Indications are that our present stocking practices are often inefficient and may, in some cases, actually make our fishing worse! Genetic research has the potential to change this and help ensure our fishing future.

GENETIC CONSERVATION: *For The Future of Fishing*

by Doug Stange

Will genetic research change our fishing future? The answer to that question is a definite and resounding, "yes!" This article, the first of a two-part series dealing with the topic of genetics and its effect on fishing, focuses on our first goal—genetic conservation. A second article will deal with more speculative, futuristic topics ranging from the effect of hybrids on our fishing, to increased production of state and world record fish, to cloning fish. It's ground-breaking material no serious angler should miss!

In my opinion, the ongoing research conducted by Dr. David Philipp and his associates at the Aquatic Biology section of the Illinois Natural History Survey may revolutionize fishing. That's a strong statement! Yet I assure you I make it only after duly measuring the potential impact of their research against everything else happening within the fishing-related scientific world. Again, it is my absolute conclusion that no other research has the potential to so transform our sport!

When it comes to transforming fishing, we all have our dreams! We worry about fishing pressure and understand that stocked fish are important to sustaining fishing in many environments. But stocked fish don't always do well, and thus contribute only slightly

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to final fish production. Wouldn't it be nice if stocking were so efficient and effective that it would definitely improve our fishing every time it took place? Perhaps you've dreamed of a time when stocking could be vastly expanded? Even without budget expansion, more efficient stocking would allow state and national money to go farther.

And wouldn't it be nice if stocked fish could be specifically tailored to and fit each environment? You know, specific stocks of fish, some tailored for farm ponds, some for shallow natural lakes, some for small streams, or large streams, or deep lakes, and even fish perfectly fit for warm water discharge areas?

Are you a north country angler who'd like to see fish of southern proportions available up north? How about cloned fish? Will it someday be possible to catch a brace of perfectly proportioned and identical bass? Or how about perfectly tailored hybrids, exhibiting hybrid vigor and growing to state or even world record proportions? Even though these dreams (and there are many more) are still slightly futuristic, the seeds have been sown and they can possibly be accomplished!

In case you haven't guessed, Dr. Philipp and his close associates, Dr. Bill Childers and Dr. Greg Whitt, research assistant Chris Kaminski and technical assistant Shirley Lowe, and graduate research students Manijeh Pasdar, Henry Parker and Jeff Koppleman, are conducting extensive, fishing-related genetics research. Recent findings have the potential to influence the management of our fisheries immediately, and this research will likely have a vast impact on the future of fishing as well.

It's our intention to run this story in two parts, first focusing on recently concluded research needing immediate attention by us, and especially state and national fisheries management personnel. While this article will deal with present findings on what's termed "genetic conservation," the article slated for October/November will focus on those more speculative, futuristic items that genetic research may or may not influence.

If you think this sounds like an exciting topic, you're absolutely right! Yet you'll have to read very closely as this story unfolds; nearly everything is complicated enough to require explanation. We often grasp for easy answers, yet in an increasing complex fishing world, there are few. What I fear most is the making of assumptions after reading only small parts of this material. For instance, if you live in Michigan, or any other northern state, and stop reading after the third paragraph, you may assume genetic research will someday give you the chance to catch bass equal in size to those growing in the south. Fact is, present research indicates north country anglers will never be able to do this in their natural lakes. Yet if hot water discharge areas exist in the state, there's a chance—if certain conditions are met.

That's the way it is with almost everything we'll deal with. Please read closely and be willing to accept the easy-to-understand with the hard, the conditional with the unconditional. You must do so if you expect to benefit from this exclusive material.

GENETIC CONSERVATION

The genetic research story, as it applies to angling, is terribly interesting and important, and qualifies as one of the few really new stories in the angling world. Yet recent genetic findings have been slow to have an appropriate impact! In part, that's the reason for this article.

While there are many forms of conservation, and we speak of them often, the term "genetic conservation" is completely new. Genetic conservation refers to *the need for state and national management policies to uphold the genetic integrity of natural fish populations.* Doesn't sound like much, does it? But the implications are staggering! *Our present lack of genetic conservation may rank along with fishing pressure as a reason for poor fishing on some waters.*

Genetic conservation, as spoken of here, is not a part of any state management policy now; although Illinois, where Dr. Philipp's research is centered, already realizes its importance and will be implementing appropriate procedures to see it become a reality. With this article, we hope to lead the way in suggesting each state and national agency follow suit as soon as possible!

Genetic conservation should be an underlying principle in every fish management program. Why? Because the lack of it has affected our fishing, often adversely, and will continue to do so unless something is done. Is it not a common practice for states to buy fish from, or to trade fish with, other states? Seems like a great idea, yet this may actually make our fishing worse. Do not some hatcheries continue to keep hatchery stock for years, often using successive generations as stock? Such line breeding (in-breeding) may produce wonderfully successful hatchery fish, but fish unable to cope in the wild. Do not some states have only a few hatcheries, or hatcheries located in only one geographic region? There is definite evidence that largemouth bass (and we surmise the same to be true for other species) from one state area may not be appropriate for other state areas. This type of stocking can, again, directly and adversely affect your fishing!

Going on, are not some southern fish farmers advertising "Florida" largemouths for sale in any part of the country, and do they not make outrageously attractive claims for the fish? Not only may the claims be false and the stock sold not the true Florida subspecies, but the fish may genetically contaminate existing stock. Unsuspecting buyers, wanting only to improve their fishing, may actually do the opposite. Not only that, but if the fish find their way into other waters, it could have an adverse effect on the fishing of a large segment of the state's anglers. Are not exotic fish such as the grass carp immediately suspect, and is not great care taken to verify that they can safely and beneficially be stocked? Yet indications are that stocks of so-called "natural gamefish," the largemouth bass for instance, may actually be considered "exotic" when injected into certain environments!

That should be enough to give you an idea what's going on. If the scenario sounds dire, it is! Yet we've been unknowingly practicing it during most of our modern fishing history. The practice of genetic conservation—managing fish stocks to uphold the genetic integrity of natural populations—isn't difficult if state and federal management programs will take appropriate steps, and we, the general angling public, will support them, or perhaps, even spur them on.

GENES AND HEREDITY

In order to understand the rest of this topic, it's necessary to cover some basic facts about the hereditary process. In 1866, Gregor Mendel, a monk who taught physics, presented a paper describing his experiments in breeding varieties of garden peas. His experiments demonstrated that definite hereditary units passed down specific characteristics in an undiluted form from generation to generation. Mendel called them units, but today they are known as genes. Genes are found inside cells, the building blocks which make up virtually all of life. To be more specific, genes are found in the cell nucleus. Inside the genes is a code of information unique to each organism.

Cells renew themselves constantly, and the genetic code within instructs them how to do so identically, time after time. We die with the same set of fingerprints we are born with, genes having maintained the individual pattern of skin cells throughout our life.

The genes that determine the characteristics and workings of each cell are made of long strands of chemical DNA, coiled in a spiral staircase called a double helix. During reproduction, a randomly picked genetic message from one living thing is mixed with the genetic message of another (usually of the same species or subspecies). Thus, a random half of each parent's genetic make-up is inherited by offspring. Gene patterns are passed down unchanged from maternal parent to offspring, which is why offspring have many characteristics of their parents.

ELECTROPHORESIS

This is where the process called "electrophoresis" enters our story. Absolutely do not let the word intimidate you; before long it will be a regular part of your fishing vocabulary.

Developed in 1937, electrophoresis is a method of separating the proteins in the cells, based on their size and net electrical charge. Although electrophoresis obviously is not new, a real breakthrough came with the

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ability to distinguish isozymes (multiple forms of a single enzyme) by combining electrophoresis with a histochemical staining process. This refinement in the electrophoretic process was developed in the late 1950's and early 1960's, and was applied to fish shortly thereafter. Not until recently, however, has this process, which allows highly trained scientists to distinguish between the genetic make-ups of fish, been applied to fish management.

Although the preceding paragraphs are necessary, you need not feel perfectly comfortable with them in order to understand why electrophoretic findings are important. In very simplest terms, remember this: Elec-

PHOTO 1

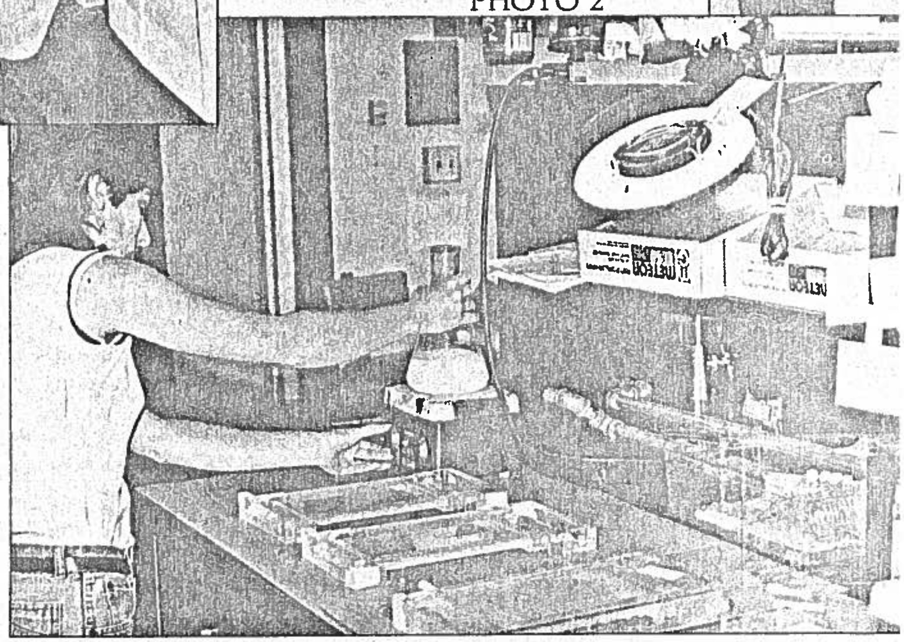
Electrophoresis

Electrophoresis isn't so simple that you can conduct it on your kitchen table, but it's certainly not so difficult you can't understand the procedures used to analyze genetic composition. In photo 1, a small bit of liver or flesh from a particular specimen is being ground. Soon it will be placed in serum and, later, will be centrifuged. As this is being done, a starch gel is heated (photo 2), and then poured into molds (photo 3).

In photo 4, each individual specimen is being placed in a specific compartment above the starch gel. The mold is then placed in a refrigerator at 39°F, and is hooked up to electric current. The electric current causes the different proteins to separate and migrate in the starch gel, and eventually allows genetic analysis.

In photo 5, the gels have been removed from the refrigerator and will eventually be chemically stained so the results can be read. Photo 6 shows the final result for one particular genetic protein; testing for over 28 different gene products is possible. Obviously, the real skill comes in being able to interpret the end results.

PHOTO 2



trophoresis allows scientists to tell the difference between fish stocks; there is excellent evidence these differences affect stocking success, which in turn affects our fishing.

Stocks, for your information, are distinct breeding units (there are several whitefish stocks in Lake Michigan, for example) within an individual population. An individual population is made up of one species. Walleyes, largemouth bass and bluegills are examples of distinct species as well as individual populations. Thus, we speak of walleyes as a species, and we also refer to the walleyes in a lake as a walleye population.

The designation "subspecies" is used to distinguish between very closely related, yet different, stocks of the same fish species. These stocks often hybridize with one another. Thus, the largemouth bass *Micropterus salmoides* is a species consisting of two different subspecies, *Micropterus salmoides salmoides*, the northern largemouth, and *Micropterus salmoides floridanus*, the Florida largemouth. The two subspecies can also comprise distinct breeding units which, along with their two reciprocal hybrids (the Florida female X northern male, and the northern female X Florida male) comprise the four largemouth bass stocks we're directly concerned with in this article.

PHOTO 3

PHOTO 4

PHOTO 5

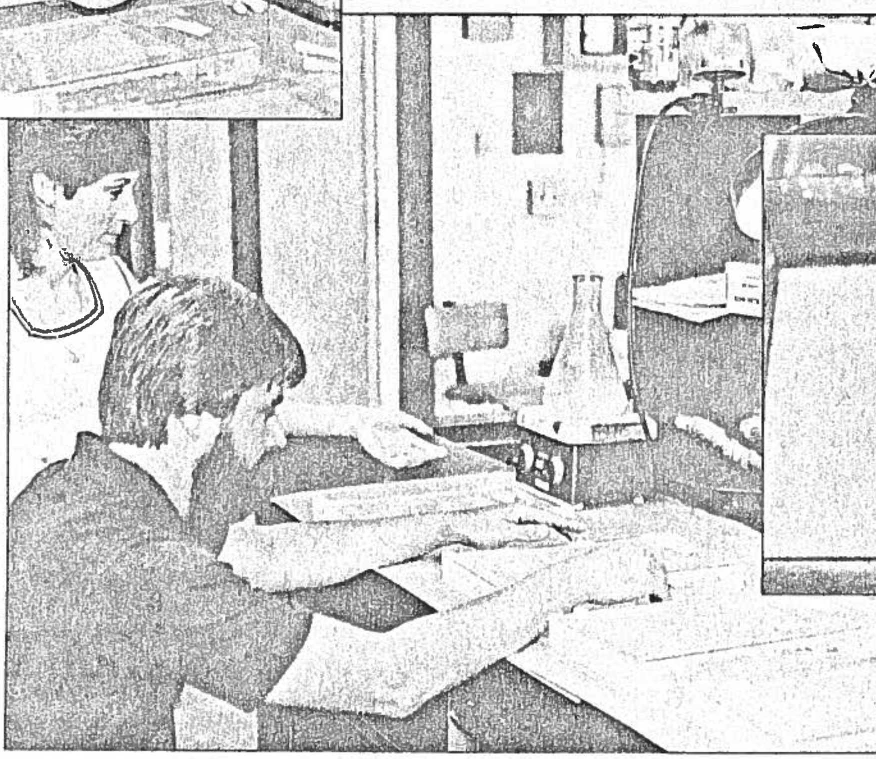
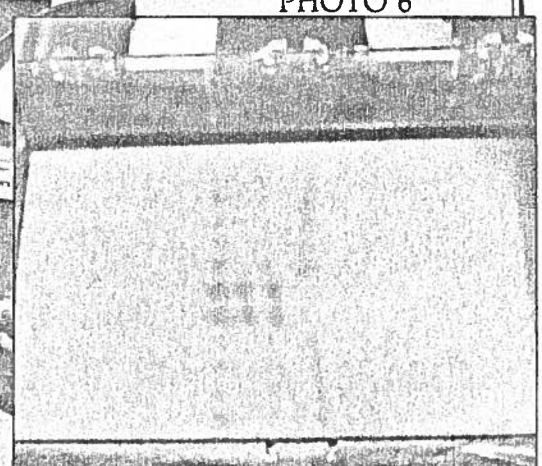


PHOTO 6



ANGLING IN THE 80'S

A SURVEY OF BASS STOCKS IN THE UNITED STATES

Although this story widely applies to other species and brings up myriad other topics, let us confine our discussion to the largemouth bass. The largemouth is probably America's favorite sport fish. It's widespread distribution (naturally, and through stocking) and attractive sporting characteristics make it so. Bass tourneys abound, and in some parts of the country, the ability to catch exceptionally large bass brings recognition a politician would envy. So it's not hard to understand that fisheries managers, owners of private lakes and ponds, and much of the general fishing public desires bigger and better largemouth bass. To achieve this, widespread stocking takes place. In particular, because the Florida subspecies has been thought to grow exceedingly large in comparison to its northern counterpart, widespread stocking of the Florida fish has been called for.

Curious about the genetic difference between largemouths in different regions of the United States, Dr. Philipp and his associates undertook a rather large project: They gathered largemouths from 90 populations across the country, and evaluated their genetic makeup using electrophoresis. The results were conclusive: Largemouth bass populations from different regions of the country, and often from different regions of a state, are genetically different. The most pronounced differences are between the northern and Florida bass, the two largemouth subspecies. But they also verified differences in pure northern stocks within a reasonably limited geographical territory. Northern largemouths from the upper peninsula of Michigan, for example, look genetically different than those in the southern peninsula.

Let's go further, however. It was evident the two distinct subspecies had hybridized over a larger-than-expected part of their range. Earlier scientists reported that an "intergrade zone" —the area where the two subspecies overlap—was restricted to northern Florida and parts of Georgia and South Carolina. The pure Florida largemouth is restricted to an area in Florida south and east of the Suwannee River, while the northern largemouth was thought to have a projected range extending from its northern limits down to the intergrade zone (northern Georgia, northern South Carolina, and northern Florida). Thus, the area where hybridization could take place naturally was considered small. Yet Dr. Philipp and his associates found Florida genes in populations from Maryland and Virginia south into South and North Carolina, Georgia, northern Florida, Alabama and Mississippi. Intergrade populations were

The Genetic Variability in 90 Largemouth Bass Populations

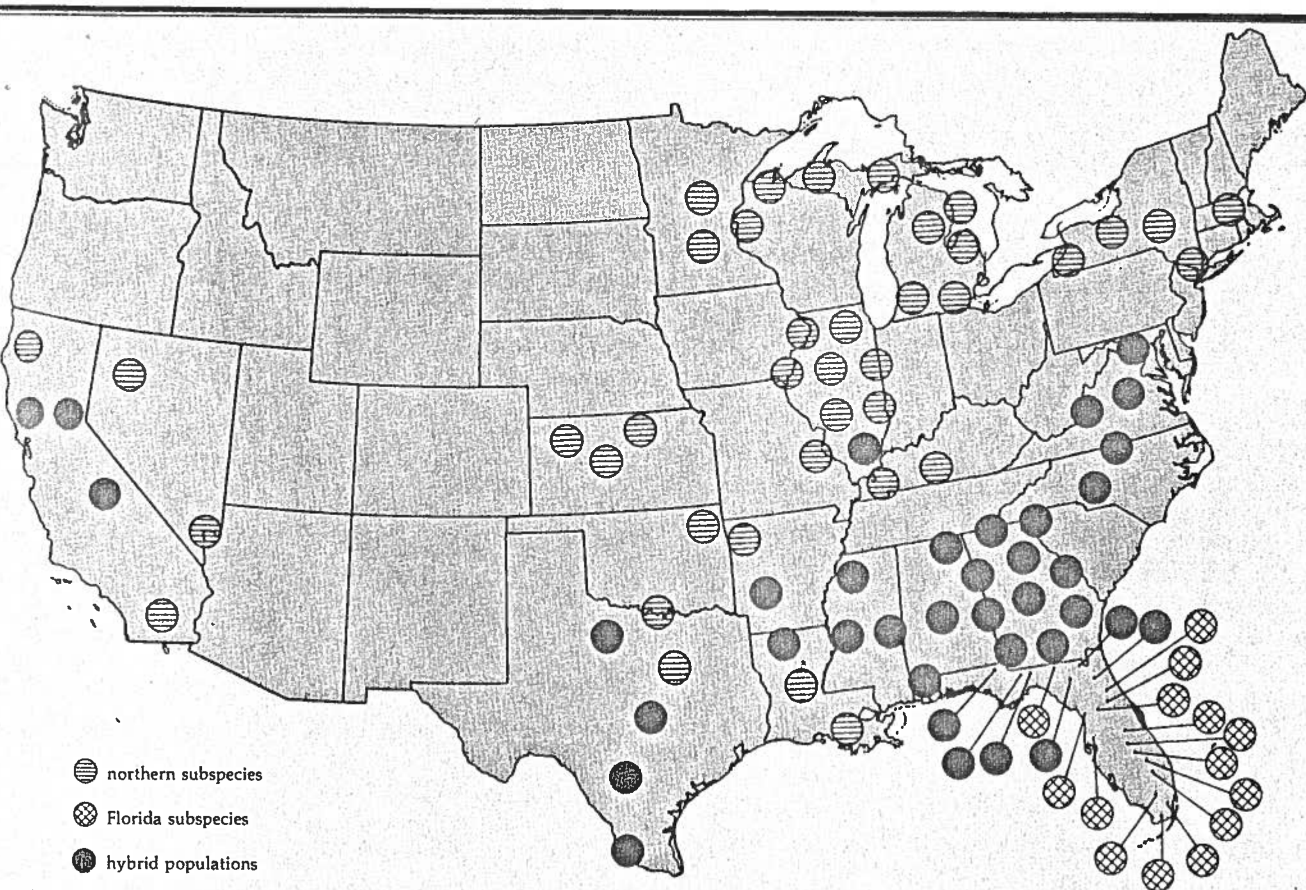
Listed here are the locations of 90 largemouth bass populations that Dr. Philipp and his associates evaluated with electrophoresis. The horizontally-lined circles indicate northern largemouth populations, while the cross-hatched circles indicate pure Florida populations. The black circles, on the other hand, indicate populations in intergrade—hybrid populations made up of varying percentages of the northern and Florida subspecies. The circles are placed in the approximate location of the population tested.

Although many states other than Florida feel they have established pure Florida largemouth populations Dr. Philipp's analysis places many of these suppositions in doubt. Such finding also have a direct effect on those states considering listing their state record largemouths in two categories—one for the northern largemouth and another for the Florida largemouth. We'll cover that discussion in the October/November issue.

The intergrade zone was once considered to exist in only northern Florida and parts of Georgia and South Carolina. Through genetic analysis, however, hybrid populations have been verified in many states. The California, Texas and Illinois populations were undoubtedly caused by stocking. The same is probably true for other states, although these stockings may have been inadvertent. It's obvious, then: In many cases, management programs on both the state and federal level don't realize what stock is being introduced.

The Genetic Variability in 90 Largemouth Bass Populations.

Population	State	Estimated Percentage of Northern & Florida Genes Present in Populations Studied: Northern Largemouth	Florida Largemouth
1. Lake Jackson	Florida	6.25	93.75
2. Lake Kissimmee	Florida	0	100
3. Lake Sangchris	Illinois	100	0
4. Conservation Area 3	Florida	0	100
5. Lake Okatibbee	Mississippi	95	5
6. Ross Barnett Reservoir	Mississippi	98.75	1.25
7. Lake Taiquin	Florida	25	75
8. Orange Lake	Florida	2.5	97.5
9. Lake George	Florida	0	100
10. Lake Seminole	Florida	48.75	51.25
11. Hillsboro River	Florida	0	100
12. Falcon Lake	Texas	78.75	21.25
13. Nolin River Reservoir	Tennessee	95	5
14. Sardis Reservoir	Mississippi	85	15
15. Fish Lake	Michigan	100	0
16. Sun Lake	Michigan	100	0
17. Lake Panasoffkee	Florida	0	100
18. Lake Okeechobee-North	Florida	0	100
19. Mill Lake	Michigan	100	0
20. Wampler's Lake	Michigan	100	0
21. Lake Tsala Apopka	Florida	0	100
22. Lake Istokpoga	Florida	0	100
23. Lake Norman	N. Carolina	67.5	32.5
24. Ocean Pond	Florida	28.75	71.25



25. Lake Shelbyville	Illinois	100	0
26. Suwannee River	Florida	3.75	96.25
27. Nine Mile Pond	Florida	0	100
28. Lake Okeechobee-South	Florida	0	100
29. Tamiami Canal	Florida	0	100
30. Sinclair Lake	Georgia	36.25	63.75
31. Keowee Reservoir	S. Carolina	21.25	78.75
32. Lake Medina	Texas	65	35
33. Okefenokee Swamp	Georgia	28.75	71.25
34. Lake Eufaula	Alabama	43.75	56.25
35. Guntersville Reservoir	Alabama	92.5	7.5
36. Lake Allatoona	Georgia	70	30
37. Blue Ridge Lake	Georgia	71.25	28.75
38. Big Creek Reservoir	Alabama	93.75	6.25
39. Waneta-Lamoka Reservoir	New York	100	0
40. Elbow Lake	Michigan	100	0
41. Lake Oklawaha	Florida	0	100
42. Lake Mitchell	Alabama	87.5	12.5
43. Chautauqua Lake	New York	100	0
44. Amawalk Reservoir	New York	100	0
45. Cherry Lake	Florida	0	100
46. Lake Barkley	Kentucky	100	0
47. Buchanan Reservoir	Texas	98.75	1.25
48. East Lake Tohopekaliga	Florida	0	100
49. Lake D'Arbonne	Louisiana	98.75	1.25
50. DeGray Reservoir	Arkansas	98.75	1.25
51. Clinton Lake-North Fork	Illinois	100	0
52. Howard Lake	Minnesota	100	0
53. Chicot Lake	Louisiana	100	0
54. J. H. Kerr Reservoir	Virginia	81.25	18.75
55. Anadonta Lake	Minnesota	100	0
56. Clark Hill Reservoir	Georgia	20	80
57. Prince Lake	Virginia	26.25	73.75
58. Bone Lake	Wisconsin	100	0
59. Lake Canadarago	New York	100	0
60. Grand Lake	Louisiana	100	0
61. Clinton Lake-East Arm	Illinois	100	0
62. Lake Anna	Virginia	53.75	46.25
63. Beaver Lake	Arkansas	100	0
64. Lake Mead	Nevada	100	0
65. Lake Baldwin-Cold Area	Illinois	100	0
66. Lake Blackshear	Georgia	43.75	56.25
67. Chauncey Pond	Massachusetts	100	0
68. Grand Lake	Oklahoma	100	0
69. West Point Reservoir	Alabama	51.25	48.75
70. Deep Creek Reservoir	Maryland	43.75	56.25
71. Lovewell Reservoir	Kansas	100	0
72. Whitney Lake	Texas	100	0
73. Lake Shasta	California	100	0
74. Coffeen Lake	Illinois	100	0
75. Clear Lake-1	California	93.75	6.25
76. Milford Lake	Kansas	100	0
77. Lake Isabella	California	48.75	51.25
78. Clear Lake-2	California	55	45
79. Lake Texoma	Oklahoma	100	0
80. Par Pond	S. Carolina	1.25	98.75
81. Horseshoe Lake	Minnesota	100	0
82. Kemp Lake	Texas	46.25	53.75
83. Peach Lake	Michigan	100	0
84. Rifle Lake	Michigan	100	0
85. Ruby Marsh	Nevada	100	0
86. Lake Kanopolis	Kansas	100	0
87. Lake Baldwin-Hot Area	Illinois	100	0
88. Lake of Egypt	Illinois	97.5	2.5
89. Crab Orchard Lake	Illinois	100	0
90. Coachella Canal	California	100	0
Mean for Intergrades		57.99	42.01
Mean for Northern Subspecies		100	0
Mean for Florida Subspecies		0	100

The point of this article is that such introductions can adversely affect fishing. Genetic conservation refers to the need for state and federal management organizations to realize the importance of protecting the genetic integrity of their fish populations. It is, in other words, imperative that management programs know about the genetic make-up of fish being introduced.□

also identified in California and Texas, and probably exist in any other state where the Florida largemouth has been stocked!

These findings immediately placed all preceding research on different bass stocks in doubt. Before electrophoresis, the methods used to identify the Florida from the northern largemouth was through comparative meristic and morphometric measurement—most often just lateral line scale counts, and occasionally by the number of pyloric caeca. But Dr. Philipp found that hybrid fish could display the external features of a northern largemouth, yet could have a genetic make-up almost entirely Florida. It is timely and important to remind you that genetic make-up determines how a fish responds to its environment, not its external features. You can't tell a book by its cover, in other words, and anyone who says they can tell a Florida from a northern largemouth, or can tell if a fish is a hybrid, by looking, is overstepping their capabilities.

These findings placed every old study comparing the two subspecies in doubt. Stock identified as pure Floridas in earlier tests may have been hybrids; the same could have been true for fish identified as northern bass. Remember, a fish identified as a northern bass from its appearance could have much of the genetic make-up of a Florida. The bass used in the old tests were not genetically confirmed. Thus, the compared stocks may have been misidentified, and therefore, results on comparative growth, thermal tolerance, catchability, and longevity could be invalid. As a result, many of the myths surrounding the two subspecies—Florida largemouths grow larger and faster, live longer, and are more difficult to catch in all environments, to mention a few—are probably just that, myths.

STOCKING PROBLEMS

On a more ominous scale, however, these findings meant that state and national stocking programs have not known, and do not now know, exactly what type of genetic stock they are introducing. This is probably evident from the fact that Florida genes were found in such states as Maryland and Virginia. This most probably indicates that the genes were introduced there through promiscuous stocking programs.

So what, you might ask? So what if Florida, northern, or hybrid bass (and thus their genes) are spread around indescriminately? Electrophoretic analysis shows the genetic difference between bass stocks, but follow-up research by Dr. Philipp and his associates also indicates a distinct difference in their physiological (bodily process) make-up.

One of the most important physiological difference between the two basic subspecies relates to water ten perature (thermal tolerance to be more specific). In si plest terms, the Florida largemouth does poorly wher subjected to extended periods of cold. During recent linois winters, over 80% of the pure Florida largemouths in Illinois Natural History Survey ponds died at the same time, northern bass stock experienced minor mortality in the 5% range, and hybrids of the two fish experienced winter death rates ranging from 10-15%.

This, That, or a This-That?

Certainly the fish that Dr. David Philipp is holding is a largemouth bass; but is it a Florida largemouth, a northern largemouth or a hybrid? The point is, you can't tell by look ing. Until recently, it's been considered possible to identify two basic largemouth bass subspecies by physical features such as the number of lateral line scales, or the number of pyloric caeca. Yet when Dr. Philipp used starch gel electrophoresis to analyze the genetic make-up of fish from groups which had been identified as either Florida or northe bass, he found that many fish were misidentified.

Fish may exhibit the external features of a northern largemouth bass, yet may have a genetic make-up almost entirel Florida. It's important to understand that a fish's genetic make-up determines how it will respond to its environment, not its external features. All the old comparative growth, thermal tolerance, catchability, and longevity tests between the two basic largemouth subspecies were based on groups fish identified by physical characteristics, and were not genetically confirmed. Thus, many of the myths surroundin the two species are just that—myths. Dr. Philipp and his associates are conducting numerous experiments which shou help to clearly define differences between the two subspecie

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Preliminary growth tests (in an Illinois environment) also indicate Florida largemouths do not grow nearly as well as northern largemouths when subjected to a wide (minimum-to-maximum) variety of temperatures. The northern largemouth, on the other hand, doesn't do well when the water temperature is very, very warm for an extended period, as is the case across much of the south.

In most cases, the reciprocal hybrids (Florida female X northern male, and the northern female X Florida male) of the two species respond to temperature variation in an intermediate fashion compared to the two subspecies. It should also be duly noted that there are two different hybrids and that they are distinctly different fish.

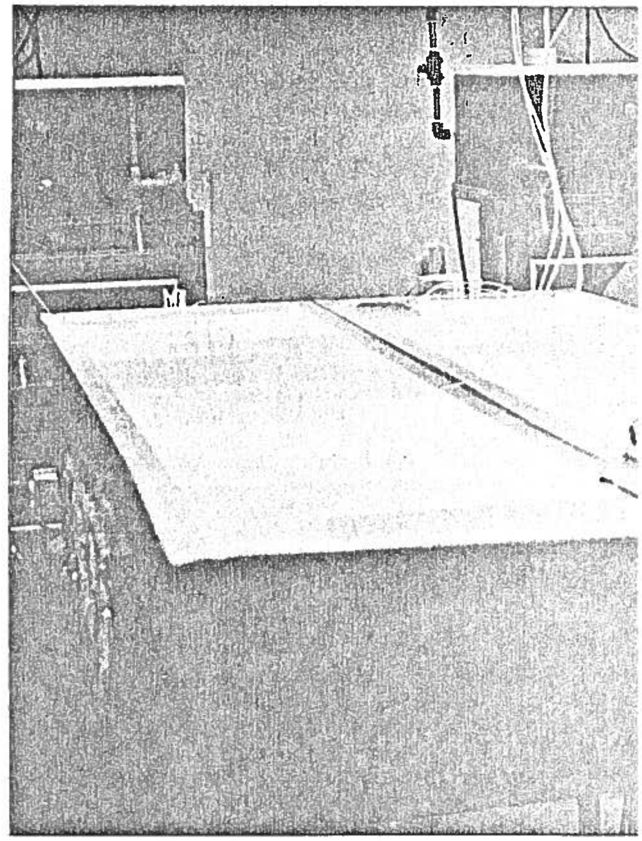
First generation hybrids from pure northern and pure Florida fish inherit half their genes from each parent. But once these fish mature and enter the breeding population, the genetic make-up of their offspring will depend on which fish they spawn with and which fry survive. Offspring could range from 99% Florida and 1% northern, to the extreme opposite.

That largemouths exhibit thermal tendencies based on their genetic make-up should be no surprise. Through natural selection (nature's way of allowing the strong to survive, so a species survives), specific populations genetically adapt to the specific thermal environments they inhabit. In other words, the entire northern subspecies is basically genetically tailored to live in a cooler environment, where minimum-to-maximum temperatures often vary widely. But also remember this: There may even be genetic thermal differences between northern largemouths living in the northern part of a state versus the southern.

By now, you should begin to see one set of problems associated with not using electrophoresis to identify the genetic make-up of bass stocks. Because Florida largemouths have different thermal requirements than northern largemouths, and these two fish have different (generally) thermal requirements than their two reciprocal hybrids, the four stocks must be released into appropriate areas if they are to do well. More than that, it is of the utmost importance that certain bass stocks *not* be released into existing populations because it may actually *lower* the fitness of the population to survive.

SCENARIO 1

Try this scenario! Yielding to pressure from enthusiastic bassers wanting bigger bass, a northern state purchases and stocks Florida largemouths into a few of its waters. First, of course, unless the fish were evaluated electrophoretically, there is no way of knowing

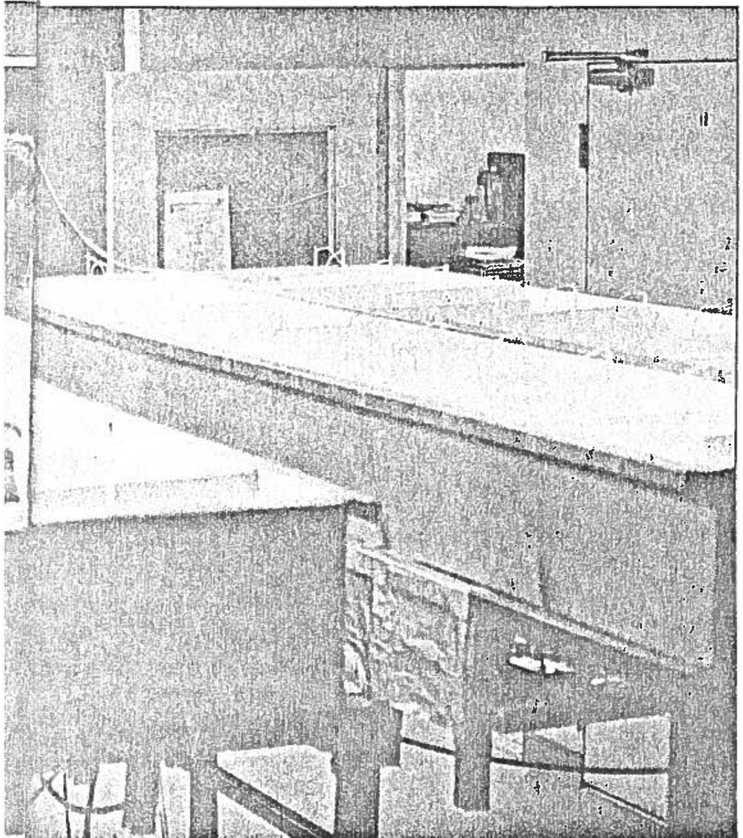


whether the state is actually getting what it's paying for—pure Florida bass. But let's assume the stock is t pure Florida subspecies and they are introduced in ti for spawning. In an environment with both pure Florida and pure northern stocks, some of the Florid will spawn with northerns, and some pure northerns will spawn with other pure northerns. Thereby, the c spring produced can be pure Florida, pure northern c 50-50 hybrids of the two.

During the first winter, the majority of the pure Florida stock will probably expire (inefficient stockin and wasted money), the pure northern stock will survive as it normally would, and the hybrid fish will have only slightly higher mortalities than their north parents. Come next spring there will be few pure Flo ida bass, so the possibility for pure Florida productio is almost nil. Yet when the hybrids mature, they will spawn with both hybrids and pure northerns, and, after a few generations, Florida genes will be spread throughout most of the remaining population.

And that's the problem! In a northern environmen the Florida genes are actually maladaptive. Not only these genes adversely affect the remaining fish's abilit to survive, but the Florida genes will actually hinder growth.

Once maladaptive genes are introduced, they may *never* be removed. In this scenario, enthusiastic angle and accommodating fisheries managers mean the best for fishing, but may actually *ruin* a population becau they have ignored the difference in the genetic make- of stocked fish. We worry about problems caused by fishing pressure, yet in this scenario the reason for pc fishing *would rest with a lack of genetic conservatio*



Graduate researcher Jeff Koppleman is conducting one of many experiments supervised by Dr. Philipp at the Aquatic Biology Section of the Illinois Natural History Survey. Jeff's experiment is designed to test the thermal (temperature) preference of the two basic largemouth bass subspecies and their reciprocal hybrids.

As you can see, stainless steel troughs and a series of electric lights are designed to establish a step-by-step difference in temperature within the troughs. Fingerlings of the four bass stocks are then placed in the troughs and allowed to choose a preferred temperature. Obviously, a scientific explanation is much more complex; but this should give you an idea of what's happening.

Although final preferred temperatures for each stock appear to be very close, 27-28°C (approximately 81-82°F), the stocks behave differently at temperatures above and below the final preferred temperature. These differences are important in assessing the suitability of a stock in a particular thermal environment.

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SCENARIO 2

Or try this scenario. Assume the same basic details: Florida bass stocked in a northern environment in time for spawning. Although actual tests are in preliminary stages, it may be that the Floridas in a population will spawn first. Depending on the circumstances, this could result in an advantage; it might then be that Floridas comprise the majority of the first year class. But remember, Floridas don't appear to winter well. Initial year class abundance could drop drastically by the following spring. Yet the pure Floridas which have hybridized with the northerns will have again introduced unfit genes into most of the population. Anglers perplexed at the lack of fish in later years may blame fishing pressure or pollution. But again, the problem may rest with the introduction of maladaptive genes. Again, the problem is a lack of genetic conservation.

SCENARIO 3

Let's try this one more time. This time assume a new lake has been built and is ready to be stocked with largemouth bass. In these financially troubled times it's not hard to imagine a funding battle within a conservation department. What's to be funded? There's a need for a kids' fishing program, and many lakes could stand supplemental walleye stocking. Or would the money be better spent to hire a new game warden to help shore-up a burdened staff.

Finally, the decision is made. Twenty-thousand dollars will be spent to stock the new lake with largemouth bass. Because the state does not have its own largemouth rearing facilities, it must purchase the bass from an out-state source. The largemouth bass are purchased without the benefit of electrophoretic anal-

Bass Myths

Because past tests comparing the two subspecies of largemouth bass probably used fish from misidentified genetic stock, the conclusions of those tests are in doubt. Old myths have received a lot of press, though, and many, perhaps most anglers, cling to them. One of the most widespread beliefs—that Florida largemouth always outgrow their northern counterparts—is just not true. Florida bass are adapted to a specific thermal (temperature) environment; if they don't have it, they don't do well. Northern bass are better adapted and will grow faster and larger than the Florida over most of the northern United States. That's not to say, however, that the Florida bass can't do well outside of Florida. California, Texas and other southern states all have waters that fill the requirements necessary to grow Floridas.

Yet that brings us another myth—that only Floridas have the potential to grow to world record size. Actually, evidence suggests that most exceedingly large bass are hybrid crosses between the two subspecies! It's a topic we'll cover in detail next time. Here, however, is a basic comparison between the Florida and northern largemouth based on new data. Yes, updates may occur as more is learned.

SUB-SPECIES	ENVIRON-MENT	BASIC RESPONSE
FLORIDA	In northern environment	Mortality—winter mortality will be high Growth—slow compared to northern bass Ultimate size—smaller than northern bass Catchability—similar to northern bass Spawning—probably earlier than northern bass
FLORIDA	In proper southern environment	Mortality—will fall within expected normal range based on a variety of factors Growth—longer growing season allows the possibility for excellent growth Ultimate size—larger than northern bass Catchability—similar to northern bass Spawning—earlier than northern bass
NORTHERN	In southern environment	Mortality—higher than Florida Growth—slower than Florida bass Ultimate size—smaller than Florida bass Catchability—similar to Florida Spawning—later than Florida
NORTHERN	In proper northern environment	Mortality—normal for species Growth—superior to Florida Ultimate size—larger than Florida Catchability—Similar to Florida Spawning—later than Florida

Keep in mind that this is for comparison only, and takes for granted that many variables, such as the abundance of forage, remain equal. Obviously, this is also considering that there is a clear-cut distinction between the "northern" and "southern" environment. That's not always so! Indications are that hybrid crosses between the two subspecies may do well in these "intergrade" environments.

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ysis to identify their genetic make-up. Although the bass are assumed to be northern largemouths, they are in reality a stock heavily laced with a Florida genetic make-up.

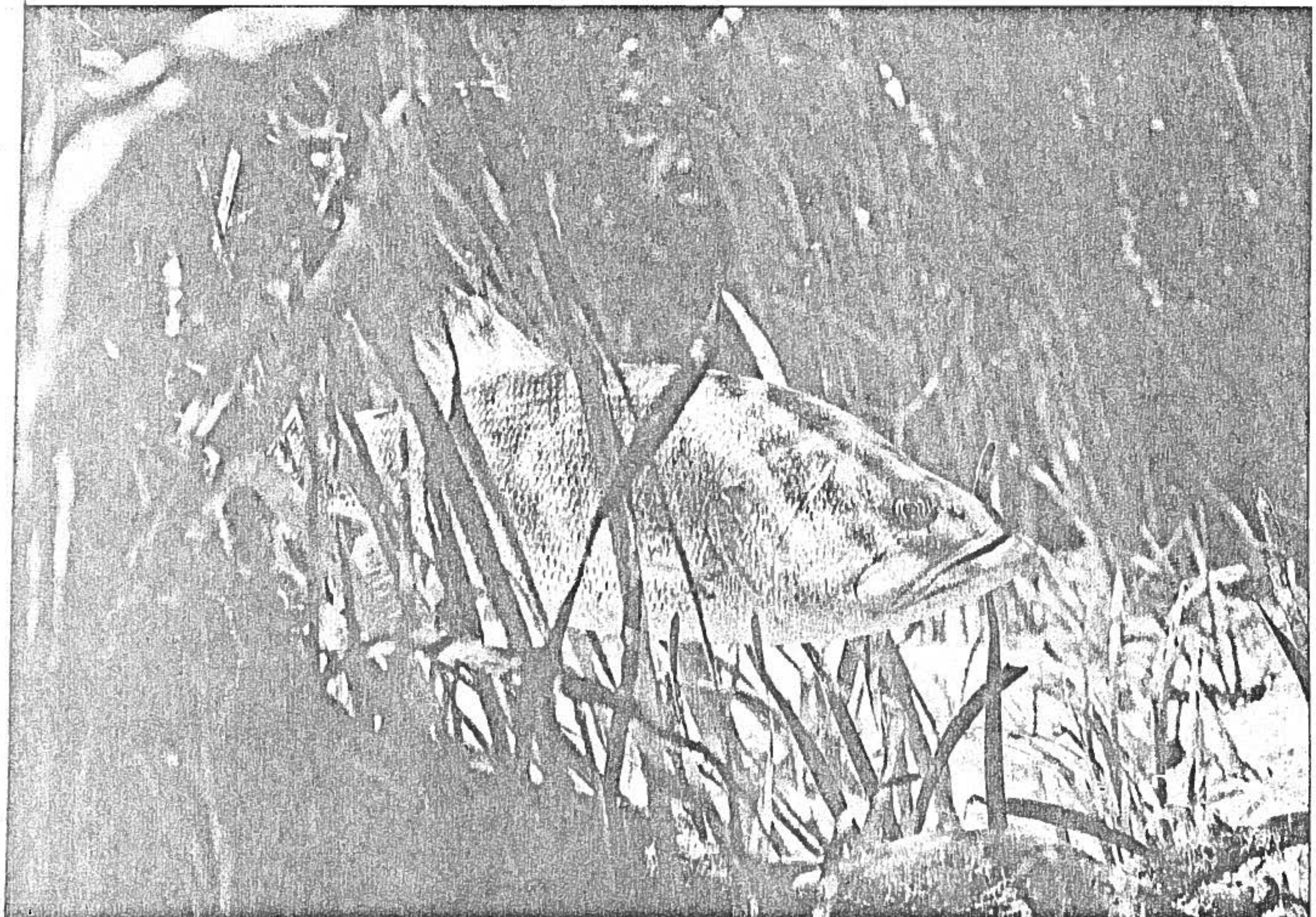
Tests show that Floridas come in to spawn earlier, and their fry can develop at lower temperatures than northern largemouths. That may puzzle you, until you realize that Floridas usually don't have to deal with the severe cold fronts that occur in the north. Apparently, northern bass have a defense mechanism which keeps them from spawning during very early season warming trends! But not the Floridas! And in our newly stocked north country lake, let us assume that such a sustained, early season warming trend triggers the fish with a high Florida genetic make-up to spawn very early. The inevitable is bound to happen: A severe cold front arrives, causing a rapid drop in water temperature, and the entire year class is ruined. Because the parental brood stock's wintering success is likely to be poor due to their high Florida genetic make-up; and because an entire year class has been ruined, also because of their high Florida genetic make-up; $20,000.00 has been wasted. If the state had practiced genetic conservation, the right stock would have been purchased and introduced, and the money would have been well spent!

THE POINT IS!

Don't misunderstand. We're not indicating that introducing Floridas or hybrid largemouths is always detrimental. Quite the opposite may be true! In fact, as you'll find out next time, the present world record bass was undoubtedly a hybrid, and hybrids result in many new state records.

One could concoct endless scenarios based on the realization that different bass stocks possess different genetic make-ups. The reason I used scenarios relating to the Florida fish is because there is such widespread clamor for its introduction. Very few groups are falling head-over-heels pushing for the introduction of northern fish. Of course, as I've said before, that's probably because the fishing press has unknowingly spread the wrong story when comparing the two basic largemouth bass subspecies. Floridas don't grow larger and faster, live longer, and just generally do better in every environment. Neither do hybrids. And northern bass don't do better in every environment, either.

And that's the point! In order to be optimally successful, stocked fish must be specifically tailored for an environment. Electrophoresis is important because it can help us accomplish this!



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The only thing prettier than a bass is a big bass! Anglers across the country are concerned with bass stocking and its effect on bass fishing. If one assumes the possibility that today's stocking procedures are inefficient, and in some cases, may actually make our fishing worse; and if we assume that genetic conservation can help to change this; it's inspiring to realize that our fishing future may be bright! Genetic conservation may actually make our future fishing better. We'll all vote for that!

Yes, the implications are staggering! Millions of dollars are spent on fish stocking each year! With proper electrophoretic analysis, stocking can be made more efficient, and this money can go much farther. At the same time, proper genetic stock has the best chance to result in year class strength and result in great fishing. And proper genetic stock has the best chance to grow optimally and produce the largest possible fish, too. As we'll discuss next time, the stocking of certain known stocks into certain environments can almost guarantee the production of the largest possible fish—fish almost certain to challenge existing state, and in some cases, world records!

Perhaps most important, though, electrophoretic analysis can keep us from introducing the wrong genes into environments where they will do long term harm. I hope I've made one point clear: Improper introduction of certain genetic stock can rival problems such as fishing pressure in ultimately causing poor fishing.

DR. PHILIPP'S RECOMMENDATIONS

Dr. Philipp's recommendations for accomplishing genetic conservation are simple and straightforward. First of all, each state (as well as federal agencies) should adopt the principles implied by "genetic conservation" as a basic, underlying part of their management program. Obviously, this requires administrators to recognize that genetic conservation is important.

Once that's agreed on, administrative powers must also agree to implement the procedures necessary to ensure genetic conservation. This calls for widespread surveying of existing bass stocks within a state to identify their genetic make-ups. This, of course, can only be done through electrophoretic analysis.

Electrophoretic analysis can be done with qualified state staff and facilities, if they exist. If they don't exist, the facilities may have to be purchased and the staff hired. Alternatives include the use of university staff and facilities, or hiring consulting firms to do the

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analyzing. Yes, this takes money. But it wouldn't cost much when you consider the size of a state budget and the amount of money that goes into producing bass and other fish. By comparison, this type of analysis would constitute a minute fraction of such costs. Besides, genetic conservation will eventually more than pay for itself through increased stocking efficiency!

Beyond basic recommendations on implementing of genetic conservation, Dr. Philipp also feels that until the appropriate genetic surveys have been completed, all programs, public or private, which involve the propagation of largemouth bass for distribution in distant geographic regions, should cease. He also recommends that the distribution of non-native stocks of largemouth bass currently being propagated by any individual or agency should be curtailed. In addition, federal and state fisheries managers should insist upon a genetic evaluation of the bass propagated in their hatcheries. Furthermore, private individuals raising largemouth bass, or any fish for that matter, for distribution to pond or lake owners, should assume the responsibility for ensuring that their business concerns do not override the more important concerns of genetic conservation. In particular, until this is accomplished, he would hope that advertisements offering to sell "Florida largemouth bass fingerlings" to anyone, anywhere, would cease.

A national program should also be initiated to evaluate hatcheries across the country. Hatcheries should then alter or add to their brood stocks to ensure production of appropriate largemouth bass. This may mean constructing several distinct stocks to be used in various geographic areas. Furthermore, both state and national fish hatcheries should curtail the practice of using successive generations from the same hatchery brood stock; in-breeding produces successful hatchery fish, but often fish which cannot cope adequately in the natural environment.

UNTIL NEXT TIME

In case you're wondering, everything we've discussed relative to the largemouth bass lends itself to postulating about other species as well. That's, in part, what we'll be discussing in the October/November issue. Recently, for example, by using electrophoresis, the state of Minnesota verified that two different stocks of muskies exist within the state. For years Minnesota has unknowingly produced much of their stocking material from a stock that rarely gets larger than 15 pounds! Unknowingly, the state has actually been ensuring the spread of smaller fish! And if it can happen with bass from across the country, and muskies in Minnesota, you can bet it's happening with other species in other parts of the country, too.

There are plenty of other superbly interesting topics to cover. If you're interested in the possibilities for cloning bass, selective breeding for big fish, the controversies surrounding record fish, why hybrid vigor produces the largest bass, and a host of other engrossing topics, be sure to tune in next time as we dip into other topics relative to genetic research.

If you're wondering what you can do to ensure that genetic conservation becomes a reality in your state, we make this simple suggestion. Whenever you have the chance, talk with your state fisheries personnel about this subject. Show them this article if you must. Don't be too presumptuous, though. What we've discussed here is a rather complete, but simplified, discussion of this topic. Also, expect to find that state budgets are such that they can't respond immediately to the need for genetic conservation. Yet they should respond, and the quicker the better!

"Electrophoresis" and "genetic conservation" may have been new and very unfamiliar words at the beginning of this article. In the future, however, expect them to become increasingly familiar to all anglers.

If one assumes the possibility that today's stocking procedures are inefficient, and in some cases, may actually make our fishing worse; and if we assume that genetic conservation can help to change this; it's inspiring to realize that our fishing future may be bright! Yes, implementation of genetic conservation may actually make our future fishing better. Until now, that's a scenario no one would have believed.

Genetic conservation: For the future of fishing? You bet! Until next time, good fishing! ■