According to Dr. Norman J. Scott, Jr., a disease agent may be the primary cause of certain amphibian declines, which he elucidates in his manuscript entitled, "The Postmetamorphic Death Syndrome in Western North America: A Recurring Pattern or Isolated Incidents?" He offers the following summary of the evidence and his tentative conclusions for consideration by other investigators of these events.

The precipitous declines and disappearances of numerous lagoon and frog populations in western North America are currently being documented, but the suggested reasons for these declines are almost as numerous as the observers. However, researchers in far removed sites have noted a common sequence of events taking place in the progression of these disappearances. The widespread occurrence of these sequelae may be an indication of a general decimating factor, or set of factors. If so, an epidemiological analysis of the syndrome might provide clues as to its causes.

This Postmetamorphic Death Syndrome (PDS) is characterized by the mortality of all or most postmetamorphic individuals in a short period of time. The proximate causes of death are usually widespread opportunistic pathogens such as Aeromonas (Red-leg disease).

Another characteristic of the nearly complete die-offs or extinctions is a pattern of synchrony in local sites but not among different regions. Rana tigrinaeae disappearances in Arizona and Sonora were essentially complete by the mid-1980s, but die-offs of other Ranidae in Arizona were not noted until 1993. In the Sierra Nevada of California mortality of Bufo canorus occurred between 1976 and 1982, and that of R. muscosa between 1979 and 1981. However, some of the Rana Sierra Nevada ranid extinctions seem to have proceeded sequentially through different watersheds; indeed, some drainages still have viable populations. In Grant County, New Mexico, disappearances of ranid frogs occurred in the late 1980s.

There may be a "ripple effect," that is, when frogs disappear first from one site, they then disappear from the surrounding area along a gradually expanding perimeter. The observations described above seem to fit this pattern. In New Mexico, the die-off of R. chilcahuanae, Gillette Tank, Grant County, New Mexico, was a year later than in Cooney Tanks less than 2 km away; in this general region all of the stocktank populations of leopard frogs disappeared within a three-year period. This ripple effect also seems to describe the pattern of disappearance of R. tigrinaeae throughout the northern part of its range; populations first appear southward into northern Sonora. A die-off moved upstream in a population of R. tigrinaeae in Sonora, Mexico.

A fourth characteristic of the PDS is that the dead and moribund animals are usually encountered during or immediately after brumation, or unusually cold periods.

The PDS does not appear to affect all species equally. Leopard Frog populations (R. yavapaiensis or R. chilcahuanae, or both) survived the die-off that eliminated R. tigrinaeae in Sycamore Canyon, Arizona. Ranids seem to be more immediately affected than Bufo, although the final outcome, extincion, may be inevitable. Ranid die-offs can often happen very quickly and completely; all of the postmetamorphic frogs appear dead in the spring, then the tadpoles metamorphose and die. Die-offs are usually less complete in Bufo. Bufo bovirr and B. hemphiiyrs baxteri in Colorado have been noted to have as much as 80% adult mortality during the winter. Many sick and dead adult Yosemite Toads (B. canorus) were reported in the Sierra Nevada of California in 1977 and 1978. However, none of the Bufo die-offs were completed in one year, and some of the sick B. canorus recovered to be recaptured in the following year.

Carey [1993, Conserv. Biol. 7(2):355-362] formulated a hypothesis to explain disappearances of B. bovirr in Colorado whereby unspecified environmental factors cause sublethal stress, which suppress the immune system; this condition combined with cold stress leads to infection by Aeromonas or other agents (continued on page 2, column 1).
Batrachians as Bioindicators

The appearance of a recent title, "The Utilization of Batrachians [Amphibians] and Reptiles as Bio-Indicators," by G.H. Parent (1992) L'utilisation des batraciens et des reptiles comme bio-indicateurs. Les Naturalistes Belgiques. 73(2):33-63 attracted the attention of numerous Task Force participants. Thanks are extended to Darryl Frost and Annie Zulderwijk for providing copies of the article. (Dr. Parent also forwarded a reprint) to Bob Johnson, and to Paul Kent who provided the English translation. This summary was composed by Jim Vial, who must be held responsible for the content.

In the context of Parent, the term "bio-indicators" is not used in reference to those species sensitive to perturbations of the environment on a global or continental scale, nor to a species response to a particular environmental change. Rather, it is applied to the establishment of a sustained research program of the environment within a prescribed region, aided by species whose decline or numerical fluctuations can at times be related to some well defined environmental parameters. To be successful, such studies require:

- an extended period of time;
- concentration of effort to a limited number of sites and subjects; and
- management of data under the aegis of a scientific institution.

Parent proposes a number of research topics, some of which include amphibians, and the decline of species and of the environment. His selection is based on the fact that results can be obtained quickly and implementation is within the capability of a versatile naturalist. He describes some special characteristics of Triturus cristatus (Crested Newt), T. vulgaris (Smooth Newt), Rana esculenta (European Green Frog), R. temporaria (Common Frog), and Salamandra salamandra (Fire Salamander).

To adopt what Parent refers to as the "much broader context of bio-indicators," the following should be considered:

- the tolerance thresholds of a species to changes in the environment;
- behavioral and life history peculiarities;
- ecological characteristics related to site protection and management; and
- potential teratological effects.

Anurans are apparently sensitive to radioactive pollution. Parent rectifies K. Rimpe's (1980) description of a population of Bufo viridis (Green Toad) near Stuttgart in which 35 to 55% of tadpoles exhibited abnormalities. These defects were similar to those displayed by larvae developing from irradiated sperm and eggs in studies conducted at the University of Hiroshima, Japan. In certain regions of France, slightly radioactive waters have been observed to accelerate growth and metamorphosis of amphibians.

It would be valuable to study amphibians in areas where natural levels of radon, thorium or uranium are known to be high. There are numerous locations listed by Parent and/or by local experts. These sites are possibly an industrial contaminant, that he recommends for study.

Parent associates the disappearance of some frog species with thermal pollution resulting from the hot effluents of nuclear power plant cooling systems.

More frequently the chemical contamination that contributes to amphibian declines or disappearances. Progressive acidification of ponds has been responsible for the disappearance of numerous colonies of Bufo calamita in Great Britain. Ponds in France and Belgium have found devoid of amphibians for any of several reasons, specifically: the pond is of recent origin - yet uncolonized; introduced predatory fish; general absence of amphibians in the area; and, in particular, because of extreme pollution by waste products, pesticides (in agricultural zones). heavy metals, etc.

Certain defects do not appear to be induced by the environment, but are the manifestation of genetic phenomena. For example, albinism in some species, supernumerary appendages or aberrant coloration would only be suspected by being environmentally prompted if such abnormalities attained a high frequency in a population and/or have been restricted to a particular site.

Determining the size of a population may be essential in order to enhance the chances of the species desiring effective conservation measures. While certain species are extremely difficult to census, observations during rainstorms can reveal the presence of overwintering retreats which have been overlooked. It is advisable in studying population dynamics to organize a team that will continue the work over many (ten) years.

Annual monitoring should be conducted by local observers. Declines of Bombina variegata and Buto calamita in Belgium probably took place between 1920 and 1980. Yearly monitoring would likely have provided much information as to actual time frame and probable causes. The same may be said for the Rana temporaria in the central Ardennes and of B. variegata in the Liege District.

Parent concludes his paper with a brief discussion of plans for updating a regional herpetological atlas and recent changes in the local distribution of Rana esculenta, the Little Green Frog (R. lessonae) and the Laughing Frog (R. ridibunda).

Copies of the original article (in French) or of the Paul Kent translation (in English) are available upon request from the SPA/P Coordinator's office.

A Report on Rana capito

The Carolina Gopher Frog (Rana capito capito) is a USA federal candidate species for listing as Endangered or Threatened. In North Carolina, it is listed as a species of Special Concern. This project was designed to gather additional information on the Gopher Frog in North Carolina in order to make informed management and protection decisions.

Historical breeding sites dating back to 1933, when the species was first recorded in North Carolina, to 1967 were visited to evaluate their physical status and to look for evidence of current use by the Gopher Frog. Additional sites representing both breeding ponds and road collected specimens were also checked. The total number of sites was 32. Five (16%) of these had been destroyed, 10 (31%) were considered inactive, six (19%) represented road collected frogs with no known breeding pond, and 11 (34%) were listed as active breeding sites. All but one of the active sites were associated with large tracts of relatively good terrestrial habitat for the frog and potential alternative breeding sites.

These conditions likely are important for the long-term survival of a population. Anthropogenic activities impacting upon R. capito populations are primarily the fragmentation of habitats, reducing the number of available breeding sites and increasing the hazards during migrations. Water table reduction and pond acidification are also significant. Because of the few remaining historic sites for the species, the great reduction in aquatic and terrestrial habitats, and the low number of active breeding sites, listing of the Carolina Gopher Frog as a Threatened Species in North Carolina is recommended.

Abstracts from Recent Meetings

The following abstracts have been selected from the programs for the 1993 annual meetings of the American Society of Ichthyologists and Herpetologists (ASIH) and the American Elasmobranch Society (AES) in May/June at Austin, Texas, USA, and those of the Ecological Society of America (ESA), July/August, at Madison, Wisconsin, USA.

POPULATIONS OF ANURAN AMPHIBIANS IN AN AMAZONIAN RAIN FOREST: SUSTAINABILITY OR DECLINE?

Anuran amphibians were sampled over a period of six years at Cuzco Amazonico in the eastern Amazonian Peru. Three sampling periods were at the beginning of the rainy seasons in 1986, 1989, and 1991; two were in the middle of the rainy seasons of 1986 and 1990, and one was in the dry season of 1989. Temperature and rainfall were recorded throughout all sampling periods. Sampling was along a series of trails and in a system of 100 X 20 m quadrants. A total of 65 species of anurans was recorded from the site. As expected, fewer species and far fewer individuals were recorded during the dry seasons than in the rainy seasons. Initial analyses revealed fewer species and individuals recorded at the beginning of the rainy seasons of 1989 and 1991 than in 1986 and fewer individuals in the middle of the rainy season of 1990 compared with that in 1986.

However, analyses of anuran abundance with respect to rainfall revealed that the number of individual anurans recorded was correlated positively with high average rainfall and the amount of the heaviest rainfall but not the number of rainy days during the sampling period. The numbers of frog and toad species observed at Cuzco Amazonico are highly variable among sampling periods, even during the same period of time in different years. The abundance of observed individuals is a reflection of rainfall patterns and does not indicate a decline in the number of individuals or species. ASIH/AES abstract by William E. Duellman; Museum of Natural History and Department of Systematics and Ecology, The University of Kansas, Lawrence, KS 66045-2445, USA.

ANURAN BIODIVERSITY IN A PERIODICALLY BURNED XERIC UPLAND HABITAT IN CENTRAL FLORIDA

Recent reports have alerted the scientific community to a possible global decline in amphibian populations. The paucity of long term studies, however, coupled with acute fluctuations of amphibian populations have hampered attempts to verify changes in amphibian populations. We report our findings from a seven year study (1982-88) of anuran occurrence on a sandhill habitat which is partially surrounded by a riverine swamp.

We captured 5360 individuals from 13 species, the four most abundant species comprised over 98% of the anuran community. Repeated controlled burning had little influence on the abundance of most anurans. Distance of a plot from the edge of the nearby wetlands was correlated inversely to the number of anurans captured. We found positive correlations among monthly rainfall patterns and monthly captures of anurans. Anuran abundance varied by an order of magnitude, from a high of 22.8, in 1982, to a low of 1.8 individuals per trap array in 1984. Three of the four most abundant species, Rana sylvatica, Hyla cinerea, and Scaphiopus holbrooki, are burrowing species that likely spend much time on the upland. Each of these species exhibited considerable annual variation in number of individuals captured per unit effort and their variation was a function of rainfall. ASIH/H/LAES abstract by E. R. Wild; Museum of Natural History and Department of Systematics and Ecology, The University of Kansas, Lawrence, KS, USA.

METAPOPULATION DYNAMICS AND PERSISTENCE OF TWO AMPHIBIAN SPECIES IN RELATION TO VARIATION IN HABITAT QUALITY

Local populations persist by various means, one of which is dispersal among local populations. Dispersal has long been viewed as important in fugitive plant and many invertebrate species, but less so for some vertebrate groups.

Two amphibian metapopulations (Rana sylvatica and Ambystoma maculatum), which consist of many breeding populations, were censused over a six to eight year period. Field experiments and observations assessed the importance of abiotic and biotic factors on reproductive output of breeding populations. Breeding habitats were of unpredictable quality for Rana sylvatica; strong predation by newts or disease outbreak during warm springs commonly eliminated entire larval cohorts. Many breeding populations were sustained by dispersal from successful breeding populations in certain years. Breeding habitats were of unpredictable quality for Ambystoma maculatum; predation by salamanders was not strong, disease outbreak of minor importance, and pond colonization rate.

Most breeding populations were self-sustaining and dispersed acted primarily as a means of colonization. ESA abstract by Spencer A. Cotwright; Indiana University Northwest, Gary, IN 46408, USA.

EPISODIC ACIDIFICATION IS NOT RESPONSIBLE FOR AMPHIBIAN DECLINES IN THE ROCKY MOUNTAINS, USA

We examine whether episodic acidification is responsible for observed declines of amphibian populations in the Rocky Mountains. Criteria for the documentation of episodic acidification of amphibian breeding habitats are defined. Monitoring pH and acid neutralizing capacity (ANC) along canyons provides evidence of anthropogenic episodic acidification of amphibian habitats. There is very limited evidence that anthropogenic episodic acidification occurs in high-elevation habitats of the Rocky Mountains, but there is no evidence that episodic acidification has led to acidic conditions (ANC < 0) or that amphibian embryos are present during the initial phase of snowmelt when episodic acidification might occur.

Previously published reports of amphibian declines, which do not meet with the criteria outlined here, cannot be credibly attributed to the effects of acidic deposition. Our surveys of amphibian decline habitats in the Rocky Mountain region show no evidence of either chronic or episodic acidification as the cause of observed declines. ESA abstract by Frank A. Verrucchi and P. Stephan Corr, Colorado State University, Fort Collins, CO, 80523, USA and U.S. Fish & Wildlife Service, Fort Collins, CO, 80525, USA.
BULLFROGS (Rana catesbeiana) INVADE A NORTHERN CALIFORNIA RIVER: A PLAGUE OR SPECIES COEXISTENCE?

Range expansion of the bullfrog, Rana catesbeiana, has coincided with declines of western ranid frogs, but the cause has not been established. I monitored the invasion of bullfrogs into a pristine northern California river system, dominated by the native frogs, R. boylii and Hyla regilla, by mapping reproduction sites and tadpole habitat utilization along 8 km of the S. Fork Eel River.

Where bullfrogs were well established, natives were rare. At invasion fronts, native and invading larvae overlapped spatially even when timing and location of hatching did not. These results suggest larval competition with bullfrog tadpoles might contribute to the exclusion of natives. I monitored previous occupied stream habitat. I tested this hypothesis by manipulating tadpole species composition and density. Bullfrog tadpoles had a great impact on R. boylii, causing a 48% reduction in survivorship, and a 24% decline in mass at metamorphosis, but only a slight impact on H. regilla (16% reduction in metamorph size, and no significant effect on survivorship).

Benthic algae and macroinvertebrate assemblages were also significantly altered in the presence of bullfrog tadpoles, although patterns varied across the spatially heterogeneous patches included in the manipulations. These results indicate that through larval interactions, bullfrog invasion can perturb aquatic community structure and exert differential effects on native frogs.

Endangered Frogs Survey

The Frog and Tadpole Study Group (FATSG) based in Sydney, Australia, has started surveys of the 21 species that are known or suspected to be in decline in New South Wales (NSW). The surveys will be concentrated in the more humid eastern half of the state. Data will be taken on habitat characteristics and population sizes at previously sampled sites (based on museum records) as well as additional locations that show promise. The work is funded in part by the Australian Heritage Commission (A$31,000). There is also a substantial voluntary input from FATSG members. The survey will continue until about March, 1995.

November 1 to 7, 1993, has been officially declared "Frog Week" in NSW and during that week FATSG members will undertake an intensive spot survey of 20 key sites/areas throughout the state. Media coverage is planned and as a result it is hoped there will be a state-wide CALL-IN. The public will be asked to mail a tape recording of their local ponds, swamps, etc. (with locality and date) for which they will receive species identifications. This will be the most comprehensive state wide survey of frogs ever undertaken in NSW.

Persons who wish to help or obtain further information may contact Harold Ehmann (Co-convenor, Frog and Tadpole Study Group, P.O. Box 450, St. James, NSW 2000, Australia).

DAPCANN III in BC

DAPCANN III, the third annual meeting of the Task Force on Declining Amphibian Populations in Canada, will be hosted by the Royal British Columbia Museum, Victoria, BC, October 15-18, 1993. The Canadian Wildlife Service (Pacific and Yukon Regions) and Environment Canada are co-sponsors.

To provide an overview of the program and express concerns before an audience of resource managers throughout North America, the initial session will be shared with the Western States and Pacific North West Wildlife Conference. Subsequent sessions will consist of amphibian research papers and a full day of discussion relating to DAPCANN objectives.

The DAPCANN Task Force is preparing a multi-authored final report, "Amphibians of Canada: Population Status and Decline," edited by David Green. Data presented, recommendations and resolutions formulated at DAPCANN III will be included. It will be here that the Canadian perspective is defined for presentation to the Second World Congress of Herpetology to be held in Adelaide, Australia, in December, 1993.

For further information contact Stan Orchard, Department of Zoology, University of British Columbia, 6757 University Blvd., Victoria, BC V8W 1X4, Canada (phone: 604-387-3649).

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