Growth rates and movements within a population of Rana pretiosa pretiosa Baird and Girard in South Central Montana
by Robert Rudolph Hollenbeck

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of DOCTOR OF PHILOSOPHY in Zoology
Montana State University

Abstract:
Growth rates and movements within a population of Rana pretiosa near Hyalite Reservoir were studied from 1966-1968. Age classes based on size were established by recaptures of marked animals. Growth rates varied from 0-0.277 mm/day and were generally higher in small individuals.

Growth rates of the Hyalite frogs were higher than those of Rana pretiosa in Yellowstone National Park (Turner, 1960a), probably due to temperature and precipitation differences between the two areas. Sexual dimorphism in size was clear-cut in fourth-year frogs, although differential growth probably occurred during the third year. The majority of males began breeding at four years of age, while most females began breeding a year later. Sex ratios favor females in the 0, I, II and V+ year-classes. A preponderance of males in the III and IV year-classes is probably due to differential sampling near breeding areas. Larval growth rates ranged from 0.3-2.0 mm/day with highest rates occurring about the middle of July. Maximum larval length is reached near the middle of August, followed by a decrease in length until metamorphosis late in August or early in September. The majority of young (0-II year-classes) individuals are found in non-breeding areas throughout the summer.. Adult males (III-V+ year-classes) were captured in breeding areas and non-breeding areas in the first of the summer in the ratio of 2:1, whereas for females this ratio was close to 1:1. Only a third as many adults were captured during the latter part of the summer as were taken during the first part of the growing season. In non-breeding movements, young frogs and adults exhibited no significant differences in distances traveled between captures. Distances traveled between summers were much greater than distances traveled within summers. Comparisons of distances between first and second and first and third capture sites indicated that only for the O-II year-classes was there a significant difference. Except for adult males, the longer the time interval between captures, the longer the distance traveled. Restricted home ranges were not. indicated in this study. Movements of adults to and from breeding areas ranged from 41. m to 553 m. Most adults remained in breeding areas until the latter part of July. Most young of the year moved from breeding ponds during the first week in September. Movement rates not connected with breeding were found to be independent of age and sex groups. The most rapid movement (8.9 m/day) took place during July and the latter part of August, primarily in response to drying of temporary water at this time of year. In 1967, an estimated 80% decrease in the larval population took place between mid-July and mid-August in the main breeding area. In 1968, at the same site, 50% of the larvae disappeared between the time of egg deposition in June and mid-July. Twenty percent of the remainder were gone by mid-August.

GROWTH RATES AND MOVEMENTS WITHIN A POPULATION OF RANA PRETIOSA PRETIOSA BAIRD AND GIRARD IN SOUTH CENTRAL MONTANA

by

ROBERT RUDOLPH HOLLENBECK

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree

of

DOCTOR OF PHILOSOPHY

in

Zoology

Approved:

Head, Major Department

Chairman, Examining Committee

Graduate Dean

MONTANA STATE UNIVERSITY
Bozeman, Montana

June, 1974

ACKNOWLEDGEMENTS

The author wishes to express his sincere appreciation to Dr. R. E. Moore for his patience and advice in directing the study and for his aid in the preparation of the manuscript. Dr. Harold Picton, Dr. P. D. Skaar, and Dr. John Rumely read the manuscript and offered suggestions. Thanks are due Mrs. Curtis K. Maxey who gave permission for the study to be carried out on her land, and to the Montana State University Department of Biology for partial funding of the project and for the awarding of an NSF Traineeship during 1967-68. I would especially like to thank my wife, Carla, who typed the manuscript, aided in the field work, and encouraged me always.

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ABSTRACT

Growth rates and movements within a population of Rana pretiosa near Hyalite Reservoir were studied from 1966-1968. Age classes based on size were established by recaptures of marked animals. Growth rates varied from 0-0.277 mm/day and were generally higher in small individuals. Growth rates of the Hyalite frogs were higher than those of Rana pretiosa in Yellowstone National Park (Turner, 1960a), probably due to temperature and precipitation differences between the two areas. Sexual dimorphism in size was clear-cut in fourth-year frogs, although differential growth probably occurred during the third year. The majority of males began breeding at four years of age, while most females began breeding a year later. Sex ratios favor females in the 0, I, II and V+ year-classes. A preponderance of males in the III and IV year-classes is probably due to differential sampling near breeding areas. Larval growth rates ranged from 0.3-2.0 mm/day with highest rates occurring about the middle of July. Maximum larval length is reached near the middle of August, followed by a decrease in length until metamorphosis late in August or early in September. The majority of young (0-II year-classes) individuals are found in non-breeding areas throughout the summer. Adult males (III-V+ year-classes) were captured in breeding areas and non-breeding areas in the first of the summer in the ratio of 2:1, whereas for females this ratio was close to 1:1. Only a third as many adults were captured during the latter part of the summer as were taken during the first part of the growing season. In non-breeding movements, young frogs and adults exhibited no significant differences in distances traveled between captures. Distances traveled between summers were much greater than distances traveled within summers. Comparisons of distances between first and second and first and third capture sites indicated that only for the 0-II year-classes was there a significant difference. Except for adult males, the longer the time interval between captures, the longer the distance traveled. Restricted home ranges were not indicated in this study. Movements of adults to and from breeding areas ranged from 41 m to 553 m. Most adults remained in breeding areas until the latter part of July. Most young of the year moved from breeding ponds during the first week in September. Movement rates not connected with breeding were found to be independent of age and sex groups. The most rapid movement (8.9 m/day) took place during July and the latter part of August, primarily in response to drying of temporary water at this time of year. In 1967, an estimated 80% decrease in the larval population took place between mid-July and mid-August in the main breeding area. In 1968, at the same site, 50% of the larvae disappeared between the time of egg deposition in June and mid-July. Twenty percent of the remainder were gone by mid-August.

INTRODUCTION

Within the last twenty years, studies of amphibian populations with regard to growth rates and movements of metamorphosed individuals have proliferated to the extent that many of the common anuran species have been studied. The methods used in these studies have varied. Bannikov (1950), working with Bombina bombina, utilized single captures of large numbers of individuals throughout the growing season as a basis for size-frequency relationships showing age classes. Force (1933), investigating Rana pipiens, and Anderson (1954), studying Gastrophryne carolinensis, also followed this procedure. This type of information, although important, tends to obscure differences in individual growth rates.

Information of greater value has been obtained by recapture of marked individuals. Using this method, one may obtain information concerning movements as well as growth data. Workers utilizing this method to study growth of metamorphosed frogs are as follows: Blair (1953), Bufo valliceps; Bellis (1961), Rana sylvatica; Breckenridge and Tester (1961), Bufo hemiophrys; Brown and Alcala (1970), Rana erythraea; Chapman and Chapman (1958), Bufo regularis; Delzell (1958), Hyla crucifer; Fitch (1956), Gastrophryne olivacea; Green (1957), Pseudacris brachyphona; Hamilton (1934), Bufo americanus; Hamilton (1955), Bufo quercicus; Hansen (1957), Rana heckscheri; Jameson (1956), Hyla regilla; Jameson (1955), Syrrhophus marnocki; Martof (1956),

Rana clamitans; Pearson (1955), Scaphiopus holbrooki; Pyburn (1958), Acris crepitans; Raney and Ingram (1941), Rana catesbeiana and Rana clamitans; Raney and Lachner (1947), Bufo terrestris; Standaert (1968), Rana virgatipes; Tester and Breckenridge (1964), Bufo hemiophrys; and Turner (1960a), Rana pretiosa.

Most of the investigators listed above found that there is considerable variation in the growth rates of different individuals and that growth rates decrease as the anurans grow larger. Turner, in two review articles (1960b and 1962), concluded that growth rates, maximal size and other growth associated phenomena may vary not only among different species, but among different populations of the same species as well.

Schroeder and Baskett (1968) have had some success in estimating the ages of bullfrogs (Rana catesbeiana) up to six years of age by observing growth marks on the pterygoid bone. Smirina (1972) utilized similar growth marks on transverse phalanx sections in Rana temporaria. Such techniques, while useful, are obviously not practical field procedures.

Data concerning home ranges and movements also are forthcoming from capture-recapture methods. Major contributions in this area are the following: Bellis (1959), Bufo terrestris; Bellis (1965), Rana sylvatica; Breckenridge and Tester (1961), Bufo hemiophrys; Carpenter (1954), Rana pretiosa and Bufo boreas; Chapman and Chapman (1958),

Bufo regularis; Currie and Bellis (1969), Rana catesbeiana; Delzell (1958), Hyla crucifer; Dole (1971), Rana pipiens; Fitch (1956), Gastrophryne olivacea; Green (1957), Pseudacris brachyphona; Hansen (1957), Rana heckscheri; Ingram and Raney (1943), Rana catesbeiana; Jameson (1955), Syrrhophus marnocki; Jameson (1956), Hyla regilla; Martof (1953), Rana clamitans; Pearson (1955), Scaphiopus holbrooki; Pyburn (1958), Acris crepitans; Raney (1940), Rana catesbeiana; Turner (1960c), Acris gryllus; and Turner (1960a), Rana pretiosa.

The majority of the investigators agreed that there was much individual variation in rates of movement and in total distances traveled. Hansen (1957) and Delzell (1958) both reported that younger frogs traveled greater distances than older frogs, and Fitch (1956) found that males appeared to have larger home ranges than females. Carpenter (1954) and Breckenridge and Tester (1961) presented evidence of non-randomness of movement, indicating at least limited activity ranges. In most cases, breeding migrations and retreat from evaporating temporary water, especially in the case of relatively aquatic frogs such as Rana pretiosa, were the causes of long distances traveled by any one individual.

Growth and survival of larval anurans in the natural state has been studied much less intensively. Bragg, working with Bufo cognatus (1940) and Rana areolata (1953), included description of development and a few quantitative measurements. Turner (1958) followed this

procedure with Rana pretiosa. Morris and Tanner (1969) correlated recognized stages of development and growth rates in a Utah population of larval Rana pretiosa. There have also been several laboratory studies describing larval development and giving quantitative growth data. Examples are: Burgess (1950), Scaphiopus hammondi; Gosner and Black (1957), several hylid species; Jameson (1950), Eleutherodactylus latrans; Licht (1971), Rana aurora and Rana pretiosa; Moore (1939), several ranid and bufonid species; Orton (1949), Nectophrynoides tornieri; and Rugh (1948), Rana pipiens.

Turner (1962) reviewed the few examples of larval survival data and concluded that larval survival in nature varies considerably even within the same population because of yearly fluctuations in environmental factors. The amount of rainfall is often critical in this regard, because of its effect on the drying-up or continuance of breeding sites.

The present study involved capturing, marking, and recapturing of metamorphosed individuals of Rana p. pretiosa Baird and Girard in a willow-bog habitat at the upper end of Hyalite Reservoir in Gallatin County, Montana. The primary purpose of this portion of the study was to investigate growth rates and movements of this little-studied frog. In addition, other associated population phenomena such as sex ratios, seasonal changes in dispersal and activity, and breeding times were investigated. The second portion of the study

involved the investigation of larval survival and correlation of growth and stages of development.

The study was conducted from July through September of 1966, June through September of 1967, and June through September of 1968. Data on tadpoles were collected only in 1967 and 1968.

STUDY AREA

The study area is located at the upper, or southern, end of Hyalite Reservoir, approximately 24.2 km south of Bozeman, Montana, in Gallatin County. The area under consideration is shown in Figure 1. Although the majority of effort was concentrated on the willow-bog habitat type, considerable time was also spent on the remainder of the area under consideration which includes breeding areas located to the west in the spruce-fir habitat type.

Elevation varies from 2042 m (the elevation of the majority of the willow-bog) to approximately 2070 m (the elevation of the highest of the breeding sites). A private road raised upon a dike runs in an east-west direction and crosses the willow-bog and the west fork of Hyalite Creek. The majority of the willow-bog lies south of the private road. Water in the area comes from small springs, snow melt, and overflow from Hyalite Creek. Water levels changed drastically between early July and the middle of August, particularly along the creek itself and in that portion of the study area north of the private road. This is largely a result of the filling of the reservoir to the point where water backs up over most of the area north of the private road and along both sides of the dike in the early part of the year. Water depths at this time range from 0.6 - 1.2 m. In August water levels in the reservoir decrease, and the area north of the dike is left almost entirely dry except for small isolated pools of water and