations.

To translocate individuals, do you look for fresh adults, who have laid few or no eggs, or use older adults so that some eggs are laid in both the collection site and the translocation site?

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