The biologist who does not recognize and understand the limitations—and liberties—imposed by practical political considerations on his director and himself has little chance of reaching the top. For example, no matter how sound, how beneficial, a radical revision of game or fish management procedures or regulations might be, unless it meets with reasonable acceptance by the public, or the public's representatives, the State legislature, it will not be successful. Proposed doe seasons have proved this.

Further, any director actively pressing such a move would not last long—and neither would his successors! While these things can be done through the long and laborious, but democratic, process of swaying public sentiment, nothing is gained by a frontal attack.

Our technical personnel cannot live in ivory towers and pass their days "assuming," "pointing to," "indicating" or "perhapsing" and herein lies an expectation in a director's viewpoint. In Virginia we have urged and expected our biologists to not only find facts and commence developments, but to spread the word—in person. This has not always been either easy or successful but those of our boys who have followed this approach have done our Commission and the sportsmen the greatest good, without any doubt.

The biologist, in my mind, should be able to stand up and explain and convince others of his plans or ideas, whether it be his fellow associates, his Commission or the sportsmen.

Along these same lines, the biologist must also develop an appreciation for the non-biological factors faced by the director and the Commission when his attaining this viewpoint than to make sure that he rubs shoulders with the public every day.

FUTURE NEEDS FOR FISH AND GAME BIOLOGISTS

By NELSON COX
Arkansas Game and Fish Commission

The obligations and organizational needs of Fish and Game Departments have changed, radically, over the past thirty-five years. Within that period we have witnessed a tremendous upsurge in our human populations, more leisure time, construction of a vast system of roads running into every part of the land, and a steady acceleration in the use of all types of recreational resources, of which our fish and wildlife resources are an integral and essential part. Coupled with this intensified use have been the changing patterns of land use resulting from intensified agriculture, urban and industrial developments, and increased uses of all kinds of resources to meet the needs of more and more people. Our population in this country, alone, has increased by 20 million in the past ten years, and it has been estimated that we will have a population of 227 million people in this country by 1975. All of these people have made more and more demands on resources.

Our population increments are great, but the use of all types of facilities for outdoor recreation has increased even more rapidly. The increased interest and use of fish and wildlife resources are dramatically demonstrated by the rapid increase in sales of hunting and fishing licenses from 1950 to 1958. Over this eight-year period, hunting license sales increased from 12,638,000 to 14,764,000, and fishing licenses purchased increased from 15,338,000 to 20,178,000. It has been estimated that hunters and fishermen now spend over 3 billion dollars per year on these types of recreation, while total expenditures for all types of outdoor recreation have been estimated at 16 billion dollars annually.

According to recent estimates, the demand for outdoor recreation will increase ten times by the year 2000. These figures demonstrate the tremendous monetary worth and use of our fish and wildlife, and outdoor recreation associated with them, but they do not evaluate the true worth of these resources, which contribute to our social welfare by providing rest, relaxation, and escape from the tensions of a fast-moving, industrialized, and crowded world.

I have prefaced my comments on future needs for biologists with these statistics to show that we are living in a rapidly changing world, and that these

changes are both imposing increasing demands on these resources and reducing their availability. Because of these changing circumstances, the modernization of our approach to fish and wildlife management has become just as essential as the improvement of our roads, our health standard or our school systems. We, who administer fish and wildlife resources, have learned that we must alter our methods to meet altered circumstances. We cannot begin to meet the demands placed on the resources we administer unless we recognize that we are living in a scientific age, and use the skills and techniques this age has made available to us.

We must also recognize that this is an era of specialization, and that our need for trained and skilled wildlife resource specialists is just as evident and as acute as the need for engineers, chemists, or trained agricultural scientists. In fact, many of the problems in conserving our wildlife result from accelerated resource use made possible by the technological skills used by other fields of endeavor. For example, our vast system of transportation is the result of research and knowledge applied to building this system, which has also, within a few years, made wildlife habitat easily accessible that was once remote. It is evident that we in the wildlife business can no longer progress in an antiquated "buggy" while the rest of the world makes use of the speedy vehicles resulting from scientific methods.

Only a little over a quarter of a century ago, relatively few men had been trained in the wildlife field. In fact, no such profession was recognized, excepting in a few states in the East, which had already begun to feel the impact of population pressures on wildlife. Most state game and fish departments confined their activities to programs of protection, predator control, game farms and fish hatcheries. In spite of these efforts to protect and restore the diminishing numbers of game and fish, the decline of these resources continued. It became evident that land use changes, clean farming, increased pressures from hunters and fishermen, pollution, drainage and other factors were effecting changes highly detrimental to wildlife, and that the methods used to halt the tide of destruction were ineffectual. Institutions and fish and game agencies, realizing these trends, sponsored efforts to provide a means for training men who could not only evaluate some of the problems which were at hand but who could, also, put into effect management methods which would save and perpetuate these vital wildlife resources. These efforts, as all of you know, resulted in the formation of the wildlife research units, supported by the states and Federal government and the Wildlife Institute at the land grant colleges, where professional training could be given men who wished to make a profession of wildlife management. Shortly thereafter, in 1937, the Pittman-Robertson Act, which provided a 11 percent excise tax on sporting arms and ammunition, made funds available for research and restoration work. These actions accelerated the training and use of qualified men, and gave us a start toward giving the wildlife worker a professional status. Our state programs, with these increased facilities, have made great strides toward better systems of wildlife management, but we still have quite a distance to go to attain a professional status equivalent to engineering or medicine.

As I have stated, this is a technological age, and I believe the technically trained wildlifer is here to stay, and we will make greater use of men in this profession in the future.

In an effort to determine the trends in employment of trained personnel, employed in the states, a questionnaire to evaluate these trends and probable future needs, was submitted to the southeastern states and a few eastern and western states for comparative purposes. The table below shows the number of technically trained men (with undergraduate or graduate degrees in wildlife management or related biological sciences), who were employed in the eleven southeastern states which submitted answers to questionnaires, and in two adjacent states (Missouri and Oklahoma) in 1940, 1950 and 1960, exclusive of those in administration.

NUMBER OF COLLEGE-TRAINED BIOLOGISTS EMPLOYED*

	1940	1950	1960
Game Biologists	48	142	183
Fish Biologists	9	38	123
TOTALS	57	180	306

* Men with undergraduate or graduate degrees.

From these figures it will be noted that the number of trained men employed have steadily increased. The total number of fish and game biologists range from as many as forty-two biologists in one state to as few as nine in another southern state. Two states reported having no biologists in 1940. The average number of biologists employed by each of the thirteen states interviewed was twenty-three, with the greatest increase in fisheries biologists.

By contrast, two states in the North and East, New York and Michigan, which got an early start in using trained personnel, and have had greater impacts on their wildlife resources, have a total of 247 trained men in these two states, and five sparcely populated western states reported the present employment of 170 trained fish and game biologists. Although these western states had a late start, they have, in recognition of the value of wildlife resources to their economy, made great strides in utilizing the services of technically trained personnel.

In reply to the request for information as to number of men assigned to research (investigations) work, 128 men were reported so assigned in the Southeast and two adjacent states. Michigan and New York reported 86 men so assigned, and the western states reporting listed 139 men carrying on investigations. In the Southeast, 118 men are assigned to development work, while Michigan reports 91 men on work of this type, and the five western states report 156. A number of states indicate that men, on specific projects, direct both types of work.

The southeastern states listed 49 trained men in education, administrative and other categories, exclusive of engineering, while five western states listed 53 so assigned.

In reply to the question, "Has your current need for wildlife trained men been filled?" five southeastern states replied, "Yes," and eight replied, "No". The southern states specified immediate need for 23 fish biologists and 27 trained game personnel. Michigan and New York stated a need for 12 fish; and 12 game biologists at this time.

In response to questions concerning needs over the next ten years, *all* except one southeastern state indicated they expected their needs for more trained men would increase. They anticipated needs for at least 64 fish biologists and 75 trained game biologists. New York expected to employ 35 additional trained men, and five western states anticipated needs for at least 34 biologists. Some states indicated that estimated needs were speculative, and their estimates might be incorrect.

When questioned as to present limitations for employing additional personnel, several states listed finances and "attitude" on the part of the public or state governing bodies as limiting factors.

Low salaries were listed as a major factor limiting employment of qualified trained men. They pointed out that wildlife biologists' salaries are considerably lower than those in other trained, professional categories.

All states questioned said that they believed the addition of trained men to their staffs had been a "distinct asset to the achievement of fish and wildlife conservation and management goals." All replied "Yes" to this question. Reasons given for this attitude included the following, "biologists have provided a sound (working) basis for management of wildlife. Their information is reliable, and research provides information applicable to management," and to quote one state they are necessary for the "formulation of new techniques and programs necessary for progress and continued public support." All state the need for trained men in development programs, based on "adequate research."

When question as to their need for men trained in other categories, such as engineering, journalism, chemistry, etc., ten states indicated they had such needs,

and listed categories needed to include "engineers, education specialists, geologists, lawyers, chemists, bacteriologists, pathologists, photographers, TV specialists, artists, soil scientists, statisticians, veterinarians, and agronomists." These special fields cover a wide range of training, and indicate the large scope of work encompassed by the wildlife field.

When questioned as to their opinions in regard to training needed by wildlife men, most said that more training was essential in the following categories: English, report writing, basic subjects such as ecology, botany, ornithology, zoology, forestry, soils, ichthyology, conservation, public speaking, etc. There was a consensus of opinion that workers needed specific training in the wildlife field. One replied that some biologists lacked sufficient "interest." Another suggested stressing "management techniques and law."

One state, where a Research Unit is located, indicated they believed training was "adequate." Two western states stressed the need for training in public relations. Michigan commented that they wished for "more accent on the humanities," and commented that their (Michigan) salaries were comparable with those "in other fields of work," but that salaries in other states were considerably below the average of college trained men in other fields. They replied that they had acute need for men in "pesticides research" to keep up with the effects of these poisons on wildlife.

When questioned as to the adequacy of salaries paid professional wildlife workers, all states replied that current salary scales were not adequate to "induce the most competent men to enter the field, and hold these men." Several states replied that "love of the work" held men who would otherwise go to jobs paying greater financial compensation. Others indicated they "lost good men after they gained experience."

With reference to salary levels, as compared with those in industry and other professions, it is worth noting that Union wage scales for bricklayers and carpenters range from $3.63 to $4.04 per hour, and that starting salaries for chemists with B.S. degrees are $5,220, and for those with M.S. degrees $5,820. Chemical engineers are started at $5,620 to $6,300. By contrast, many trained wildlife men, with years of experience, are paid less than the beginning rates in these and other professional categories.

A request for further statements from the states questioned brought the following comments, among others.

> One state said, "this type of paper is an excellent idea."
>
> Another, "higher salaries and modification of duties will be necessary to attract qualified biologists to enforcement branches."
>
> Another commented, "Biologists and technicians get discouraged with political turnovers. . . . During these upheavals we have lost good men."
>
> Another commented: "Trained men with experience and ability are not being able to advance as fast as in other fields." All states were in agreement on this point.

Finally, I think we can conclude that the wildlife biologist is here to stay, and that his knowledge and abilities are needed to carry on an effective program.

Administrators would like to see biologists better trained in public relations work, since their final objectives should be getting the knowledge they possess back to the public.

We also feel that there is a great need for men who are able to assimilate and condense technical information into a readable and understandable form, since the public must be educated through bulletins and informational material of all types to accept new ideas and concepts.

I think we all agree that salary scales are low, when compared with other professional categories, and that biologists need to be accorded a professional status along with lawyers, chemists and workers in other scientific fields.

It is evident, too, that as our population, land uses, and recreational demands increase, we will need to employ more of these trained men to cope with the increasing demands made on fish and wildlife. We cannot expect to compete, in this modern age, unless we, too, use the methods of science to help perpetuate and preserve these great resources.

In conclusion, may I say to you professional men here that as biologists—you have chosen one of the most wholesome and reputable professions existing today.

Always have confidence and pride in your individual ability and a genuine desire to produce an "end result."

Remember that the public will forgive you if you make mistakes—unless that is all you make. You *must* make better game and better fish, not only quantity-wise but quality-wise as well. Thank you.

THE COOPERATIVE ORGANIZATION IN WILDLIFE STATISTICS

DR. J. A. RIGNEY
N. C. State College

Has anyone in the audience had the frustrating and somewhat frightening experience of being asked by your high school son how to take the first derivative of a quadratic function and then find the maximum point on the curve it represents? Do you realize that within ten years this will be a commonplace experience? Do you further realize that ten years from now unless he can do this kind of math, a high school graduate may not even be able to get into a college to study in your particular area of fish or game management? If this is true, and I believe it is, what will your wildlife research and your literature be like in ten years? Undoubtedly the research will call upon more powerful and efficient techniques than are in use today and the literature will contain many papers written in the shorthand language of mathematics. This is quite a contrast to the situation that existed when most of us went to college. We probably got very little training in mathematics, and we have had little need to use our math in such things as statistics. Does this mean then that in ten short years most of us will be regarded as useless antiquated hangers-on in science? My guess is that it could, but it probably won't!

The complexity and rapid pace of today's society requires quick adaptation to avoid obsolescence, and this is particularly true for those of us who work in scientific disciplines. In your work in the Southeast you have hit upon a novel and apparently effective method of coping with this situation. You have developed a cooperative research and consulting service which will keep you abreast of new developments. It is my pleasure to describe this service this morning and to report to you on its performance to date.

Almost your entire efforts of research, of management or of control, hinge upon the estimation of certain properties of populations. These may be populations of fish, game, insects, hunters, or licenses. The business of interpreting the value and meaning of these population estimates lies in the domain of the biologist. However, the business of developing the *methods* for obtaining these estimates efficiently, without bias, with desired precision, but within a specified time and at a cost that can be tolerated, is the domain of the statistician. For many years a few highly competent and mathematically trained biologists have worked on statistical procedures for wildlife problems. Often, their contributions were not fully understood or were ignored by the general biologist. In recent years, however, it has been generally realized that a large portion of the fish or game research and management dollar is invested annually in *collecting* estimates. Therefore, it has been inevitable that more and more attention be given to the statistical procedures undergirding wildlife activities in an effort to get more information from every dollar spent.

Two important facts need to be called to your attention in this connection. First, modern statistics is based on pretty sophisticated mathematics, and research in statistical procedures themselves requires a strong background in math. It does not necessarily follow however that one must be an expert mathematician in order to use the techniques effectively. Secondly, most of the statistical techniques developed for other scientific fields cannot be adopted directly in fish and game problems without alteration. This means on the one hand that some mathematically capable people are now needed in this area to develop more basic tools. On the other hand it means that wildlife biologists who have little math training must be able to communicate effectively with those highly trained statisticians to set up problems and to give adequate biological interpretations to the statistical results.