

## SOME ASPECTS OF BAIT FISH RESEARCH IN THE LOWER COLORADO RIVER COMPLEX

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**Abstract.** The University of Nevada in association with the Bureau of Commercial Fisheries and the Nevada Fish and Game Department is conducting research concerning the rearing of bait fishes in the desert Southwest. The ultimate goal of this project is to develop methods and techniques for producing a quality product in sufficient numbers at a low cost per of unit effort. The first year's work of the project has been analysis of supply and demand for bait fishes within the complex. The research on review and selection of bait species suitable for rearing in the Southwest will continue during the second year's operations with emphasis on studies of preference of predator species for selected bait species.

The total number of retail bait outlets in the lower Colorado River basin is presently 53. Over 90% of these dealers were interviewed. The largest concentration of retail outlets exists in the Las Vegas-Lake Mead area (17), followed by the Lake Havasu and Mohave County area (14), and the Parker Dam area (10). There are six dealers in each of the remaining two areas--Blythe-Palo Verde, California and Yuma, Arizona.

The total value of bait sales in the study area was \$457,000 in 1968. Approximately 40% of this sum was spent in the Las Vegas-Lake Mead area. The total sales volume in 1968 was 4.3 million units of live bait--salamander larvae and minnows. The sales of salamander larvae exceeded minnow sales by 0.7 million units.

The wholesale market in the study area consists of five local wholesalers, two wholesalers in central California, and a large number of independent catchers of salamander larvae who obtain their supplies from almost all states in the western part of the United States. The most significant aspect of the wholesale market is the fact that each subarea within the study area is largely, sometimes exclusively, dominated by one local wholesaler. The supply of minnows produced within the lower Colorado River basin meets only about 50% of the demand from retailers in that area. The remaining 50% of minnows are imported from two hatcheries located in central California. It is concluded that there exist

ample opportunities for a significant expansion of raising minnows in the lower Colorado River complex. The demand for sport fishing recreation and live bait within the study area is expected to increase at a predicted rate of 9 to 10% per annum in the next decade.

Studies on the preference of largemouth bass for selected bait species under experimental conditions have indicated that bass show a definite preference for golden shiners over goldfish (2.2:1) and for salamander larvae over golden shiners and goldfish (2.2:1 and 4.2:1). Future preference experimentation will include the use of striped bass and several native minnows.

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Retail Outlets - Structure of the Market. The market for baitfish in the Lower Colorado River complex, for the purposes of our study, was divided into five (5) geographical areas: (1) Las Vegas-Lake Mead area, (2) Mid-River area around Lakes Mohave and Havasu, (3) Parker Dam Area, (4) Blythe-Palo Verde, and (5) Yuma, Arizona.

The total number of retail outlets in the lower basin, as of early 1969, is equal to 53. Forty eight (48) --over 90%-- of these retail dealers were interviewed. The largest concentration of retail outlets exists in the Las Vegas-Lake Mead area (17), followed by the mid-river around Lakes Mohave and Havasu (14), and Parker Dam area (10). There are six (6) dealers in each of the remaining two areas.

The total value of bait sales within the complex amounted to somewhat less than \$500,000 in 1968. Approximately 40% of this sum was spent in the Las Vegas-Lake Mead area, over 20% in the Parker Dam area. Yuma and Blythe accounted for slightly less than 10 and 5%, respectively, of the total expenditures on bait. Thus the volume of sales is greater at the northern end of our study area (Las Vegas-Lake Mead) and steadily diminishes as one approaches the Mexican border, an apparent relationship with population density and tourist traffic.

Bait sales were divided into two categories: waterdogs (salamander larvae) and minnows. The sales volume of waterdogs in 1968 amounted to approximately 2.5 million and the sales of minnows approximately 1.8 million. In the first three areas of our study the sales of waterdogs exceeded sales of minnows by a margin of 40%. This divergence between the northern and southern areas lies not on the demand side but rather on the supply side. Almost all bait dealers in the southernmost areas expressed their complaints about difficulties in securing adequate, reliable and timely supplies of waterdogs.

Waterdogs were first introduced as bait in the Lake Mead area in the early 1950's. Their popularity grew very rapidly. It was estimated that in the early 1960's (probably) one million waterdogs were sold in the Lake Mead area. Since 1960 the rate of increase in sales has slowed down substantially, primarily due to the difficulties in securing adequate supplies.

In the past ten (10) years the Las Vegas market for bait has undergone a

significant transformation. The degree of market concentration in this area has been greatly reduced. While in the late 1950's one dealer was selling probably as much as 75% of all bait in this area, today there are 17 retail outlets in this area, and the market share of the largest dealer does not exceed 20%. It is clear that the Las Vegas market structure has been changed from a virtual monopoly and price leadership in the late 1950's to a more competitive and less concentrated structure in the late 1960's.

Our study has revealed that the sale of bait in all cases except one is connected with other business activities and, in general, it represents a relatively small proportion of the total business activities in the cases of grocery stores and marinas, and a much larger proportion of business volume in those instances where they are connected with the sales of fishing tackle.

The sales value of bait varied substantially among dealers. Approximately 70% of the dealers indicated that their sales of bait amounted to less than \$10,000 per year. Approximately 20% reported sales between \$10,000 and \$20,000 per year. Of the remaining dealers who reported sales over \$20,000, two marinas had sales over \$30,000. In one marina, sales of bait represented 2% of the total business volume while in the case of the second marina they accounted for about 20% of total business.

Examination of the four largest dealers has indicated that all of them had experienced a rather rapid growth and a satisfactory profit level in the past, and that three of them were planning to expand their business in the future.

Although it was not possible to ascertain precisely the past growth of the market in terms of volume and value of bait sales, there are many indications that the market has shown a rather significant rate of growth in recent years. More than 50% of the interviewed dealers stated that their business has been expanding while only about 10% stated that their business has been declining. The remaining dealers stated that their businesses have recently remained more or less stationary.

Price Policies. The price structure and policies in the bait market are characterized by a high degree of price stability, rigidity and uniformity. This stability and uniformity is much stronger within each subarea of the market than it is for the whole market in the Lower Colorado River basin. It also appears to be stronger in the market for minnows than it does for waterdogs.

Within the total area of the Lower Colorado River, nearly 75% of all dealers charged the same price for minnows (\$1.25/doz.) and about 40% charged the same price for waterdogs (\$1.25/doz.). Almost all of the deviations from the uniform price level were limited to cases of marinas that were located in rather isolated places, somewhat distant from other dealers.

It was concluded therefore that the market does not display any price competition at all. As there is also very little competition in quality, it appears that the business location constitutes the main element of competition.

As mentioned earlier, it was not feasible to ascertain precisely the growth of demand for bait in the past. On the basis, however, of an increasing number of dealers in the past few years and also on the basis of individual replies given in our interviews, it can be estimated that the demand for bait in our study area has shown a significant rate of growth in the past. The market for bait within the whole area of the complex has been increasing in recent years at a probable rate of slightly higher than 10% per annum.

The demand for bait shows a higher amplitude of seasonal fluctuation. There are two very definite peak periods--one in the spring and the second in the fall. It appears that the spring demand is twice as high as the fall demand. The two periods of very low demand occur from November to February and during the months of June, July, and August. In spite of substantial seasonal variation in demand, retail prices for bait remain stable throughout the year.

Supply of Bait. The supply features of the industry are totally different for each bait category. Minnows are supplied by local wholesalers and their supply is reasonably constant throughout the year. Our study has disclosed that each subarea within the Lower Colorado River basin is usually dominated by one wholesaler. It also appears that with the exception of short-term, occasional shortages during the spring period, the supplies of minnows seem to be adequate. Many retailers voice, however, their strong criticism of the present regulations imposed by the Nevada Fish and Game Department which attempts to regulate the importation of minnows from outside of the State of Nevada. Apparently, those regulations which require the retailer to notify the Department 10 days in advance that he is planning to bring in minnows from out of state, have the effect of hindering the inflow of minnows, and thus leading to temporary shortages in the spring.

Several dealers have also expressed their concern about the alleged violations of those regulations. It is believed by some dealers that occasionally some retail outlets will obtain supplies of minnows that have not been inspected by the proper authorities. Many believe that the present regulations are largely unenforced, or maybe even non-enforceable, and they appear to handicap those dealers who desire to follow the law. At the same time those dealers who are less concerned about the law, are able to gain considerable advantage, especially in times of local shortages.

The supply of waterdogs shows completely different characteristics. Waterdogs, in addition to being supplied by local wholesalers, are supplied in most cases by small independent waterdog catchers who bring them from almost all states west of the Mississippi River. This flow of supply is highly erratic, unreliable, and unpredictable. The complaints about the unreliability and uncertainty of supply were voiced by almost all dealers in our area. In the early spring when the demand for waterdogs is relatively high, their supply is usually very limited and frequently serious shortages develop on the market. During the summer months when the demand is relatively low, supplies are overabundant and excessive, and surpluses will develop that will depress wholesale prices and result in very high mortality rates.

As mentioned previously, our study failed to discover any significant degree of excessive competition. There appears, however, to be an excess capacity on the market. There are probably too many small dealers, and many of them could handle a much larger volume of sales without enlarging their premises or purchasing additional equipment. The existing excess capacity has been created by a reasonably free entry into the bait market, relatively low capital requirements to establish a bait outlet, and also by the fact that no special professional skills are required to handle bait. The pressure of excess capacity will obviously diminish the profits of individual dealers. This situation is not basically different from that involving many other types of retail stores, such as groceries, gas stations and liquor stores.

To remedy the situation, some of the dealers have suggested that the State Fish and Game Departments limit the number of licenses issued for the sale of bait. Such a suggestion seems totally unwarranted. Retail sales of bait have neither the character of public utility nor of natural monopoly, and it appears that the best course of policy would be to leave the market to the pressures of normal elements of competitive behavior. Such a policy would better protect the consumer's interest than a policy of restrictive licensing.

Wholesale Outlets. The wholesale market in our study area consists of five (5) local wholesalers, two (2) wholesalers in California, and a larger number of independent waterdog "rustlers" who scour the Western states.

Two of the local wholesalers deal with waterdogs and minnows. Two of them are limited to supplying minnows only, and one is limited to supplying waterdogs. Waterdogs are obtained by the wholesalers from their own crews of "rustlers" operating in several states. Some minnows sold by the local wholesalers are supplied from central California, and in addition, two of the local wholesalers raise their own.

It is practically impossible to determine the total wholesale volume of waterdog sales, primarily because there are no records of transactions involving the independent "rustlers" and the retail dealers. The total wholesale volume of minnows is approximately two (2) million per year, more or less equally divided between minnows raised locally and those imported from two (2) California hatcheries.

The size of the local wholesalers varies considerably. Four of them have total annual sales of between \$15,000 and \$45,000, while the fifth has sales amounting to almost \$100,000 per annum. Four of them have been in business for more than ten (10) years, while a fifth started his operations only two (2) years ago. All of them experienced steady growth in the past and almost all are planning to expand their business in the future.

Probably the most significant aspect of the wholesale market is the fact that each subarea within our study area is largely, sometimes even exclusively, dominated by one local wholesaler. It was concluded, therefore, that as far as the wholesale market for minnows is concerned there is no competition at the

present time.

As mentioned earlier, the supply of minnows produced within the lower Colorado River basin meets only about 50% of the retailer demand in that area. The remaining 50% is supplied from two (2) central California hatcheries. Our investigations have indicated that the local and central California sources of supply are, in general, able to meet the local demand for most of the year. Usually, however, occasional shortages of minnows occur in the spring.

A conclusion that has emerged very distinctly from our study, is that there exist ample opportunities for a significant expansion of minnow raising in our area. Such an expansion would allow gradual elimination of the necessity to obtain minnows from central California.

Projections of Future Demand and Supply. In general, the demand for outdoor recreational activities, including sport fishing will be determined in any particular area by the following factors:

- a. growth of the local population
- b. added leisure time
- c. mobility of the population
- d. personal income
- e. flow of tourists

According to reliable sources (the various economic surveys conducted in southern Nevada), between 1965 and 1980,

- population in southern Nevada will increase by 235%
- average leisure time will increase by 10%
- personal mobility will increase by 35%
- personal income will increase by 40%

On the basis of these parameters, it could be calculated that the demand for outdoor recreational activities in southern Nevada by local residents will increase almost 5 times by 1980.

Prospectus. Such an expected increase by 1980 would indicate an annual rate of increase of about 11%. As far as the demand for recreational activities by tourists is concerned, it can be assumed that it will depend simply on the rate of inflow of tourists. It is expected that this flow to Nevada will increase by 210% by 1980. It follows, therefore, that the annual rate of increase of demand by tourists would be approximately 5%.

As there is no a priori reason to believe that the increase in demand for sport fishing in the period 1965-1980 would proceed at a different rate than the demand for all other outdoor recreational activities, it could be assumed, therefore, that those rates will also reflect the expected rates of increase for sport fishing in southern Nevada. Further studies conducted by the Nevada Department of Conservation and Natural Resources have also disclosed that approximately 40%

of the sport fishing in southern Nevada is done by tourists and about 60% by the local residents. Combining the expected rates of increase for sport fishing by local residents and tourists, it could be concluded that the aggregate demand for sport fishing in southern Nevada will increase at an annual rate close to 9%.

If the assumption that the demand for bait is directly related to the demand for sport fishing activities is valid, it can be concluded that during the next decade the demand for bait in southern Nevada will increase at an annual rate of about 9%.

In addition to the projected increases in the population of the Lake Mead-Las Vegas area, the projections of population trends in other areas within the complex must be considered. The areas around Lake Mohave and Havasu and Parker Dam constitute the main elements of Mohave county in Arizona. Since 1960, the population of this county has been increasing at an average rate of about 11% p.a.

We have concluded that the remaining two areas within the complex will not exert any decisive impact on the aggregate projections. These areas generate only about 15% of the total demand for bait and their populations are expected to increase by only a rate of about 2.5-3% p.a.

The final conclusion, therefore, concerning the projection of demand for bait in the lower Colorado River basin as a whole, for the next decade, is: the demand for bait will increase at an annual rate of approximately 10%.

This conclusion is based, however, on two very important assumptions:

- (1) That a reasonable amount of sport fishing quality can be maintained throughout the next decade.
- (2) That the supply of bait, especially waterdogs, will increase proportionate to the increase demand.

It is very doubtful that the first assumption will hold true--especially for the Lake Mead area. The Lake Mead fishery has been declining at an accelerated rate since 1959 (0.8 fish/hr. to 0.3 fish/hr.) with the exception of a brief recovery in 1963. Perhaps the Nevada and Arizona Fish and Game Departments' programs of transplanting striped bass, coho salmon, and rainbow trout into Lake Mead will generate enough fishing activity to sustain the projected demand of 10% throughout the next decade. On the other hand, severe population pressure, greater use of water for irrigation and industrial purposes, and unabated water pollution may drastically reduce fishing success to a point where there is a reduction in demand for sport fishing activity and bait in the latter part of the decade. Lake Mead is rapidly being polluted by the dumping of inadequately-treated sewage effluent in the Vegas Wash area. Neither local nor state authorities seem to be willing or able to do anything about it. Also projected increases in salinity within the project area could have considerable impact on the fishery.

An estimate of future supply of bait in the basin presents a relatively simple

picture. As far as the supply of minnows is concerned, there are all indications that this supply will be able to increase proportional to the increased demand, either from the local sources or from central California. If it is assumed that the sources from central California would or could be gradually eliminated, then the supply from local sources would experience a tremendous growth potential in the long run. On the other hand, if local sources of wholesale supply fail to develop, there are indications that import of central California minnows could easily be increased. At present, two large hatcheries are providing about 50% of the wholesale supply to our area, and as those supplies constitute, in aggregate, only about 10% of their total production, it can be safely assumed that they could expand their production and shipments to lower Colorado outlets, if and when the market situation warrants it.

As far as the supply of waterdogs is concerned there is no reason to believe that the present situation characterized by rapidly fluctuating and unpredictable supplies will change for the better. As the sources of waterdogs are being gradually depleted and as, very probably, less and less people will be interested in catching waterdogs, it may be expected that the flows of supply will become even more erratic in the future, and this would lead to an even greater imbalance between demand and supply, and would result in severe shortages.

It appears that unless some methods of raising waterdogs on a commercial scale are designed and developed--or a suitable substitute can be found--there is little hope that a significant improvement in the present situation can be expected.

Our approach to the problem is to come up with a suitable substitute. We believe that we may have one in the Virgin River Spinedace--Lepidomeda mollispinis.

The work we completed last year on the preference of large-mouth bass for selected bait species under experimental conditions indicated that this native minnow may be just as effective a bait as the waterdog. A total of 24 preference experiments were completed. These experiments were conducted in 8' and 10' diameter plastic wading pools and involved 29 trial periods with a total trial time of 275.3 days (mean trial period 9.5 days). A total of 25 different bass were utilized in determining single and group profiles. Largemouth bass showed a definite preference for golden shiners over goldfish (2.2:1) and for waterdogs over golden shiners and goldfish (2.2:1 and 4.2:1). In a limited number of experiments (4), Lepidomeda were preferred over waterdogs by a margin on 1.1:1, over golden shiners by a ratio of 22:0 and over goldfish by a 28:1 margin.

Although we plan to continue preference experimentation with Lepidomeda, we now feel that it will serve as a suitable substitute for the waterdog. What remains is to develop techniques for rearing this species on a commercial basis and then to convince the sportsman that Lepidomeda is a worthy bait item.