ENDANGERED KANAB AMBERSNAIL USE OF NATIVE AND NON-NATIVE HOST PLANTS IN GRAND CANYON, ARIZONA

SEPTEMBER 1997 ANNUAL TECHNICAL AND ADMINISTRATIVE REPORT

NAU PROJECT NO. BIO 351Z

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Submitted To:

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April 1997 Kanab Ambersnail Research Summary

A proposal for research on endangered Kanab ambersnail (KAS) use of native and non-native host plants in Grand Canyon, Arizona was funded by the Bureau of Reclamation in September 1996. The proposed work involves three phases: laboratory study, habitat establishment, and initial establishment of an experimental Kanab ambersnail population at Glen Canyon Dam. The U.S. Fish and Wildlife Service Recovery Plan (1995) for the Kanab ambersnail states that 10 additional Kanab ambersnail populations are to be discovered or established before the species can be downlisted, and at least one of these populations is expected to be in Arizona. Recovery activities are proceeding but will require considerable time. Meanwhile, ecosystem management of the Colorado River in Grand Canyon depends on the ability of the Bureau of Reclamation to conduct habitat building flows. Our feasibility study will help determine Kanab ambersnail habitat requirements and life cycle, as well as the feasibility of establishing an experimental population at Glen Canyon Dam.

Phase I of this project consists of five specific objectives involving literature review, host plant propagation and life cycle information, data collection on Kanab ambersnail life history and the development of a life history model, as well as an optional evaluation of the effects of parasitism on ambersnail life history. Host plant propagation in experimental KAS enclosures has been initiated, the literature review is underway, and pilot experiments involving host plant life history and growing conditions are in progress. Young ambersnails were collected in August 1997 and have been placed in experimental enclosures at NAU. The captive population of ambersnails has been monitored on a daily basis, and preliminary growth rate data has been collected. Methods for other experiments have been developed, though are subject to change pending committee evaluation.

PHASE I PROGRESS

1. Literature Review

- April 1997: A comprehensive review of all relevant literature pertaining to Kanab ambersnail, succineid ecology, parasitism of molluscs, genetic isolation, geographic speciation, autecology of the two host plant species, and host plant shifts among invertebrates has been initiated (see attached literature review).

2. Data collection and analysis regarding propagation of ambersnail host plants has been initiated, as well as growth rates, seed longevity, and plant life cycle information.

- September 1996: Both Kanab ambersnail host plants were collected at Vasey's Paradise, and have been successfully growing in an NAU greenhouse.

- February 1997: Construction of the first experimental chamber (a plexiglass plant/snail enclosure) was completed, and initial host plants were propagated.

- May 1997: Kanab ambersnail host plants were collected at Vasey's Paradise and transported down river by boat. Collected root masses were placed in existing enclosures at Northern Arizona University green house laboratory.

- May 1997 to Present: Propagation of KAS host plants was successful. Plants are continuously being monitored on a daily basis to determine basic life history processes, and optimal growing conditions. Experiments involving plant responses to varying levels of nutrients and light intensities will be initiated when enough plants are successfully propagated

3. Laboratory experiments on snail growth, preference, survivorship and fecundity.

- August 1997: Small (<4.0 mm) Kanab ambersnails were collected at Vasey's Paradise, and transported on boats down river. Snails were then transported to the Northern Arizona University green house facility, where they were measured and placed on the corresponding host plants from which they were removed.

- September 1997: Measurements have been taken on KAS 3 times since their introduction into captivity. A total of 248 snails were placed in enclosures containing each of the two host plants. This arrangement distributed 124 snails among 10 cells in each enclosure for each plant type.

TABLE 1. Preliminary data on growth rates is presented below (also see attached data sheets) measuring KAS placed on the two host plants in the original enclosures. Average size of KAS on Naof increased between measurements 970809 and 970906 then appear to average out. This can be attributed to the presence of some smaller snails (3.0 mm-5.0 mm) most likely having hatched during captivity. Sample sizes varied between measurements due to invasive nature of the snails, and limited impact to habitat during surveys. Mortality has also increased, possibly attributed to age, or survivorship curves.

DATE MEASURED	HOST PLANT TYPE	TOTAL SNAILS MEASURED	AVERAGE SIZE	STANDARD DEVIATION	EGG MASSES	MORTALITIES
970809	NAOF	124	3.4 mm	0.88		0
	MICA	124	3.2 mm	1.17		0
970906	NAOF	92	8.5 mm	2.21		0
	MICA	77	7.4 mm	1.33		0
970926	NAOF	89	8.4 mm	2.17		11
	MICA	76	8.5 mm	1.82	1(~12)	5

AVERAGE LENGTHS OF KAS ON EACH HOST PLANT TYPE

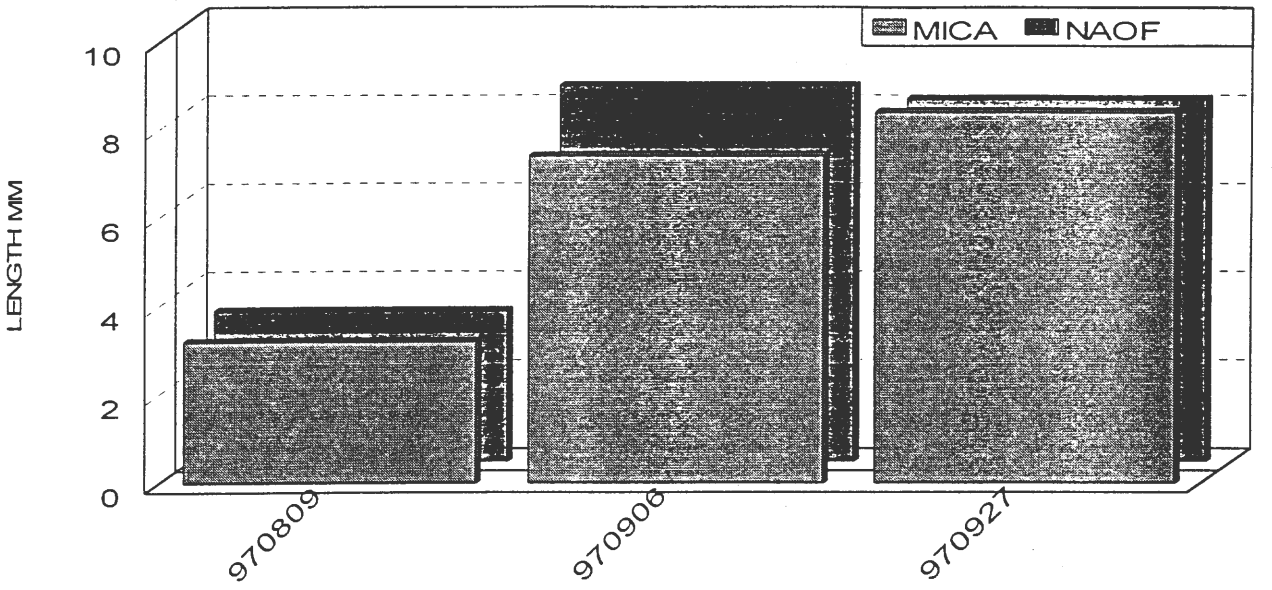

Figure 2. Graphical representation of KAS lengths measured on 3 different occasions.

- August 1997 to Present: Collection of data pertaining to snail survivorship, growth rates, fecundity, ovipositional preference on the two host plants will be initiated using the following methods:

PHASE I METHODS

2. Data collection and analysis regarding propagation of ambersnail host plants has been initiated, as well as growth rates, seed longevity, and plant life cycle information.

- Host plants have been successfully propagated, by both root mass regeneration and by seed. We are currently building a seed bank in order to test seed longevity in both the field and laboratory. Seeds will be kept in containers with hoods, to prevent direct contact with moisture, while still being influenced by abiotic factors. Seeds will then be taken out of the containers at monthly intervals and propagation success will be recorded.

- Growth rates on the Nasturtium average 5.5 cm per month. However, these rates are variable with progression of plant age (younger plants seem to grow more vigorously). Approximately half of the Nasturtium plants have flowered once since August, and will continue to be monitored.

- Growth rates on Mimulus average 2 cm per month, and need to be continuously trimmed back to a height of 30 cm. Mimulus blooms on an almost monthly basis, producing viable seeds which have propagated within the enclosures.

3. Laboratory experiments on snail growth, preference, survivorship and fecundity.

A new snail enclosure will be built with five 1 square foot cells, which will be further divided into four smaller cells by way of sliding plexiglass walls. This new design will increase the ease and accuracy of future experimentation by allowing us to trace individual snails throughout their life history.

enclosure naof 2

cell 1	cell 2	cell 3	cell 4	cell 5

enclosure mica 2

cell 1	cell 2	cell 3	cell 4	cell 5

enclosure naof 1

cell 1	cell 2	cell 3	cell 4	cell 5

enclosure mica 1

cell 1	cell 2	cell 3	cell 4	cell 5

New experimental enclosure (each cell has removable dividers which reduce cell area by ¼)

naof ¼	mica ¼	naof	mica	naof	mica	naof	mica	naof	mica
mica ¼	naof ¼	mica	naof	mica	naof	mica	naof	mica	naof

cell 1 cell 2 cell 3 cell 4 cell 5

Figure 1. Existing experimental enclosures, and the new "prototype enclosure" for increased ease and accuracy of KAS and host plant experiments.

Experiments in the new enclosure will adhere to the following methods:

- 6 to 10 small snails (<2mm, F_1 generation) will be placed in each cell of the new enclosures, and distributed among the two host plants in even proportions. Snails will be marked by color code when they reach approximately 4 mm to allow for the monitoring of individual snails through time. These snails will be removed from each of the two host plants on which they have hatched in the original enclosures, and placed on corresponding plants in the new enclosure, as well as the opposite plants from which they were removed in order to account for differing genotypes.

- Snails will be monitored on a daily basis, and measured on a tri-weekly basis to ensure an accurate time-line based growth chart. These snails will be observed until they are mature enough to reproduce. After reproduction has occurred, the ovipositon points of the snails on each of the two host plants will be recorded and closely monitored in order to determine a possible ovipositional preference, and any differences in the success of hatching for the offspring on each host plant type.

- During mating, snails will also be inspected to determine if any sexual-dimorphism exists with respect to snail size, color, and behavior.

- Snails in each enclosure will be followed from their introduction through oviposition, to mortality. The same protocol will also be followed for the F_1 generation of the

snails observed from hatching through mortality in the new enclosures to ensure the most accurate development of a life history model.

- To determine feeding preference, snails will be given an option of different substrates. Substrate options will include: host plant leaves(dead and alive), litter (stems), scrapings from dead stems (possible fungi), and soil, all in various stages of decomposition. These will be blended and placed on a 30cmx30cm sheet of Plexiglas in a semicircular pattern. Snails representing each size class (<2mm, 6mm, 9mm, >12mm) will be placed in the middle of the semicircle and movement towards particular substrates will be noted. During this experiment we also hope to note if snails utilize any particular taxis in their substrate choice.

- We will also place snails of each size class in an enclosure consisting of all the substrate options. Snails will be marked, and their movement to particular substrates will be mapped and recorded.

4. Kanab ambersnail parasitism studies (2nd year; optional)

- We may start these analyses in Year 2 of the project, if sufficient levels of parasitism are detected in the Vasey's Paradise population.

5. Kanab ambersnail life history model.

- Model development will take place near the end of Phase I of this research project. This will depend upon completion of the above experiments and observations with a statistically proper amount of repetitions.

PHASE II PROGRESS

1. Interagency consultation on Kanab ambersnail habitat construction at Glen Canyon Dam.

- September 1997: Discussed KAS habitat construction and snail introduction options with Dam managers. We have agreed upon a preliminary construction site and enclosure dimensions (see attached proposal).

2. Construction of habitat and establishment of host plants.

- Following final consultation with Dam operators, we plan to initiate construction of Kanab ambersnail habitat and propagation of host plants at Glen Canyon Dam. We hope to accomplish this element of the project by winter 1997.

PHASE III PROGRESS

1. Establishment of an experimental KAS population at Glen Canyon Dam.

- This element will be initiated following habitat establishment at the dam, in spring 1998.

ADMINISTRATIVE REPORT

PHASE I AND II

BUDGET	FY97	FY98	TOTAL
Research stipend for Clay B. Nelson ($13,500 per year; 1996/97 and 1997/98)	13,500	13,500	27,000
Overhead costs for Northern Arizona University(20%)	2,700	2,700	5,400
Benefits 1%	135	135	270
Equipment costs (aquarium and field supplies)	1,915	1,915	3,830
Office, graphics and page costs	750	750	1,500
Subtotal of NAU Costs	17,085	17,085	34,170
Subtotal of non-NAU costs	1,915	1,915	3,830
TOTAL PHASE I AND II	**19,000**	**19,000**	**38,000**

PHASE I AND II EXPENDITURES TO DATE (September 22, 1997)

Graduate assistant stipend	10,666
Equipment costs	1,114
TOTAL	**11,780**

LITERATURE REVIEW

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NORTHERN ARIZONA UNIVERSITY KANAB AMBERSNAIL PROPAGATION AND EXPERIMENT DATA SHEET

ENLOSURE	SNAIL TOTALS/ENCLOSURE									10					15					20					25	AVG(mm)	STDEV	TOTAL
N1A	8.0	7.0	6.0	6.0																						6.8	0.96	4
N1B	8.0	8.0	6.0	6.0	5.0	4.5	4.5	5.0	5.0	5.0	3.0															5.5	1.49	11
N1C	9.0	9.0	10.0	12.0	10.0	9.0	8.0	10.0																		9.6	1.19	8
N1D	11.0	10.0	10.5	14.0	8.5	9.0	3.0	2.0																		8.5	4.06	8
N1E	7.0	8.0	8.0	7.0	8.0	9.0	7.0	6.0	7.0	9.0	6.0	6.0	6.5	6.0	7.0	8.0	6.0	6.0	7.0	5.0	6.0	7.0				6.9	1.05	22
N2A	6.0	6.0	6.0	8.0	7.0	5.0	7.0	7.0	7.0	7.0	8.0	6.0	7.0	7.0	7.0	5.0										6.6	0.89	16
N2B	9.0	10.0	10.0	10.0	11.0																					10.0	0.71	5
N2C	9.0	9.0	11.0	10.0																						9.8	0.96	4
N2D	8.5	9.0	10.0	10.0	10.0	10.0	10.0	9.0																		9.6	0.62	8
N2E	11.5	9.0	11.0																							8.8	1.64	3
MORTALITIES	9.5	8.0	9.0	8.0	7.0	8.0	10.0	9.0	8.0	5.0	9.5																	
NAOF TOTAL	measured 970927																									**8.2**	**2.10**	**89**
M1A	9	8	9	8.5	10	9	4	5	4	4	7															7.0	2.35	11
M1B	10	11	12	12	12																					12.0	0.89	5
M1C	10	10	10	6	7	9	10																			8.0	1.68	7
M1D	8	10.5	8	8	6	4	6	8	1	1	1	1														4.0	3.47	12
M1E	8	8	8	10																						8.0	1.63	4
M2A	7	9	9	9.5	8.5	7	9	9	8	5																8.1	1.39	10
M2B	11	9	8	9	9.5	9.5																				9.0	0.98	6
M2C	11	9.5	9	9	9	8																				9.3	0.99	6
M2D	9	10	9.5	9	8.5	8	8	9	12	9																9.2	1.16	10
M2E	9	9	8	8.5	9	9.5	6	8	8																	9.0	2.02	9
MORTALITIES	13	13	8.5	7																						**10.4**		**4**
MICA TOTAL																										**8.4**	**2.48**	**80**

MEASUREMENTS TAKEN 970927

NORTHERN ARIZONA UNIVERSITY KANAB AMBERSNAIL PROPAGATION AND EXPERIMENT DATA SHEET

ENLOSURE	SNAIL TOTALS/ENCLOSURE									10						15					20					25	AVG(mm)	STDEV	TOTAL
N1A	3	3	4	4	2	3	4	3	3	3.5	4																3.3	0.64	11
N1B	3.5	3.5	3.5	3	3	3	4	4.5	3	3	3	4															3.4	0.51	12
N1C	3	3	3	5	4.5	4	3	3	3	5	3.5	4	4														3.7	0.78	13
N1D	4.5	3	2	3	3	2	4	2.5	2	3	4	2.5															3.0	0.84	12
N1E	2	2.5	3	3	3	2.5	2	2	2	3	3	5															2.8	0.84	12
N2A	4	4	3.5	4	4	4	3	4	4	3	2	3	5														3.7	0.75	13
N2B	3.5	3.5	2	4	3	2	5	4.5	2.5	4	4.5	5	4														3.7	1.03	13
N2C	4	3	3	5	4	2	4	3.5	3	5	3.5	3.5	3.5														3.6	0.82	13
N2D	6	4.5	3	4	4	3.5	4	2	6	5	3	4	5														4.2	1.16	13
N2E	3	4	3	4	3	3	3	3	4	4	2	3															3.3	0.62	12
NAOF TOTAL	measured 970809																										**3.4**	**0.88**	**124**
M1A	4	2.5	3.5	3	4	4	2	4	1	3	4.5	4															3.3	1.03	12
M1B	1	2	1.5	3	2	6	2	1	3	4	5	2.5	4														2.8	1.53	13
M1C	4	3.5	1	4	3	2	2	2	2.5	5	1	2.5															2.7	1.23	12
M1D	4	2	2	2	1.5	3.5	1	2	5	2	3	4															2.7	1.21	12
M1E	2	3.5	4	5	2.5	5	2	2	2	2	4	4															3.2	1.21	12
M2A	5	1.5	2.5	1.5	2	4.5	5	3	2.5	3	4	5	3.5														3.3	1.30	13
M2B	4	2	2	3.5	2.5	3	3	2	3	2.5	3	3	3														2.8	0.60	13
M2C	5	4	3.5	4	3.5	3.5	4	2	1	4.5	4																3.5	1.13	11
M2D	3	4	4	3.5	3	3	1.5	3	4	4	4	4.5	5														3.6	0.89	13
M2E	5	5	3	3	4.5	4	5	4	4	4	4	3	5														4.1	0.77	13
MICA TOTAL	measured 970809																										**3.2**	**1.17**	**124**

MEASUREMENTS TAKEN 970809

NORTHERN ARIZONA UNIVERSITY KANAB AMBERSNAIL PROPAGATION AND EXPERIMENTAL DATA SHEET

ENLOSURE	SNAIL TOTALS/ENCLOSURE																									AVG(mm)	STDEV	TOTAL
										10					15					20					25			
N1A	6.0	7.0	6.0	7.0	8.0	8.0	6.0	6.0	7.0	7.0	5.5	5.0														6.5	0.94	12.0
N1B	9.5	9.5	9.0	6.0	8.0	7.5	7.0	7.5	7.0	7.0	7.5	6.0	8.0													7.8	1.03	13
N1C	10.0	9.0	10.0	9.5	11.0	10.0	12.0	10.0	10.0	9.0	8.0															9.9	1.05	11
N1D	15.0	8.0	11.0	11.0	10.0	9.0	8.0	8.0																		10.0	2.39	8
N1E	11.0	8.0	10.0	10.0	7.0	8.0	8.5	7.0	7.5	7.5	7.0	7.5	7.0													8.2	1.34	13
N2A	6.0	5.0	7.0	8.0	7.0	8.5	8.5	8.5																		7.3	1.31	8
	4.5	5.5	5.0	6.0	6.0	5.0	5.0	5.0	5.0	4.0	5.0	4.0	3.0	4.0	4.0	3.5	3.5	3.0	2.5									
N2B	9.0	9.5	12.0	10.5	8.5	7.0	10.0																			9.5	1.58	7
N2C	7.0	7.0	7.0	7.5	7.5	7.0	8.0	7.0																		7.3	0.38	8
N2D	9.0	6.0	10.0	9.0	9.5	10.0	8.0	9.0	11.0	8.5																9.0	1.35	10
N2E	8.5	11.5																								10.0	2.12	2
NAOF TOTAL	measured 970906																									8.5	2.21	92.0
M1A	5.5	9	7	8	7	6.5	7.5																			7.2	1.11	7
M1B	9	10	9.5	9.5	8																					9.2	0.76	5
M1C	8	6	9	8	6	8	5.5	8																		7.3	1.28	8
M1D	7	6	6	5	10	10	5																			7.0	2.16	7
M1E	8	5	7.5	5	8	9.5	6																			7.0	1.71	7
M2A	7.5	8	9	6	8	7	8	7																		7.3	1.11	8
M2B	6	7.5	6	7	7.5	7																				6.8	0.61	6
M2C	7	5	6	7	8	7.5	8	10	9																	7.5	1.59	9
M2D	8	7	5.5	7	7	6.5	7	9	9.5	8																7.5	1.19	10
M2E	9	7	8	7.5	7	7	7.5	8	8	8																7.5	0.82	10
MICA TOTAL	measured 970906																									7.4	1.33	77

MEASUREMENTS TAKEN 970906