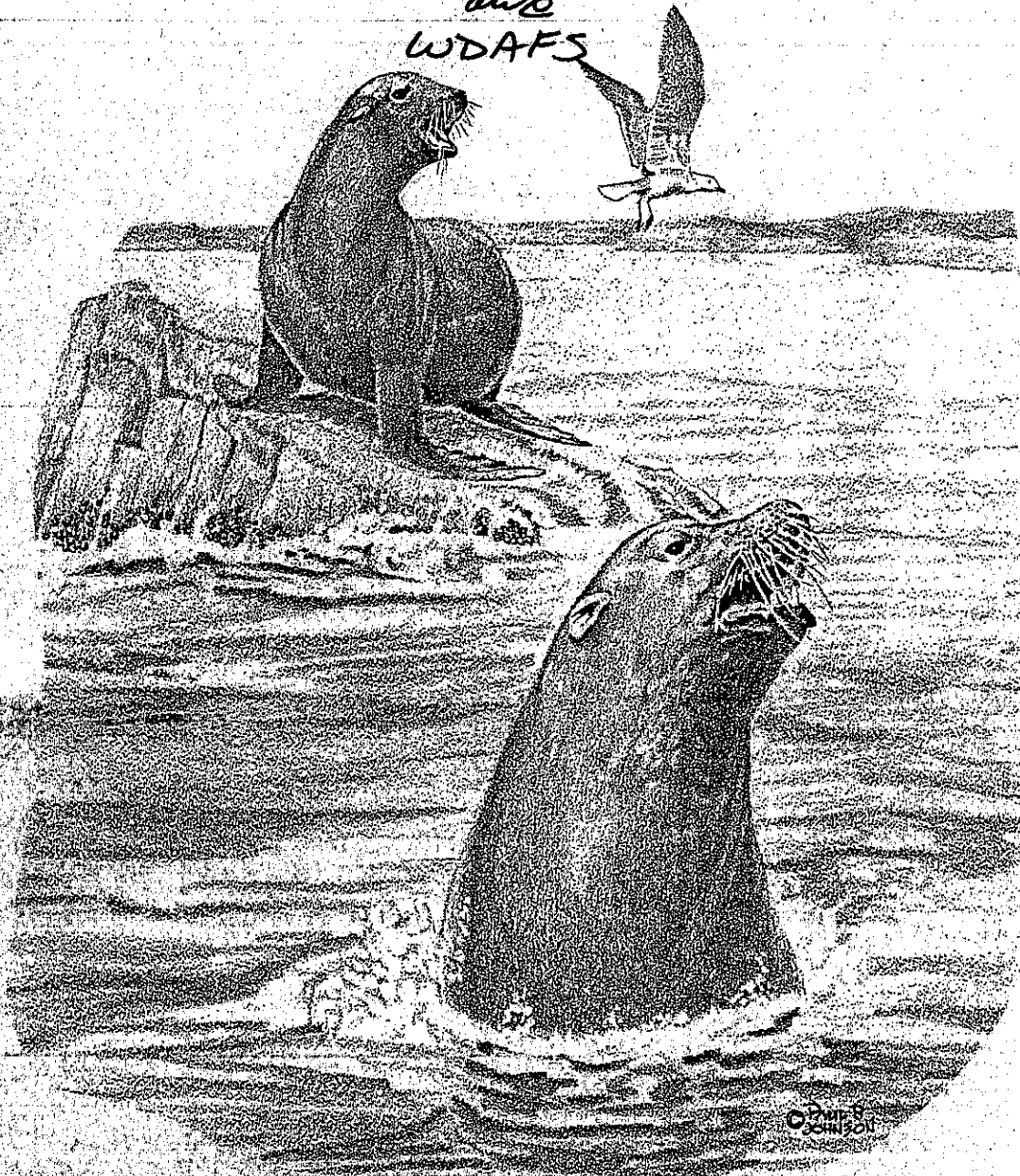


Donald M. Martin

# Western Proceedings

66th ANNUAL CONFERENCE  
of the  
Western Association of  
Fish and Wildlife Agencies

*and*  
WDAPS



Portland, Oregon  
July 20 - 23, 1986

**PROCEEDINGS**

**of the**

**WESTERN ASSOCIATION OF  
FISH AND WILDLIFE AGENCIES**

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Portland, Oregon  
July 20-23, 1986

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## INTRODUCTION

The 66th annual conference of the Western Association of Fish and Wildlife Agencies in Portland, Oregon, focused on "Fish and Wildlife...Are They Worth It?" Issue debates on such topics as "How Much Do They Really Contribute to the Economy?", "Should the Use of Fish and Wildlife Be Promoted by Agencies?", and "Should Hunting and Fishing Opportunities on Private and Public Lands Be Sold?" seemed to raise more questions about the economic impact of fish and wildlife and future funding options. Resolutions calling for surveys of economic values of fish and wildlife were adopted and the Western Association urged the International Association of Fish and Wildlife Agencies to lend support to this extremely important segment of resource management.

Awards presented during the conference included: "Commission of the Year" to Colorado for numerous actions including the development of a mitigation policy, program on nontoxic shot, new big game harvest strategy, and work on future funding; "Professional of the Year" to William "Dick" Humphreys of the Oregon Department of Fish and Wildlife for his work on winter big game feeding and Baker County Land Use Planning; "Outstanding Citizen Wildlife Contribution Award" to John C. McGlenn for his work on Washington State's Initiative 90, the sales tax initiative; and an Honorary Membership to Don Dexter.

These proceedings are printed to provide a record of information exchanged so that all interested persons may have an opportunity to share knowledge that is pertinent to the production and management of fish and wildlife resources of the western states and provinces.

Copies of these proceedings are available for \$10.00 a copy.

Sandra J. Wolfe, Secretary/Treasurer  
Western Association of Fish  
and Wildlife Agencies  
1416 9th Street, 12th Floor  
Sacramento, CA 95814  
(916) 445-9880

Cover artwork by Paul Johnson

# PAST PRESIDENTS AND MEETING PLACES

<u>Year</u>	<u>President</u>	<u>Meeting Place</u>
1922	David H. Madsen (Utah)	Salt Lake City, Utah
	David H. Madsen (Utah)	Sacramento, California
1923	C. A. Jakways (Montana)	Missoula, Montana
1924	A. E. Burghduff (Oregon)	Portland, Oregon
1925	Roland G. Parvin (Colorado)	Denver, Colorado
1926	R. E. Thomas (Idaho)	Boise, Idaho
1927	Sam F. Rathbun (Washington)	Seattle, Washington
1928	Robert H. Hill (Montana)	Seattle, Washington
1929	Isadore Zellerback (California)	San Francisco, California
1930	Ed L. Perry (New Mexico)	Santa Fe, New Mexico
1931	Bruce Nowlin* (Wyoming)	Flagstaff, Arizona
1932	Newell B. Cook (Utah)	Salt Lake City, Utah
1933	Newell B. Cook (Utah)	Vancouver, B.C.
1934	Mat F. Corrigan (Oregon)	Portland, Oregon
1935	Elliott S. Barker (New Mexico)	Santa Fe, New Mexico
1936	Elliott S. Barker (New Mexico)	San Francisco, California
1937	Roland G. Parvin (Colorado)	Denver, Colorado
1938	Herbert C. Davis (California)	Yellowstone National Park
1939	B. T. McCauley (Washington)	Del Monte, California
1940	William W. Sawtelle* (Arizona)	Seattle, Washington
1941	Newell B. Cook (Utah)	Salt Lake City, Utah
1942	Lester Bagley* (Wyoming)	Jackson Hole, Wyoming
1943	Frank B. Wire (Oregon)	Reno, Nevada
1944	K. C. Kartchner* (Arizona)	Phoenix, Arizona
	C. N. Feast (Colorado)	Salt Lake City, Utah
1945	C. N. Feast (Colorado)	Denver, Colorado
1946	James O. Beck (Idaho)	Twin Falls, Idaho
1947	Elliott S. Barker (New Mexico)	Santa Fe, New Mexico
1948	Ross Leonard (Utah)	Salt Lake City, Utah
1949	Don W. Clarke (Washington)	Seattle, Washington
1950	Charles A. Lockwood (Oregon)	Portland, Oregon
1951	Thomas L. Kimball (Arizona)	Phoenix, Arizona
1952	Robert Lambeth (Montana)	Glacier National Park
1953	Edward L. Macaulay (California)	Long Beach, California
1954	Frank W. Groves (Nevada)	Las Vegas, Nevada
1955	Lester Bagley (Wyoming)	Moran, Wyoming
1956	Frank R. Butler (British Columbia)	Vancouver, B.C.
1957	Thomas L. Kimball (Colorado)	Glenwood Springs, Colorado
1958	Ross Leonard (Idaho)	Sun Valley, Idaho
1959	P. W. Schneider (Oregon)	Portland, Oregon
1960	Harold S. Crane (Utah)	Salt Lake City, Utah
1961	Fred Thompson (New Mexico)	Santa Fe, New Mexico
1962	John Biggs (Washington)	Seattle, Washington
1963	Robert J. Smith (Arizona)	Tucson, Arizona
1964	Walter J. Everine* (Montana)	
	Walter T. Shannon (California)	San Francisco, California
1965	James W. Brooks (Alaska)	Anchorage, Alaska
1966	Frank H. Dunkle (Montana)	Butte, Montana
1967	Michio Takata (Hawaii)	Honolulu, Hawaii
1968	Frank W. Groves (Nevada)	Reno, Nevada

1969	James B. White (Wyoming)	Jackson Hole, Wyoming
1970	Dr. James Hatter (British Columbia)	Victoria, British Columbia
1971	Harry R. Woodward (Colorado)	Snowmass-at-Aspen, Colorado
1972	John W. McKean (Oregon)	Portland, Oregon
1973	John E. Phelps (Utah)	Salt Lake City, Utah
1974	Ladd S. Gordon (New Mexico)	Albuquerque, New Mexico
1975	Carl Crouse (Washington)	Seattle, Washington
1976	Joseph C. Greenley (Idaho)	Sun Valley, Idaho
1977	Robert A. Jantzen (Arizona)	Tucson, Arizona
1978	E. Charles Fullerton (California)	San Diego, California
1979	Ronald O. Skoog (Alaska)	Anchorage, Alaska
1980	Dr. Robert F. Wambach* (Montana)	
	Keith L. Colbo (Montana)	Kalispell, Montana
1981	Kenji Ego (Hawaii)	Honolulu, Hawaii
1982	Joe Greenley* (Nevada)	
	William Molini (Nevada)	Las Vegas, Nevada
1983	Donald Dexter (Wyoming)	Teton Village, Wyoming
1984	Donald J. Robinson* (B.C.)	
	David Narver (B.C.)	Victoria, British Columbia
1985	James B. Ruch (Colorado)	Snowmass, Colorado
1986	Dr. John R. Donaldson (Oregon)	Portland, Oregon

\*Resigned before date of annual conference.

# SPECIAL AWARDS

PROFESSIONAL OF THE YEAR	<u>1969</u>	Walter Neubrech, Washington
COMMISSION OF THE YEAR	<u>1971</u>	Oregon
COMMISSION OF THE YEAR PROFESSIONAL OF THE YEAR	<u>1972</u>	Wyoming George Warner, California
COMMISSION OF THE YEAR PROFESSIONAL OF THE YEAR	<u>1973</u>	Utah Robert C. Holloway, Oregon
COMMISSION OF THE YEAR PROFESSIONAL OF THE YEAR	<u>1974</u>	Washington James B. McCormick, California
COMMISSION OF THE YEAR PROFESSIONAL OF THE YEAR	<u>1975</u>	California Wayne W. Sandfort, Colorado
COMMISSION OF THE YEAR PROFESSIONAL OF THE YEAR SPECIAL AWARD	<u>1976</u>	Colorado Jack C. Fraser, California Robert L. Royce, Idaho
COMMISSION OF THE YEAR PROFESSIONAL OF THE YEAR SPECIAL AWARD	<u>1977</u>	Arizona Dale A. Jones, New Mexico Wayne E. Kirch, Nevada
COMMISSION OF THE YEAR PROFESSIONAL OF THE YEAR SPECIAL AWARD	<u>1978</u>	Idaho Harold K. Chadwick, Calif. Charles Junge
COMMISSION OF THE YEAR PROFESSIONAL OF THE YEAR	<u>1979</u>	New Mexico Jean Jones, California
PROFESSIONAL OF THE YEAR SPECIAL AWARDS	<u>1980</u>	William S. Huey, New Mexico Dr. Charles P. Hibler, New Mexico A. Kay Belnap, Idaho Wynn G. Freeman (posthumously), Montana
COMMISSION OF THE YEAR PROFESSIONAL OF THE YEAR SPECIAL AWARDS	<u>1981</u>	Oregon Robert J. Tully, Colorado Joseph J. Klabunde, Montana Lewis C. Smith, Utah
COMMISSION OF THE YEAR PROFESSIONAL OF THE YEAR	<u>1982</u>	Idaho Robert L. Salter, Idaho
COMMISSION OF THE YEAR	<u>1983</u>	Washington
COMMISSION OF THE YEAR PROFESSIONAL OF THE YEAR	<u>1984</u>	Nevada Douglas F. Day, Utah

COMMISSION OF THE YEAR  
PROFESSIONAL OF THE YEAR

1985

Wyoming  
Kerry Baldwin, Arizona

COMMISSION OF THE YEAR  
PROFESSIONAL OF THE YEAR  
SPECIAL AWARDS

1986

Colorado  
Wm. "Dick" Humphreys, Oregon  
John C. McGlenn, Washington

# HONORARY MEMBERS

- 1935 Col. Arthur Foran - Washington, D.C.  
Carl D. Shoemaker - Washington, D.C.  
David Madsen - Salt Lake City, Utah  
Mrs. Harold Peck  
William J. Tucker - Austin, Texas  
Fred J. Foster - Seattle, Washington  
E. H. Smith - Colorado
- 1952 William Carpenter - Butte, Montana
- 1953 Virgil Bennington - Walla Walla, Washington  
Elliott Barker - Santa Fe, New Mexico
- 1957 Lester Bagley - Afton, Wyoming
- 1959 Seth Gordon - Sacramento, California  
Fred Faver - Buckeye, Arizona
- 1962 Frank Butler - Vancouver, British Columbia
- 1967 Wayne E. Krich - Las Vegas, Nevada  
Ben Glading - Sacramento, California
- 1969 Phillip W. Schneider - Portland, Oregon
- 1970 Walter Shannon - California  
John Biggs - Washington
- 1971 Cleland Feast - Denver, Colorado  
Tom Kimball - Washington, D.C.  
John R. Woodworth - Boise, Idaho
- 1972 Ross Leonard - Washington, D.C.  
Edward Macaulay - California  
Robert J. Smith - Washington, D.C.  
Walter J. Everin - Montana  
Frank H. Dunkle - Montana
- 1973 Harry Woodward - Colorado  
Frank Groves - Nevada
- 1975 R. Withers Cool - Colorado  
G. Ray Arnett - California
- 1976 Carl Crouse - Washington  
R. J. "Rocky" Holmes - Twin Falls, Idaho
- 1977 John W. McKean - Oregon  
John E. "Bud" Phelps - Utah  
Arthur S. Coffin - Washington
- 1978 Ladd S. Gordon - New Mexico  
Homer C. Pickens - New Mexico  
Fred A. Thompson - New Mexico  
James B. White - Wyoming
- 1981 Glen Griffith - Nevada  
Robert A. Jantzen - Arizona  
Allan L. Kelly - Oregon
- 1982 Joseph C. Greenley - Nevada  
Earl Thomas - Wyoming  
Kenji Ego - Hawaii  
Michio Takata - Hawaii
- 1983 Ronald O. Skoog - Alaska  
E. Charles Fullerton - California
- 1984 Douglas F. Day - Utah  
Jack Grieb - Colorado  
Donald J. Robinson - British Columbia  
Robert L. Salter - Idaho
- 1985 Jean K. Tool - Colorado  
Frank Lockard - Washington
- 1986 Don Dexter - Wyoming



Western Association of Fish and Wildlife Agencies

PRESIDENT'S ADDRESS

JOHN R. DONALDSON

July 21, 1986

I, too, want to welcome you to Oregon and to Portland. We are happy to see so many of you here and we hope you are happy to be with us. Your Oregon hosts will be smiling at you a lot the next several days because we like who we are, where we are, and what we do. We encourage you to see as much as you can while you are here by staying as long as you can. Your hosts will help you do this--with a smile.

If you can't sample the great variety of our robust outdoors around the State, then take time before or after lunch or dinner just to walk about the city. Tree- and flower-lined "nature" walks are possible in downtown Portland. Or you can take an art and architecture stroll. And in the hills you see just to the east you can walk in a wilderness and get lost while still within the city. Washington Park has many miles of wooded trails.

Right now the ocean is producing coho and chinook salmon in abundance and there is a near record run of steelhead in the Columbia River. Big sport-caught halibut are being landed at coastal ports and sturgeon fishing in the Columbia is exceptionally good. And if you like clams, minus tides are ideal for digging this week.

There is no game to hunt just now, but there is lots to see and you could come back.

Oregon is still blessed with a favorably low ratio of residents to land mass and residents per bio-mass of fish and wildlife. Open space and solitude are close at hand. Yet Baryshnikov danced three days last week just across the street. And you can see the Magna Carta on display a block further on. Ask the next face with a smile you pass and they'll agree--because they're one of your Oregon hosts.

Last year in Snowmass, Colorado's Jim Ruch was up here doing this very thing. And he did it very well. "So Goes Wildlife" was his theme. He rewove the fabric of a bio-tapestry we all know so well. The amount of natural habitat fabric in that tapestry today is the most we are ever going to have. Meaning, tomorrow there will be less than today.

Change, that axiom of all natural things, is ever taking place. Unfortunately the quantitative aspect of nature is ever diminishing. Wooded space falls tree by tree, the earth's meringue of soil steadily melts downstream, plugs are pulled on shallow ponds. A pair of spotted owls no longer make a living in the big old fir trees, the eggs from a pair of steelhead suffocate in the silted creek gravel, a mated-for-life pair of Canada geese fly by the plowed field that once was home. Yes Jim, "So Goes Wildlife."

The measure in each of the three above habitat dramas was a human assessment of worth. Someone decided there was a higher value and so there was induced change. What was is no more and what is, is very different. Better? That's a value judgment to which there are more than several views. But a decision was made, sometimes rash and impromptu, and sometimes lavishly bureaucratic.

What has happened is a shifting from a process of take it where, when and how much you can to one of taking by permission.

Taking by permission only is a resultant of the conservation movement during the first half of this century, followed by the popularizing of environment and ecology in the 1960s. From this came terms like "environmentalist" and "ecology now." I wonder where ecology had been up until then.

So our guilt-ridden conscience stimulated laws that brought acronyms to nature like NEPA, EIS, EAR, and permits upon permits. If you did the right things in order you were given permission for a taking. And the lovely world was going to be well again. Conservationists were proud. Ecology was finally now. The spoilers of all things handsome and natural were shackled.

Really it was more like hobbled. Ma Nature's protective suit of acronyms were troublesome to penetrate and there was major bleating from the takers. But what actually happened is that taking was only slowed. Because necessity will always be the mother of invention, the takers found a gaggle of clever bio-specialists ready and able to translate the natural acronyms.

For a price they would do an EAR. New jobs were created and a subculture emerged.

And the old naturalist wondered what had been created. Who were these new people who worked only with paper while propped on their soft parts? How had this come to pass?

Worth assessments were made and the taking continued. To cut, to doze, to drain in order to manufacture, to farm, to build for work places or dwellings; civilization was allowing to have a higher worth.

Yes, there was more wilderness set aside, a park here and there, a special sanctuary now and then and some helpful laws and rules on changing air, water and soil conditions; but the net natural habitat balance annually is less. And so it will continue until we, assembled in groups like this one here today, answer the question factually, affirmatively, and forcefully: fish and wildlife--are they worth it?

Natural resource economics is in transition from an art form to a science. Just a decade or two ago there were but a few such practitioners. Now they are popping up with refreshing regularity. Techniques are developing and figures are flowing. Questions are being asked and creditable answers are being given. Comparable worths, natural not human, are being accessed. And as you certainly would expect your economist and my economist are being squared off against each other to test their science.

The value in all this is just that--values. Values upon which informed decisions can be made about the quantity and quality of fish and wildlife habitat. And the answer to our conference theme: Fish and Wildlife--Are They Worth It?, is more and more coming out of the taking contest as yes. Getting into the worth process with numbers instead of emotion is making a difference. There is further slowing of the taking. That's progress for now. I would certainly hate for us to be accused of being greedy.

There is another critical arena we as professional managers and advocates for fish and wildlife must stimulate to promote our worth--people's attitudes. Shaping a mind set that understands and believes we are worth it. We have to sell.

Not just how, where and when to hunt and fish, but to sell the need for quantity and quality in natural habitat and the willingness for people to pay a price.

Public relation efforts, information and education programs, whatever they are called, need to get out front and hustle hard. The best set of facts on our worth are worthless if we are just talking among ourselves.

I hope that you believe as I that each of us is an advocate, that we are worth it, can prove it and we are ready and willing to sell.

That is the theme of this conference. Now go to work to stimulate, inform and develop yourselves here these few days. There will always be a challenge to protect and promote our habitat advocacy.

I hope you received and accepted my message. If so, thank you. This is my last opportunity as a State director to appeal to you. I'm going to miss this forum very much, the professionals in the field, on the staffs, and the directors. These have been good times for me.

Thank you all very much for helping make it happen.

## HOW DO FISH AND WILDLIFE CONTRIBUTE TO THE ECONOMY

by

Patrick Graham  
Montana Fish, Wildlife and Parks  
Helena, Montana

Good afternoon. My challenge today is to stir up a debate on the role of fish and wildlife in the economy.

Someone, like myself, who shows an interest in economics in the field of fish and wildlife could be considered to be a lot of things, but I've found that none of them is too complimentary. I often thought my interest might have something to do with living in Montana. In Montana one is surrounded by spaciousness - in fact our new travel promotion slogan is "we ain't got much, but we sure know how to spread it around."

That spaciousness has been known to affect people in different ways. Writer Wallace Stegner concluded that in all this spaciousness, man could acquire an exaggerated notion of himself and embrace illusions of independence and self-reliance.

That didn't sound too bad until I heard what historian Bernard DeVoto said, that the true individualists in the West usually wound up on the end of a rope whose other end was in the hands of a bunch of cooperators.

Now if any of you have the misimpression that I am an economist, I hope to dissuade you. And if you still think I am after this presentation, then I'll know Stegner was right and hope DeVoto was wrong.

By chance, you may have read an article recently about the problems a laboratory in California was having. The lab was under siege by a group of animal rights activists. The animal rights folks wanted the scientists to stop using rats in their experiments. They pelted the lab with rotten tomatoes, tossed bricks through windows, and chanted outside. The scientists feared for their lives, and knew they had to do something. So they made an announcement. They would stop using rats. They would use economists instead. Economists are just as prolific, but you don't get as attached to them, and there are somethings a rat just won't do.

You probably expect me to start spouting numbers about the contributions of fish and wildlife to the economy. Well, I won't disappoint you. Here they are: \$32.5 billion, \$4.2 billion, \$16.47. The last one is what I spent on beer and tackle at Bob's Bait and Beer Saturday.

I'm not going to try and convince you that our pile of beans is bigger than their pile. (If you want some numbers they are attached as an appendix to this paper.) Such generalizations are of limited use.

What we spend is important. From the backyard bird feeder to the outfitted fishing or hunting trip. And it is increasing, from \$2.8 billion in 1955 to 27.2 billion in 1980. The pursuit and enjoyment of fish and wildlife touches nearly every person in the country--a walk in the park, a nature program on TV or a wilderness encounter. But I chose not to make that the center of my presentation today. Instead, I would like to focus on the relationship of fish and wildlife to the economy and society. With that understanding we can begin to weigh the dollars spent against opportunities gained or lost.

We might not be talking about this subject if we were more self assured of the importance of fish and wildlife to the economy. Many people look at fish and wildlife as possessing only amenity values. And, like apple pie and motherhood, who can be against them?

But there are those who ask - Can we afford them? It reminds me of the southern senator defending his opposition to bussing as a way to integrate schools when he said, "But some of my best friends are buses."

Robert Alison, a Canadian naturalist, noted that through history, "societies could rarely afford the luxury of insight into future dilemmas..." While... "conservation enthusiasm emerges early in the evolution of a particular society, its incorporation into the behavior of citizens, is restricted to the advanced stages of the society, since only then can it afford the luxury of concern."

Certainly most people today in North America can afford to think about the consequences our actions will have for future generations. Few of us are concerned about where our next meal will come from or where we will sleep tonight. (Although some of you probably should be.)

In fact our society shows many signs of excess. Everybody must own at least one diet book. And comedian Richard Pryor's commentary rings true when he says, "cocaine is Gods way of telling you, you make too much money."

We North Americans have taken many actions to conserve wildlife at home and abroad by establishing refuges, through international treaties and more. Still the questions are asked, "How much is it worth and can we afford it?"

The difficulty in answering these questions is compounded by the role in which fish and wildlife advocates have been cast. Joseph Wood Krutch captured it by saying, "The campaign to preserve America's wild land and wildlife has at times been characterized as a battle between man and nature. In some respects, that has been an unfortunate characterization. Nature never really fought man and some of his intemperate schemes. Nature usually just

endures our heavy hand and at times extracts a form of retribution for mistakes we have made."

Still, fish and wildlife advocates respond to the questions, but they are often dismissed as obstructionists to economic progress. But now, possibly more than ever before, the opportunity exists to change that thinking. I say that because now, possibly more than in any recent time, there is great confusion about what our economy is and where it is going.

In defining the role of fish and wildlife in the economy the first thing we must decide is which economy we are talking about. The economy of the nation, of the West, of Oregon, or Bob's Bait and Beer. There is no single economy. California and other western states look for trade in the Pacific Rim countries, Florida looks to South and Central America. Montana to her neighboring states and Canada. Bob's Bait and Beer looked to me - Bob must be the same guy selling screwdrivers and toilet seats to the Pentagon.

In recognizing these different sectors of the economy, we must communicate values in terms that people understand and in a context that has meaning in their world. Rural communities are much more likely to see the benefit of fishing and hunting expenditures. But it is people from urban and suburban areas who are pushing up the demand for fish and wildlife often beyond our ability to supply them.

When extolling the benefits of fish and wildlife we must recognize that benefits to one group are likely to be costs to another. Maximizing expenditures is certainly no benefit to the sportsman. It is not enough to have good values, we must know how to use them.

A second important feature of today's economy is its short-term focus. Fortunes are won and lost in the stock market on quarterly profit statements. In Montana, the private timber industry is reportedly liquidating its timber holdings. Timber management is driven by the needs of the mills. They are harvesting a crop they never planted, and it seems some have little interest in harvesting it again. If fish and wildlife were managed with such a short-term perspective, there would undoubtedly be even fewer opportunities.

Unfortunately the short-term economic gain from a one-time harvest of timber, coal or oil and gas is often more attractive than the economic benefits provided by fish and wildlife. Increasingly, laws have been implemented to minimize the damages to fish and wildlife, but the pressure to compromise these values always lurks.

These problems are compounded by government-subsidized water and land development programs. In fact, the terrible abuse of economic principles used to justify these projects has contributed to a general disdain and mistrust of economics.

A third feature of today's economy is our recognition of and demand for quality and diversity of products. People are willing to pay for quality and they demand choices, often many choices. Quantity is no longer a substitute for quality.

This is reflected in fishing and hunting in the form of our willingness to travel long distances for the opportunity to find quality experiences. Montana, for example, sells the third largest number of non-resident, freshwater fishing licenses in the country, following only Wisconsin and Michigan. Those states border the Great Lakes and have large population centers nearby. Our 17,000 non-resident big game licenses sell out in less than a week. And recently an Oregon man paid \$79,000 at an auction for a Montana Bighorn sheep license.

But people do not come simply to catch fish or shoot game or view wildlife. If they did, we could line them up at hatchery raceways or shoot grain-fed elk in the parking lot. They come for a number of more complex reasons. We must not lose site of those reasons or we risk losing our base of support.

Another aspect of our perceptions of quality and diversity related to fish and wildlife is the increased interest in non-game wildlife, on outdoor photography, and more. In sport fishing there is a significant trend away from the consumptive use of fish. Many more fishermen are releasing fish-- not because they have to, but because they want to. While not entirely non-consumptive, the trend is refreshing if not essential. In spite of success in habitat conservation and improvement we find increasing need to encourage less consumptive uses of fish and wildlife to maintain quality opportunities.

Regardless of the motive, these people come and spend money and that's what it's all about - right? The one thing we often forget is you need somebody else's money to stimulate your own economy. Everybody that is except the federal government, they just print more.

It's been said that it is better to know some of the questions than all of the answers. And one question we have to answer is-- how much should fish and wildlife contribute to the economy? Economists, among others, have been accused of knowing the price of everything and the value of nothing. To an economist, your lunch today had a value measured by the price you paid for it. To the nutritionist, its value was measured in calories, percent of fat and fiber, minerals and vitamins. Values for fish and wildlife include market, recreational, scientific, aesthetic, cultural, historical, religious, genetic diversity, therapeutic and intrinsic. These different values are why many of us find it uncomfortable to talk about fishing and hunting in economic terms. Dollar values seem to isolate us from what we perceive as the real values of fish and wildlife.

In fact, maximizing economic return of fish and wildlife has never been the mandate for management agencies. The objective has instead been to conserve fish and wildlife while providing recreational opportunities to as many people as possible.

Fish and wildlife are like many other goods and services provided outside the marketplace. Society and its many institutions provide such things as our national defense system, social security, and protection against crime. The natural environment provides clean air and water, and the opportunity for quality outdoor recreation.

People in small towns and rural areas common in much of the West tend to make less money and to have fewer job opportunities; but these areas usually offer a high quality of life. University of Montana economist Tom Powers noted that this relationship is no coincidence.

What's more, one need not use fish and wildlife to hold them in high value. Many of us are willing to pay to have the option for use in the future or simply to know wildlife and wildlands exist.

I think an analogy can also be drawn to the plight of the family farm. Many people are concerned about the family farm, not because they are concerned about what will be produced or even how much. They are concerned about who will produce it. It's not about preserving lives, but lifestyles. Maybe even Bob's Bait and Beer.

This brings us full circle. All this talk about fish and wildlife is fine but just remember - what we need is real jobs to keep the economy going.

But stop for a moment, so many of the conflicts with fish and wildlife are the result of activities whose eventual product is to make our lives - more comfortable, to make our work - easier, to provide us with - even more choices.

We have set for ourselves an increasingly difficult goal - to have an ever expanding economy and ever improving standard of living. Ironically, the product of these endeavors produces more time and money to pursue the very opportunities we often spoil.

Fish and wildlife point to an alternative. While they alone are not the answer, they are symbolic of what is necessary to maintain a stable and diverse economy. They are truly a renewable resource--not in a lifetime or a thousand lifetimes, but every year. And a healthy biological community can teach us much about a healthy economy. A rich environment results in a more productive, diverse, and stable community. Exploiting that richness for short term gain simply robs it of its future stability. Reclamation, trust funds, and conservation reserves all contribute to future stability.

Fish and wildlife make another contribution to the economy. You might call it the environmental IRA account. I think we have proved time and again our capability to literally destroy the very environment we live in and, in short order to consume many of the resources at our disposal. One classic example today is



the destruction of the Central American rain forests to raise a crop of Whopper burgers. To the degree we conserve wildlands and wild rivers, we reserve options for the future.

This debate will continue, but advocates of nature in our society will remain at a disadvantage. Philosopher Ralston Holmes of Colorado State University concluded that we think of our relationship to wild nature as recreational since we do not do work there. We are at leisure and not economically productive. In this respect our attitude toward wilderness will be different from our grandfathers who for the most part went into it to reduce the wild to the rural and urban. Their success forces us to question the worth of the wild.

Such a disadvantage does not lessen the chance for success, it should help focus our resolve. Fellow Montanan, Dan Kemmis, former Speaker of our House of Representatives said:

"People who value something in isolation, thinking they are alone in caring about it, are easily overcome. They doubt the authenticity of their values, thinking those values reside in their minds alone. But if they see that what matters to them is also important to many others, and that those values, moreover, have a foundation, not just in their minds or in the minds of others but in the structure of life itself, their confidence in those values can be multiplied many times over. People who knowingly share values which are deeply and confidently held are the kind of people who can make history happen."

In summary, four points to remember are:

- 1) We need to communicate values of fish and wildlife in terms that people understand.
- 2) We should focus on the value of long-term stability and growth over short term profit and uncertainty.
- 3) We must articulate and provide diverse and quality opportunities or risk losing support.
- 4) When conveying the role of fish and wildlife in the economy, we must not unwittingly advocate expanding that role without first considering how it will affect fish and wildlife and peoples perception about them over the long-run.

Fish and wildlife are no longer at the bottom of the pile crawling up for public recognition. In moving closer to the top we acquire new responsibility. We can not use economics simply to take shots; we must use it to provide alternatives.

Let's go win one for Bob's Bait and Beer.

## Appendix

### Summary Statistics on Economic Value of Fishing and Hunting

#### CANADA<sup>1/</sup>

- o 84% of the 15.5 million people in Canada participate in wildlife-related-recreation.
- o These Canadians receive \$800 million annually in benefits.
- o \$4.2 billion is expended on wildlife-related-recreation.
- o This results in - \$8.8 billion in Gross Business Production.
  - \$5.2 billion in Gross Domestic Production.
  - 185,000 jobs
  - \$2 billion in federal and provincial tax revenue.

#### USA

- o 59% of the people over 16 years of age<sup>2/</sup> (99.8 million) participated in wildlife-related-recreation.
- o 36.4 million freshwater fishermen spent \$7.8 billion in 1980
- o 17.4 million hunters spent \$8.5 billion.
- o 28.8 million nonconsumptive users spent \$4.0 billion on trips to enjoy wildlife.
- o State hunting license revenues (FY84) \$292 million.
- o State fishing license revenues (FY84) \$260 million.
- o Federal fiscal year 1986 - \$107 million federal aid in wildlife restoration funds.
  - \$110 million federal aid in sport fishing restoration funds.

<sup>1/</sup> The Importance of Wildlife to Canadians, 1985, Canadian Wildlife Service Environment Canada, by F.L. Filion, A. Jacquemont and R. Reid.

<sup>2/</sup> National Survey of Fishing, Hunting, and Wildlife - Associated Recreation, USFWS, 1982.

SHOULD AGENCIES PROMOTE THE  
USE OF FISH AND WILDLIFE?

Sara Vickerman  
Regional Program Director  
Defenders of Wildlife

As one of the few representatives of environmental organizations here today, I consider it a privilege to have been invited to address the Western Association of Fish and Wildlife Agencies. Although I'd be pleased to think I'm on the program because Defenders of Wildlife has such a unique and thoughtful position on the question of agency promotion of fish and wildlife utilization, I suspect that it's because the other organizations considered the topic too hot to handle. Indeed, the people with whom I conferred on the subject before preparing this paper were uniformly surprised that I had accepted the invitation to appear in this forum.

At the risk of disappointing those who came to this session for the entertainment value, expecting a lively debate on hunting, I should clarify my organization's position on the issue. We are neither for, nor against, hunting. Rather, we consider the activity on a case-by-case basis when the question arises - usually in the context of more complex circumstances. Although our policy is not appreciably different from other environmental groups, it does diverge from the traditional wildlife conservation organizations who primarily encourage the orderly utilization of game animals. It also differs from the extreme protectionist opposition to the killing of individual animals under any circumstances. Defenders emphasizes the protection of ecosystems, and all of the dependent species of plants and animals, without preference for certain members. It is our goal to protect viable populations of all wildlife and to encourage the acceptance of a new wildlife ethic, which recognizes that wild creatures have intrinsic value beyond their utilitarian purposes.

Our priority projects concern the protection of threatened and endangered species, including reintroduction of predators where they have been extirpated, like the wolf in the Rocky Mountains. We seek preservation through protective designation of land by public agencies and support policies and practices which minimize the adverse effects of man's activities on a variety of wildlife species, such as finding alternatives to poison in animal damage control.

We are seeking federal funding for the implementation of the Fish and Wildlife Conservation Act of 1980, which would provide

funding for state nongame programs. We lobby Congress for funds to purchase refuges, and have helped obtain money to research the entanglement of marine mammals, birds, turtles, fish, and other creatures often killed in fishing nets and other debris. Despite our inflammatory name, and involvement in some controversial issues, our staff does work constructively with agencies and industry representatives to find solutions to difficult resource management dilemmas.

I have been asked to present the case in opposition to the promotion of fish and wildlife use by agencies. For the purpose of the discussion, I'll limit my remarks to this activity as it relates to state fish and wildlife agencies, rather than federal ones, although most of my points will be applicable to both.

Although the purpose for promoting the use of fish and wildlife has not been explained, I assume that the reason is to increase the revenue for the state fish and wildlife agencies suffering from financial difficulties. The effects of federal budget cuts and the recession have affected all government programs, but fish and wildlife projects may be more vulnerable than most to the extent that legislators perceive recreational and aesthetic pursuits as being non-essential. We all recognize that there are now fewer dollars available for all government programs, and ever-expanding demands for the funds.

Given the bleak economic picture, it is not unreasonable to suggest that if the fish and wildlife agencies were able to "package" their products and advertise their availability more effectively, more people would purchase hunting and fishing licenses, the agencies would have more money, and the resource would be better off. Right? Not necessarily. This approach has a number of pitfalls, which I'll introduce briefly, and then explain.

Promoting the utilization of fish and wildlife may confirm the suspicion held by many of the agencies' non-hunting critics that the only animals the government acknowledges are the ones available to shoot and eat. Encouraging license sales appears to benefit the agencies more than the public or the wildlife. Increasing the number of fishermen and hunters probably won't please the people who already fish and hunt, and could lead to depletion of some wildlife populations. It's not the appropriate role of the government to encourage one form of recreation over another or to become an advocate in debate over controversial issues. Promotion of consumptive use may even cause the controversy surrounding hunting and trapping to intensify. It's probably impossible to reverse the long-term socio-economic trends which have contributed to shifting public interests. And finally, there are much better ways to make money for fish and wildlife programs, which don't carry the aforementioned liabilities.

Promoting exploitation of animals reinforces the perception that fish and wildlife agencies have a very narrow view of their responsibilities.

Traditionally, the emphasis has been almost exclusively on hunting and fishing, game species, and the people who engage in such activities. Although the gradual establishment of threatened and endangered species and nongame programs within the state agencies has helped, the striking imbalance remains.

Defenders has mailed surveys to, and is compiling data from, all fifty states concerning the funding of wildlife programs. Although we have not received replies to our inquiries from all states yet, here are preliminary figures from the western states which have responded.

<u>State</u>	<u>Year</u>	<u>Game Budget</u>	<u>Nongame Budget</u>	<u>Percent of Wildlife Budget Spent on Nongame</u>
Nevada	1987	\$ 1,951,640	\$200,400	10%
Wyoming	1985	11,468,969	668,310	5.8%
Montana	1986	4,000,000*	53,000	1.3%
Washington	1987	27,700,000	800,000	2.9%
New Mexico	1986/87	1,947,000	489,000	25%
Utah	1986	3,600,000	511,000	14%
Oregon	1986	7,959,989	516,669	6.4%

Figure 1

Although there is a wide discrepancy in the total expenditures between the states, the pattern is clear. Although 80-90% of wildlife species are nongame (Audubon, 1986), the programs established to protect them constitute a trivial portion of the state agency budgets.

Therefore, to the extent that more consumptive use is promoted by agencies, the perception that the agencies ignore most of the wildlife and most of the public will persist. Furthermore, it's not simply a matter of perception. It's a reality.

\*Includes endangered species projects and wildlife management areas.

**Agencies promoting the use of fish and wildlife may be seen as being self-serving, and emphasizing fluff rather than substance.**

Regardless of the advertising content and media selected for selling the states' wildlife and fish, it is certain to be expensive. Television and radio time, newspaper ads, design, printing, and publication of any material, and media consultants, may rapidly deplete agency funds. Critics will point out that for the cost of the promotion campaign, the agency could conduct wildlife research, acquire habitat, fence riparian vegetation, arrest poachers, etc. Even if the "campaign" generates more license revenue, it is not without cost. It is not inconceivable that the costs of promotion could exceed the net increase in income derived from increased sales of licenses. In any case, agencies who conduct visible advertising campaigns may find themselves defending information and education programs against criticism that they produce no demonstrable public or resource benefits.

**Attempting to increase hunting and fishing license sales is unfair to the people who now hunt and fish, and could lead to a depletion of the resource.**

Although it has been suggested that fish and wildlife are selectively "under-utilized", it seems risky for any agency with a broad legislative mandate to protect the resource from over-exploitation to attempt to increase the consumptive use of the resource. Several rather obvious reasons follow. First of all, many people who now hunt or fish do so because they enjoy the solitude, and the wilderness experience. Few hunters will appreciate the prospect of a longer wait to use the duck blind, decreasing opportunity for one's application to be selected through a drawing or competitive process, or finding more boats lined up at their favorite fishing spot. A fish or wildlife population producing a "surplus" in one year may not do so in subsequent years, causing possible disappointment for persons lured into the activity by the agency's seductive appeal. Although most biologists find the process distasteful, decisions concerning the level of harvest are often political, and an accelerated demand for fish and wildlife may be satisfied through direct pressure on decision-makers by powerful individuals. Biologists will never completely control the process, and cannot ensure that over-exploitation won't occur.

Finally, if there are surplus fish and wildlife available for "sale" through the agency, it may be increasingly difficult politically to justify efforts to increase game and fish populations through artificial means such as supplemental feeding, habitat manipulation, propagation, predator control, and introduction of exotic species.

Promoting utilization of the fish and wildlife resources is not the proper role of the government.

Although state statutes authorizing fish and game management activities vary and change periodically, there are common themes. For example, Oregon's wildlife laws mention optimizing recreational and aesthetic benefits, preventing the depletion of any indigenous species, and permitting orderly and equitable utilization of wildlife. The statutes also establish the fish and wildlife agency and commission and delegate certain powers. Oregon law does not specifically authorize the agency or commission to promote the use of fish and wildlife (ODFW, 1983-84).

Few would disagree with the appropriateness of certain informational and educational activities conducted by a fish and wildlife agency. The public must be informed as to when and where fishing and hunting is permitted, how to obtain tags and licenses, and other details necessary for the efficient administration and monitoring of the activities.

Few would challenge the agency's preparation of pamphlets describing the natural history and habits of indigenous species. Most state agencies have published magazines or bulletins on a regular basis - though these are predominantly game-oriented. Articles on nongame appear in the fractional proportions roughly equivalent to the overall attention given to nongame species by the agencies.

The line between "education" and propaganda, however, is thin. Crossing the line makes agencies vulnerable to criticism, perhaps even legal challenges in extreme cases. Caution is advised whenever an agency spokesperson makes an official statement or releases a publication concerning a controversial issue. The line is clearly crossed if the controversial issue is before the voters. The courts have found consistently that although governments may engage in some forms of speech, they are still prohibited from advocacy intended to perpetuate themselves in power. In *Burt vs. Blumenauer*, Oregon Supreme Court Justice Betty Roberts quoted a case in which New Jersey citizens had challenged an expenditure made by the school board to publish an informational booklet about a bond election. The expenditure was held unlawful because:

"...the board made use of public funds to advocate one side only of the controversial question without affording the dissenters the opportunity by means of that financed medium to present their side, and thus imperilled the propriety of the entire expenditure..."(Roberts, 1985).

The State Supreme Court also found that the Oregon Sheep Commission, a state agency, had illegally contributed to a

political action committee for the purpose of defeating a ballot measure which would have limited the use of certain animal traps.

Even if there is no specific wildlife or fish management question before the voters or the legislature, it seems prudent for agencies to take the high road, avoid the appearance of impropriety, and strive to protect their professionalism by adhering to the objective presentation of information and avoid advocacy, particularly regarding hotly debated issues. Wildlife management proposals are often controversial and do come before the voters occasionally (dove hunting in South Dakota, trapping restrictions in Oregon and Ohio, and moose hunting in Maine) (Lautenschlager, 1983) and under such circumstances it would probably be illegal for the agency to advocate one side or the other. However, even when the question of expending public funds to influence elections is not the central issue, legislators and citizens will legitimately question the financing of a propaganda campaign by any government agency. For example, the 1981 Oregon Legislature defeated an agency-supported trapper education bill which would have provided the private trappers with the opportunity to advocate trapping to beginners through a training manual, printed at state expense.

Project Wild, a package of educational materials published at public expense (and funded initially by private organization like Defenders of Wildlife) has generated tremendous controversy because the authors failed to apply a tough standard of objectivity to the text.

Our democratic process works best when organizations keep their designated role in sharp focus. Private organizations are properly advocates for certain positions. Legislatures write laws, agencies implement them, and the courts enforce them. Fish and wildlife agencies should not confuse their informational responsibilities with lobbying or grass-roots lobbying. When they do, it may operate to their disadvantage.

**Promoting the utilization of fish and wildlife may polarize the issues and destroy opportunities for cooperation between agencies and private organizations.**

As long as roles are not confused, there are a number of ways in which private conservation organizations can work effectively with fish and wildlife agencies. There are barriers, however, to the formulation of constructive relationships, which must be overcome. The most serious is probably the historical stereotyping of people or organizations with extreme views. Some fish and game managers see protectionists as "antis" or "bambi lovers", while the animal rights activists dismiss agency personnel as "hook and bullet boys". Confrontational politics use energy which might be more constructively channeled into protecting resources.



If fish and wildlife managers are interested in forging new coalitions for the mutual benefit of wildlife, fish, and people, there must be a conscious effort to break down old images. The agency's public statements and "advertising" messages are the most visible signals to the public that things are changing - or that they aren't. To encourage the broadest public acceptance of agency activities, it would seem in the best interest of any resource agency to objectively consider diverse points of view and conflicting demands on resources.

Promoting the use of fish and wildlife will be about as popular in some circles as it would be for the U.S. Forest Service to advertise the availability of more ancient trees to cut, or for the Bureau of Land Management to encourage the gobbling of a few more wildflowers and willow shoots on public lands by domestic livestock. The natural, unsolicited demands on the resources are already excessive, and may increase even if the agencies don't try to drum up business.

Political activity surrounding wildlife issues has increased dramatically during the last decade and this trend will probably continue. Progress in protecting fish and wildlife is much more likely if private organizations and agencies are working together, rather than fighting each other. There is a serious risk that failure to acknowledge legitimate public requests for change in the agencies' approach to managing wildlife will encourage efforts to dismantle the agencies. There is already some opposition to nongame programs from people who have no confidence in the ability of fish and wildlife agencies to administer the programs. Such skepticism may jeopardize the voluntary contributions to nongame. In more extreme examples, several animal protection groups initially opposed the nongame bill which recently passed in Connecticut, because they felt it didn't contain strong enough language directing the agency how to spend the money. Opponents envisioned that funds would be diverted to game programs. In New Jersey, a bill was introduced by animal protection groups to remove the endangered and nongame species program from the Division of Fish, Game and Wildlife, and establish an equal and separate Division of Wildlife and Nongame Species. The current department would be renamed Division of Fish and Game. Several years ago, in Arizona, the executive branch proposed a reorganization in which the Game and Fish Department would have been placed under a broader natural resources division.

Another common, and increasingly serious threat to fish and wildlife agency budgets is the growing demand by agricultural interests to receive compensation for crop damage caused by wild animals. Agencies will need strong public backing to resist the nibbling of funds intended for resource protection. The conservation community can be very helpful.

There is some question as to whether even an effective campaign to sell more fishing and hunting licenses will make a difference in the long run.

Anyone who knows how to get a political candidate elected, or to pass or defeat a ballot measure, recognizes the utility of an expensive campaign to influence voter choices. People do respond to effective advertising. However, whether agency promotion will influence people's recreational choices sufficiently in the long run to increase license sales and stabilize agency funding is seriously doubtful. It would require the reversal of several significant social and demographic trends that may be working in combination to create the funding squeeze.

The overall trend in license sales is probably stable or declining slightly. Figure 2 shows U.S. license sales from 1970 to 1983 based on data from a standard statistical abstract (U.S. Bureau of Census, 1984). For comparison, the total U.S. population for the same time period is also graphed in Figure 3. The slight and gradual increase in license sales roughly mimics the increase in the total population, suggesting that the combined percentage of people buying fishing and hunting licenses fluctuates slightly. However, license sales data can be misleading, because some people buy more than one license, some license purchasers don't use them, and combined hunting and fishing licenses obscure trends.

The 1980 national survey of fishing, hunting, and wildlife associated recreation shows a slight decrease in the numbers of hunters, mainly due to fewer waterfowl hunters.

The regional breakdown offers a clearer picture of trends over a longer time period. Figure 4 shows the percentage of adults 12 years and older who hunted and fished from 1955 to 1980 (USDI, 1982).

Three conclusions are obvious: The percentage of people hunting is decreasing; fishing is increasing; and both activities are more popular in the Mountain States than in the Pacific States. Most remarkable is the small percentage of the population in the Pacific States (5.8) who hunted in 1980. (USDI, 1982). The percentages may have declined further since the survey was published.

A growing number of citizens find sport hunting to be objectionable. Westervelt and Llewellyn found that 79% of fifth and sixth graders surveyed disapproved of sport hunting. Females, urban residents, and children in the Pacific States were the most likely to object (Westervelt, 1985). Kellert concluded that "The American public is slowly shedding some of its traditional support of hunting activities." (1981).

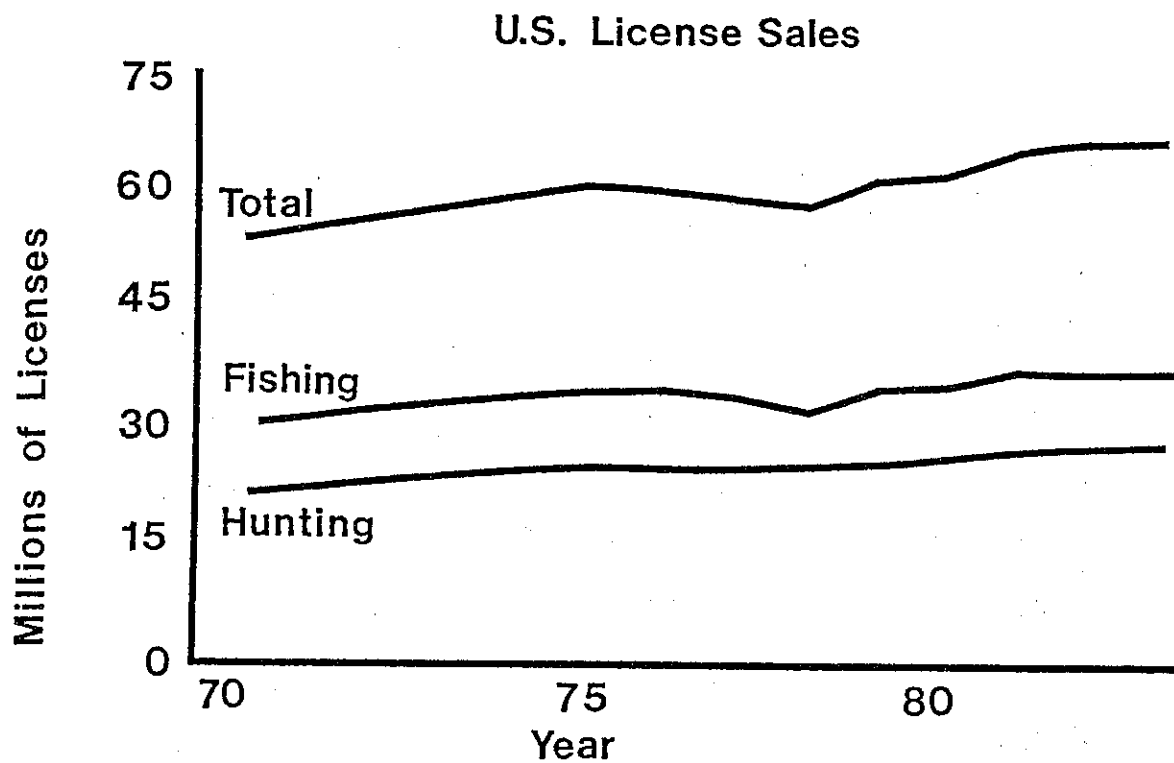


Figure 2

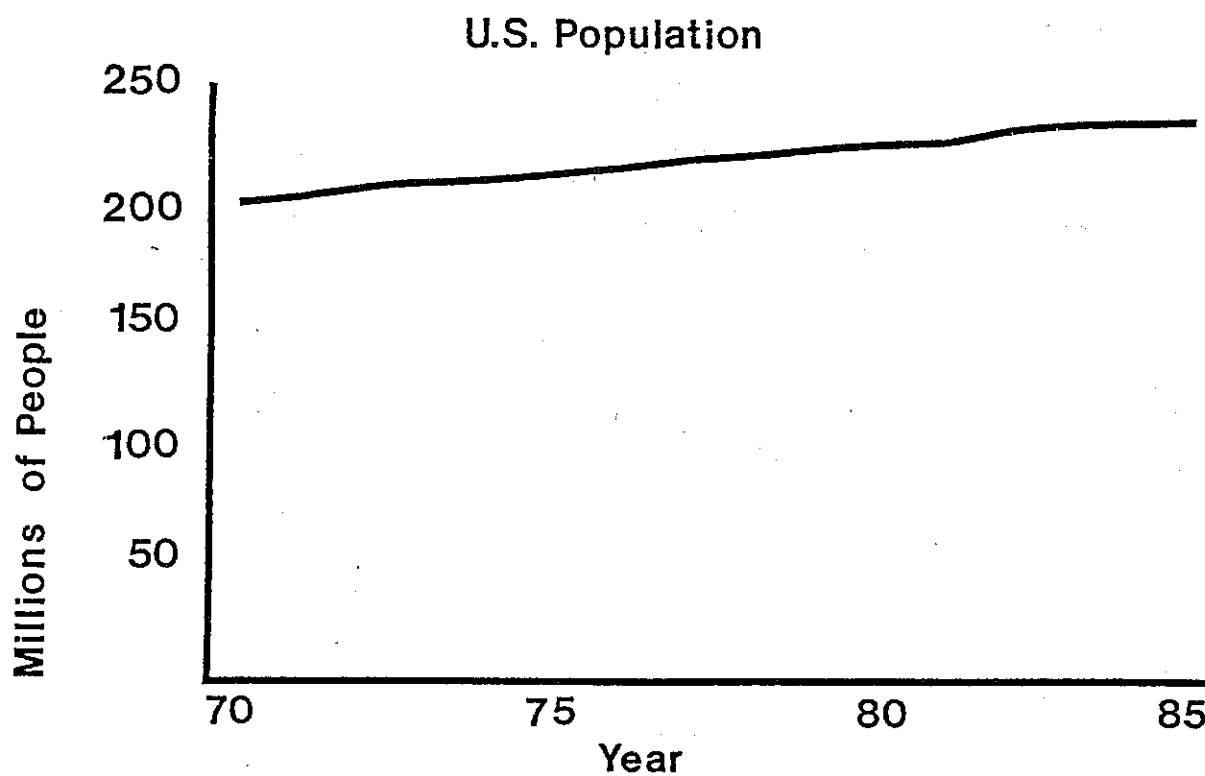


Figure 3

Mountain States

	<u>% Fished</u>	<u>% Hunted</u>
1955	24.6	17.6
1960	26.3	21.4
1965	25.1	19.6
1970	31.3	17.3
1975	29.7	15.3
1980	27.3	13.8

Pacific States

	<u>% Fished</u>	<u>% Hunted</u>
1955	16.6	8.2
1960	19.5	8.4
1965	21.4	8.2
1970	20.0	7.3
1975	23.4	7.0
1980	21.9	5.8

Figure 4

Another important trend affecting the interest in hunting and fishing is loss of habitat. According to the Audubon Wildlife Report, wetlands alone are disappearing at the rate of a half-million acres per year (Cerulean, 1986). Fewer habitats mean fewer animals, with increasing competition for the remaining wildlife.

The trend away from an agricultural-based economy continues, and has a profound effect on where people live and how they spend leisure time. John Naisbitt, author of Megatrends, described our national transition from farmers to laborers to clerks. Urban white collar workers (clerks) are less likely to take up hunting than either rural residents or laborers (Westervelt, 1985).

Political trends are also important. As more women assume policy-making positions, traditional emphasis on consumptive use of wildlife may be challenged. Ninety-two percent (92%) of hunters in the U.S. in 1975 were men (USDI, 1977).

A final important trend will affect the budgets of state fish and wildlife agencies. As the federal agencies refine their approaches to land-use planning and resource allocation debates intensify, state agencies will be called upon to provide information on the impact of proposed actions. The federal agencies and interested citizens will expect objectivity and balanced information about fish and wildlife resources, which will divert state attention away from traditional activities and may shift the emphasis more toward habitat analysis (Chandler, 1986).

**Even if promotional efforts do increase license sales and consumptive use of fish and wildlife resources, the increased revenue will be insufficient to meet the public's future demands of the state fish and wildlife agencies.**

Continuing to focus on traditional uses of fish and wildlife may be institutional suicide for state agencies. Even if advertising produces short term benefits, this narrow approach is almost certain to render the agencies irrelevant in the future. It makes about as much sense as a major advertising campaign to sell reel-to-reel tapes after the invention of the cassette recorder.

Every indication points to the future growth of nonconsumptive wildlife recreation. The demand is shifting. The signals are clear.

. The 1980 FWS survey of wildlife recreation indicated between 83 and 93 million people 16 and over enjoyed wildlife in nonconsumptive ways. This represents growth from 49 million in 1970 and is now 55% of the American population (USDI, 1982).

. In Oregon, the number of nonconsumptive wildlife recreation days increased from 7 million in 1976 to 27 million in 1986 (ODFW, 1986).

. A pilot study of Connecticut school children showed that 82% of the total sample said their families fed the birds (Kellert, 1983).

. The National Wildlife Federation wildlife photo submissions increased from 1700 in 1969 to 16,000 in 1986 (Anon., 1986).

. A family birdseed business in Eastern Oregon has grown 30% in each of the last five years (McAllister, 1985). Five hundred million dollars was spent on birdseed in 1984.

In order to meet these demands in the future, state agencies and the U.S. Fish and Wildlife Service will need substantially larger budgets. The greatest expense will be habitat acquisition. The purchase of urban wildlife habitats will be necessary to meet the public's interest in wildlife viewing and photography, and urban real estate is expensive. The public is also likely to expect interpretive programs, and where wildlife and humans interact, there may be a need to control visitor use to minimize adverse impacts on the ecosystems.

Additional funds will also be required to enable agencies to survey nongame wildlife populations. This data will be useful in assisting other agencies and private landowners in protecting important habitats.

After examining these trends, it's clear that not only are most fish and wildlife agencies still putting most of their eggs in the same basket, it's the wrong basket. Although change is difficult when traditional attitudes are entrenched, broadening the perspective of the state agencies is critical to their own survival and essential if the wildlife and fish resources are to be protected.

## Recommendations

1. State agencies must diversify their funding bases to decrease reliance on license revenue, and find new sources of money. Options include an earmarked percentage of sales tax revenue, vehicle license or registration fees, excise taxes, severance taxes, general fund appropriations, and many other possibilities.
2. To keep in touch with the public and ensure a broad base of support for fish and wildlife programs, agencies should periodically sample public opinion concerning projects and priorities to make sure the programs are consistent with the public's expectations. Encouraging public input may also increase contributions to nongame check-off funds (Manfredo, 1986).
3. The decision-making process in fish and wildlife agencies should be opened to accommodate a broader variety of interests. Traditionally, the only perspectives given serious consideration are those of sportsmen and resource-consuming industry groups whose interests often conflict with wildlife values. The public's view should not be disregarded. Nonconsumptive users are generally a well-educated and affluent constituency (Moss, 1986) who will be effective advocates for wildlife and sound agency programs.
4. Strive for excellence, objectivity, and scientific credibility in agency publications. Avoid propaganda and advocacy-oriented political positions which contribute to polarization and interfere with protection of the resource.
5. Develop comprehensive fish and wildlife programs which recognize the value of all indigenous species and make the transition from single species to ecosystem-oriented management. It's not a new idea. Years ago, Aldo Leopold said:

"The public, not the sportsman, owns the game. The public (and the sportsman) ought to be just as interested in preserving nongame species, forests, fish, and other wildlife, as in conserving game. In the long run, lop-sided programs dealing with game only, songbirds only, forests only, or fish only, will fail because they cost too much, use up too much energy in friction, and lack sufficient volume of support" (Wilson, 1984).

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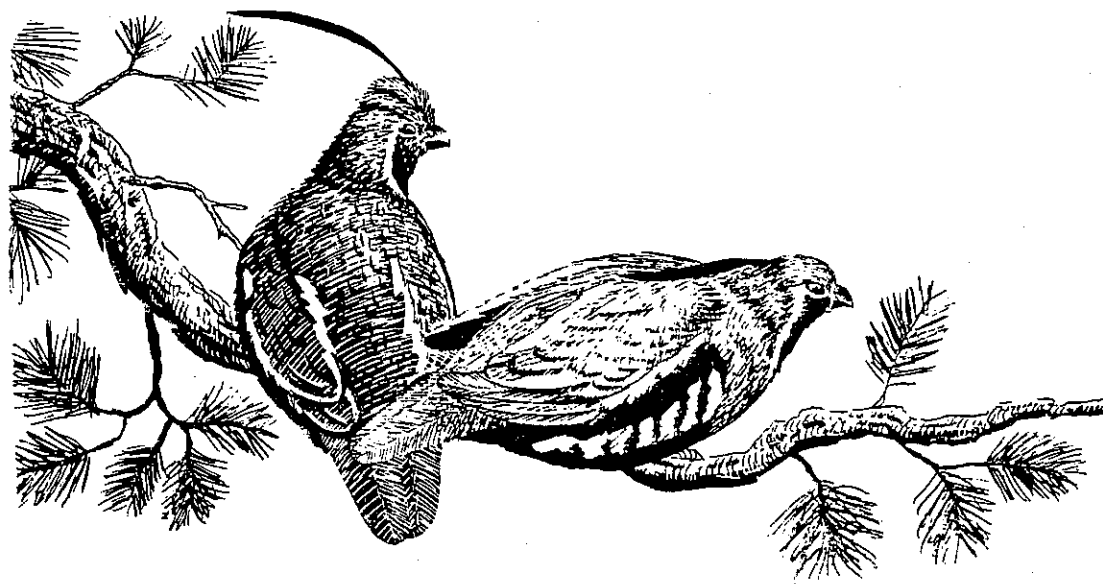
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FEE HUNTING ON THE PUBLIC'S LANDS?  
AN APPRAISAL

Jack Ward Thomas  
U.S. Forest Service  
Pacific Northwest Forest & Range Experiment Station

### The Call for Fee-hunting on Public Lands

Should hunters pay for hunting on lands managed by the USDA Forest Service (FS) or the U.S. Department of the Interior, Bureau of Land Management (BLM)? The Public Land Law Review Commission (1970:169) recommended "...A Federal fee...for hunting and fishing on all public lands open for such purposes." The National Research Council's Committee on Impacts of Emerging Agricultural Trends on Fish and Wildlife Habitat (1982:182-183) observed that "...the trend toward charging fees for wildlife production will have to increase if wildlife habitats are to be protected or developed...The users-pay concept should also be extended to public lands..." Secretary of Agriculture John R. Block said that economics requires the FS to recover more costs of meeting recreation demands (Peterson 1982). The FS has long desired to operate with income exceeding expenditures (Steen 1976). John B. Crowell, Jr., Assistant Secretary of Agriculture, (1983:5) said "...We believe the National Forests can turn a profit...and...the American people should expect such a profit..." FS Regional Forester Craig Rupp (Findley 1982:313) was quoted as saying "The times are changing. Today it's a matter of dollars and cents. That makes it tough on uses that don't produce income, such as recreation."

### Fee-hunting on Private Lands

Hunters paying land holders for hunting is common. The best example is Texas (Teer 1963, Teer and Forrest 1968) where most land is privately owned. The development of fee-hunting from 1930 to 1960, assisted by the Texas Game and Fish Commission, was the salvation of big game hunting. Hunters paid landowners \$108,000,000 in 1971 (Berger 1974) and probably more than \$200,000,000 in 1983. Good hunting can cost \$5 or more per acre each year, with demand still exceeding supply (Teer et al. 1983). Fee-hunting is spreading across midwestern and western states, primarily on lands in private ownership (Severson and Gartner 1972), but is developing more slowly in states with much publicly owned land (Dill et al. 1983, Teer et al. 1983).

### Fee-hunting: Why Now?

The public's view of big game hunting on public lands is changing, and fee-hunting is increasingly discussed. There is an "...increasing enthusiasm for the use of economic analyses..." in public land planning (Convery n.d., p.46) as encouraged by the Forest and Rangelands Renewable Resources Planning Act of 1974 which requires "...identification of...outputs, results...and benefits associated with investments...such...that...costs can be compared with...benefits and...returns to the Federal Government."

Such planning was pursued from 1979 to 1983 during a recession that was particularly evident in locales reliant on forest products industries. This planning emphasized the importance of commodities produced on public lands to those communities and increased awareness of the costs and benefits of various

management alternatives. Simultaneously, decreased tax revenues and government budgets led to more users paying for goods and services formerly provided through taxes (Peterson 1982). It thus seems timely to examine effects of land-use planning by the FS and BLM on big game and hunters, including questions of equity, impacts of fee-hunting on decision making, potential revenues, and consequences for big game and hunters.

### Limiting the Discussion

Why discuss only big game hunting -- why not all wildlife? Game became a commodity when states began charging for hunting licenses. Yet, these fees do little to make game a commodity in the eyes of planners and managers as fees are small and do not accrue to the FS or BLM. How can game receive equal consideration with commodities such as wood and livestock in land-use planning?

Jackson (1980:5-6) said "...The essential difference between game and non-game...is the degree to which ...property rights are...obtained...When you have it in your creel or bag, it's yours...non-game wildlife never becomes the property of an individual...The "lucky" hunter converts a capital item to non-durable goods...title...is transferred from the state to the...individual...[Hunters] privatize the commons.

Leopold (1949:210) said: "One basic weakness in a conservation system based wholly on economic motives is that most members of the land community have no economic value...Yet these creatures are members of the biotic community...[and] are entitled to continuance." Legislation concerning public land management reflects this philosophy (National Environmental Policy Act of 1969, the Endangered Species Conservation Act of 1969, and the National Forest Management Act of 1976). For example, the FS must insure viable populations of presently occurring species. This mandate to consider all species is a constraint in land-use planning. Species given disproportionate attention include those hunted, trapped, or identified as threatened or endangered. Big game are manipulated and their habitats controlled to sustain hunting. This is commodity production and a different objective than maintaining viable populations.

Fee-hunting is examined through a discussion of production and hunting of elk (*Cervus elaphus*) and deer (*Odocoileus* sp.) on FS and BLM lands in the western states, Oregon, Wallowa County, and the Wallowa-Whitman National Forest in northeast Oregon. Principles and concepts could apply to all hunting and fishing. How fee-hunting might alter the consideration of big game in planning is examined by a look at joint production of livestock and deer and elk. The process and conclusions could apply to other commodities.

### The Private Public Land Connection

Oregon's private landowners can and sometimes do charge for hunting, though it is less practical than in states where most land is privately owned. Free hunting on public lands is severe competition (51 percent of the land in Oregon is owned by the Federal government).

Management is complicated by the movement of elk and deer between summer and spring-fall ranges (areas commonly in public ownership) and lower elevation winter ranges (often in private ownership). Most elk and deer are on public lands during hunting seasons. Hunter access to private lands is frequently denied because of perceived disincentives to owners including: damage to

roads, fences, and range and forest lands; vandalism; and gates left open. When there is more to lose than gain by allowing hunting, denial of hunter access increases. In addition, some landowners consider elk and deer themselves a problem citing competition with livestock, trampling of forage and wet soils, and damage to crops and fences.

Many landowners in the vicinity of FS and BLM lands graze livestock on those lands for a fee (\$1.40 per Animal Unit Month in 1983). These "rights" are, in practice, transferred with ownership of private land. This seasonal grazing may enhance the value of the private land (USDA and USDI 1977). Some analysts maintain that enhancements were absorbed by the first seller and no longer exist (Winter and Whittaker 1981). The FS and BLM control periods of grazing and livestock numbers and cooperate with graziers to enhance grazing.

Over the past 40 years, elk have increased in numbers and occupied new range in northeast Oregon. The number of mule deer has fluctuated and, coincidentally, the number of livestock grazed on public lands has declined. Some people perceive a cause-and-effect relationship: others do not. There are insufficient data on forage availability, utilization, or range condition and trends to settle the dispute.

Jackson (1980:3) said the United States is a mixed economy (production of goods and services is shared by public and private sectors). Wildlife is state owned while individuals and government (Federal, State and local) own the land. "...This...mixture of public and private responsibility...lies at the heart of most...wildlife management problems." Having recognized this, how can it be corrected? Changing wildlife ownership is unlikely as is large scale transfer of FS and BLM lands into private ownership. There may be other ways: fee-hunting is one.

### **Big Game and Land-Use Planning**

The FS and BLM are carrying out land-use planning and resource allocations with second generation plans to be completed in 1983-1985. Planners present alternatives for consideration by users, citizens, and decision makers. The alternatives contrast mixes of products with associated social, economic, and environmental effects. One alternative is "preferred." After public comment, the decision maker selects an alternative or has a new one created to guide management.

These alternatives usually project inverse relationships between high levels of timber production and elk numbers and between livestock and elk and deer numbers. Elk welfare seems to have evolved into a surrogate for amenities to be contrasted against timber and livestock as commodities. Differences of opinion over appropriate allocations between those whose interests are in amenities and those whose interests are in commodity production seem to focus on disputes over elk versus timber and livestock.

Livestock and wood have market values, and economic effects of decisions influencing these industries are discernible -- particularly at local levels. Leontief's (1955) input-output models have been used to trace alterations within an area's economy caused by changes in levels of livestock and wood production (Obermiller et al. 1981, Obermiller and West 1983). The FS and BLM have not used these methods, but the burgeoning debate over land-use allocations for northeast Oregon have been influenced by such analyses.

## Deer and Elk: Commodities or Amenities?

Because big game on public lands are not market valued, values have been indirectly assigned by various techniques (Brown et al. 1973, Langford and Cocheba 1978) including: hunters' expenditures; hunters' willingness to pay; revenue forgone (opportunity costs) from commodity production to produce elk and deer; value of the meat; valuation of each day of recreation; direct costs of big game production; and travel costs. These methods yield varying values (Loomis and Sorg 1983) and are for hunting; not for big game and habitats per se. Methods can be chosen and values manipulated to alter contrasts between commodities and big game production.

Ostensibly, these values are treated similarly to those derived from market values. Yet, everyone knows "real dollars" (derived from market value) from "estimates." Such estimates fare poorly when contrasted against revenues and do not measure monetary impact but welfare or consumer surplus. Comparing such estimates against market determined values is dubious (Gum and Martin 1975, Bishop and Heberin 1979). Only when game values are expressed as revenues can they receive the same respect as commodities. Other expressions of value will, I suspect, always be viewed incredulously.

With no market value, elk and deer are considered amenities by planners and decision makers who must consider cost:benefit ratios. Demands for and values of commodities will grow as the land base shrinks (USDA FS 1980a) and population increases (USDA FS 1980b). Likely there will be pressures to enhance and exploit foreign market opportunities, stimulate natural resource based industry, address balance of payments problems, and increase revenues from the public lands while cutting costs. Therefore, amenities are apt to suffer, increasingly and over the long-run, in tradeoffs against enhanced commodity production (Ophuls 1977).

## Questions of Equity

Maintaining big game to support current or greater levels of hunting will be made difficult by questions about equity: who wins and who loses in the planning-allocation game? Planning is most specific at the lowest level (National Forests) where impacts on people, economies, and environment are most discernable. Receipts (25 percent) from FS timber sales and livestock grazing are paid to counties within which a Forest lies. Further, timber management and harvesting, grazing, and production of wood products contribute to local economies through employment, business, and taxes. Regional and national impacts are more difficult to identify.

When wood production or grazing is constrained to benefit big game, local communities bear most of the cost (Obermiller 1980). Opportunity costs include payments to local government; job income associated with growing, harvesting, and processing trees; income to local rangers; investments in plants; and profits to suppliers, shippers, and entrepreneurs. Of course, elk and deer benefit local hunters. But, most hunters come from more affluent, heavily populated, extensively developed, and economically diversified regions. Opportunity costs are likely to be much less for hunters from distant communities.

Obermiller and West (1983) examined a FS planning alternative that reduced timber cutting and cattle grazing in Wallowa County in favor of recreation — including big game hunting. Of 21 economic sectors, 4 gained and 17 lost.

There were losses anticipated in household and business income of 1 percent of total transactions. Gains and losses up to 4 percent were anticipated in some sectors. Consider, then, Jackson's (1980:4) statement, "...It is this transfer of resources from taxpayers in general through bureaucracies to their constituents that characterizes the non-market portion of the mixed economy. The lack of quid pro quo arrangements automatically infers wealth transfers."

#### **Advocacy Planning — A Win-Lose Game**

When demand exceeds supply, supplies are allocated among competitors. The playing board is delimited by "multiple-use" requirements — wood, water, wildlife, recreation, and forage will be provided. But flexibility exists in how resources may be allocated (i.e., equality among resource interests is not implied). Policies, such as aiding economic and social stability of local communities, have bearing. Direction from the Executive Branch or Congressional mandates (usually in the form of funding) influence the mix and amounts of "products." Laws and regulations govern permissible levels of activity or impact, i.e., the size of clearcuts or maintenance of viable populations of native wildlife. Funding determines, to large extent, the emphasis of management. Current planning produces "win-lose games:" when one player wins another loses. Win-lose gaming encourages and sharpens competition while discouraging cooperation.

Consider forage allocation between livestock and big game, for example. Planners commonly convert animals to Animal Units (AU) — one 1000-pound cow or its equivalent. An Animal Unit Month (AUM) is one AU grazing one month. Other ungulates are converted to AUMs on the basis of weight (2.5 elk/AUM and 5 deer/AUM). Though such comparisons overestimate competition (Flinders, n.d.), the process has become traditional. Allocation procedures usually call for limiting AUMs while maintaining or progressing toward specified range conditions. AUMs are divided between domestic livestock and wild ungulates.

#### **Wildlife: A Federal/State Responsibility**

Determining how many big game animals are to be killed and when, where, how, and by whom is a state prerogative (Peek et al. 1982). Whether the Federal government could exercise such authority (Bean 1977) is moot here. There is no desire to disrupt existing arrangements. The FS and BLM set goals for AUMs but regulate only livestock. A state may or may not choose or be able to manage big game numbers at levels specified.

This produces a win-lose game between graziers and big game enthusiasts. If AUMs are distributed between livestock and big game, and substitutability assumed, one group gains only at the other's expense. When planners allocate forage on public lands to big game they, to some extent, allocate forage on private lands that support those animals for part of the year. In the debate over forage allocations between elk and livestock in northeast Oregon, elk have been called "welfare animals" by graziers; i.e., they do not pay their upkeep in revenue to landowners. By extension, those who hunt elk are "welfare recipients." This perception, true or not, may gain adherents if conflicts intensify.

Sustaining hunting influences planners and decision makers only if it is a land management objective. Demand for big game hunting is anticipated to increase (USDA FS 1980a). Viable populations (the current minimum requirement) could be maintained with many less animals than currently present

and with no adjustments in practices to enhance timber and livestock production.

### No "Free Lunch"

Consider two of Commoner's (1971) "laws" of ecology: everything is connected and there is no "free lunch." There is increasing competition for resources (Ophuls 1977). Land-use planning will likely continue and intensify. Commodity production is apt to become more dominant with each planning cycle. Hunting may decline over the long run. Chances of maintaining status quo could improve if big game became a commodity that competed effectively in a game where points are scored with superior cost:benefit ratios. Or, as Jackson (1980:8) put it, "...In many instances, major wildlife costs will not show up in an agency budget. These costs are simply forgone income. Any attempt to ignore these costs represents a fallacious free lunch. Perhaps the recent mandate to use economic decision criteria...demonstrates that the price tag...is starting to emerge."

### Fees From Hunters: Slicing the Pie

The application of user-pay concepts to hunting on public lands is the point here. My purpose is to stimulate consideration; not to prescribe. Receipts may vary widely by locale. The following is one of many possible approaches. The Sikes Act of 1974 provides opportunity for states to take the lead in prescribing fees for hunting on Federal lands. Such fees are presently charged by Virginia, West Virginia and Arizona.

Hunters could be required to purchase a Federal stamp to be attached to their state hunting license for each big game species hunted on public land. The price should, at least, reflect opportunity and direct costs of producing the big game. Then, if that price is less than full value, prices could be increased to insure competitiveness with other commodities. Why not charge full value? Equity problems are reduced if users pay full value, but determining full value for some uses in a generally acceptable way is difficult, and those who lose in competition for resources will not be mollified merely because the winner paid full value. No system of charges will dampen desires of user groups to obtain their wants and needs (Clawson 1975).

Receipts could be allocated to make the scheme more acceptable to various levels of government, those who profit from using natural resources, hunters, and the public. A portion (25 percent) of timber and grazing receipts go to counties for schools and roads. Such payments should not decline if big game is favored at some cost over timber and livestock interests. Desired big game habitats in managed forests and rangelands are achieved largely through modifications in practices that could be used to increase timber and livestock production. This may cost livestock and timber interests by reducing production potential.

Management of public lands can affect big game use of adjacent private lands. Therefore, one-quarter of receipts could be allocated to states to enhance management on private lands that provide seasonal habitat for big game residing partially on public land. This should make fee-hunting more acceptable to the states and private landowners.

Some percentage of revenues (say 25) could be treated similarly to funds

reserved from timber sale receipts for forest establishment and improvement. There is a similar allocation of grazing receipts. A portion of hunting fees could be similarly dedicated to timber sale design, habitat management, establishment and maintenance of hunter facilities, road management, and enforcement.

The remaining 25 percent of revenues (less administrative costs) could go to the Federal Treasury. There are no guarantees, but those who frame and legislate budgets seem more inclined toward expenditures that produce revenue. If so, all or part of this money might be dedicated to wildlife management.

What would fee-hunting do for big game and hunters? Big game would move from amenity to commodity status. Hunter fees would go to local governments (to support schools and roads), to state governments (to mitigate problems for private landowners), to the land management agency (to manage wildlife habitat), and to the Federal Treasury (perhaps to be appropriated for wildlife management). Such contributions might enhance the image and influence of hunters.

### Potential Revenues

Deer and elk harvest data (Table 1) and the potential revenues from fee-hunting on public land (Table 2) were derived for the western states, a state, a county, and a National Forest. Experience with increases in elk hunting license fees (Potter 1982) indicates that demand is elastic; i.e., demand drops with price increases. There is limited experience, however, with fee-hunting on public lands. Potential revenues are presented so that declines in demand with various fees can be estimated.

Table 1. Elk and deer killed by hunters on public lands in the western states, State of Oregon, Wallowa County, and the Wallowa-Whitman National Forest<sup>a</sup>.

	Elk	Deer
Location of kill:		
Western states <sup>b</sup>	79,406 <sup>c</sup>	1,298,000 <sup>d</sup>
Oregon	14,379 <sup>c</sup>	62,812 <sup>d</sup>
Wallowa County	3,000 <sup>c</sup>	1,755 <sup>c</sup>
Wallowa-Whitman NF	4,296 <sup>c</sup>	4,743 <sup>c</sup>
Number of hunters		
Western states	566,962 <sup>c</sup>	4,475,862 <sup>d</sup>
Oregon	99,578 <sup>c</sup>	189,619 <sup>c</sup>
Wallowa County	15,262 <sup>c</sup>	6,167 <sup>c</sup>
Wallowa-Whitman NF	25,288 <sup>c</sup>	16,522 <sup>c</sup>
Percent hunter success:		
Western states	14 <sup>c</sup>	29 <sup>d</sup>
Oregon	15 <sup>c</sup>	33 <sup>c</sup>
Wallowa County	20 <sup>c</sup>	28 <sup>c</sup>
Wallowa-Whitman NF	17 <sup>c</sup>	29 <sup>c</sup>

<sup>a</sup> Statistics on mule deer and black-tailed deer for the western states are from 1975.

<sup>b</sup> The "western states" include Alaska, Arizona, California, Colorado, Idaho, Montana, Nebraska, Nevada, New Mexico, Oregon, South Dakota, Utah, Washington, and Wyoming.

<sup>c</sup> Derived from data in Potter (1982). It was assumed that 80 percent of all elk killed were taken from public land.

<sup>d</sup> Derived from data in Conolly (1981).

<sup>e</sup> Derived from data in Oregon Department of Fish and Wildlife (1980).



Table 2. Potential income from sale of hunting stamps for deer and elk hunting on public lands at various price levels based on 1979 data (in \$thousands).

		Percentage of 1979 hunters that will hunt at the price indicated					
		100		80		60	
	Price/stamp	To States, Counties, Forests, and Districts, Treasury		To States, Counties, Forests, and Districts, Treasury		To States, Counties, Forests, and Districts, Treasury	
		Total		Total		Total	
Western states <sup>a</sup>	\$100	\$ 56,696	\$14,174	\$ 45,357	\$11,339	\$ 34,018	\$ 8,504
	50	28,348	7,087	22,678	5,670	17,009	4,252
	25	14,174	3,544	11,399	2,835	8,504	2,125
	10	5,670	1,418	4,536	1,134	3,402	851
Oregon <sup>a</sup>	100	9,960	2,490	7,968	1,992	5,976	1,494
	50	4,980	1,245	3,984	996	2,988	747
	25	2,490	623	1,992	498	1,494	374
	10	1,000	250	800	200	600	150
Wallowa County <sup>b</sup>	100	1,526	382	1,221	305	916	229
	50	763	191	611	153	457	114
	25	382	95	305	76	229	57
	10	153	38	122	31	92	23
Wallowa-Whitman NF <sup>b</sup>	100	2,529	632	2,203	506	1,517	379
	50	1,264	316	1,012	253	759	190
	25	632	158	506	126	379	95
	10	253	63	202	51	152	38

ELK

DEER									
Western states <sup>c</sup>	50	223,799	55,950	179,039	44,759	134,279	33,570		
	25	111,897	27,974	89,518	22,379	67,138	16,785		
	10	44,759	11,190	35,807	8,952	26,855	6,714		
Oregon <sup>c</sup>	50	9,480	2,370	7,584	1,896	5,688	1,422		
	25	4,740	1,185	3,792	948	2,844	711		
	10	1,900	475	1,520	380	1,140	285		
Wallowa County <sup>b</sup>	50	308	77	247	62	185	46		
	25	154	39	123	31	93	23		
	10	62	15	50	12	37	9		
Wallowa-Whitman NF <sup>b</sup>	50	826	207	661	165	496	124		
	25	413	103	330	83	248	62		
	10	165	41	132	33	99	25		

<sup>a</sup> Derived from data presented by Potter (19082).

<sup>b</sup> Derived from data provided by Mike Kemp and Vic Coggins of the Oregon Department of Fish and Wildlife.

<sup>c</sup> Derived from 1975 data (Connolly 1981).

## Return Per AUM

Returns per AUM could be used in contrasting land-use alternatives involving forage allocation between livestock and big game. Graziers paid \$1.40/AUM to the Federal government in 1983. Fees vary yearly considering livestock prices and production costs. Potential revenues per AUM for deer and elk are shown in Table 3. These revenues exceed those from livestock, with elk stamps at \$5.00 and deer stamps at \$10.00, assuming no decline in hunter numbers (Table 3). The actual value of livestock grazing is higher than grazing fees -- \$7.90 in 1979 (USDA FS 1980C) -- because the fee is set through non-market mechanisms that include consideration of leasee labor, management, and equity capital costs. At these prices, elk produce more revenue at a stamp price of \$20 and deer at a price of slightly more than \$50.

## Advantages to Private Landowners

AUMs would not be allocated considering only revenues. Multiple-use mandates, contributions to community stability, tradition, established use, and political realities would enter in. It is not likely that livestock numbers would be reduced substantially to favor deer and elk. Pressures would likely develop for techniques to determine AUM equivalencies between livestock and big game. Overestimates of competitiveness would be less tolerable.

Table 3. Estimated value per AUM of elk and deer on public land at various stamp prices and hunting levels for the State of Oregon, Wallowa County, and Wallowa-Whitman National Forest, 1979.

	Price/ stamp	Location	Percentage of hunters continuing to hunt at this price			
			100	80	60	40
Elk	\$100	Oregon	37.38	29.90	22.43	14.95
		Wallowa County	25.22	20.18	15.13	10.09
		Wallowa-Whitman NF	25.12	20.10	15.07	10.05
	50	Oregon	18.69	14.95	11.21	7.48
		Wallowa County	12.61	10.09	7.57	5.04
		Wallowa-Whitman NF	12.56	10.05	7.54	5.02
	25	Oregon	9.35	7.48	5.61	3.74
		Wallowa County	6.31	5.05	3.79	2.52
		Wallowa-Whitman NF	6.28	5.02	3.77	2.51
	10	Oregon	3.74	2.99	2.24	1.50
		Wallowa County	2.52	2.02	1.51	1.01
		Wallowa-Whitman NF	2.51	2.01	1.51	1.00
Deer	50	Oregon	7.55	6.04	4.53	3.02
		Wallowa County	7.66	6.13	4.60	3.06
		Wallowa-Whitman NF	11.23	8.98	6.74	4.49
	25	Oregon	3.77	3.02	2.26	1.51
		Wallowa County	3.83	3.06	2.30	1.53
		Wallowa-Whitman NF	5.62	4.50	3.37	2.25
	10	Oregon	1.51	1.21	.91	.60
		Wallowa County	1.53	1.22	.92	.61
		Wallowa-Whitman NF	2.25	1.80	1.35	.90

Private landowners who provide seasonal ranges for big game residing partly on public land would benefit from hunter fees. Payments to counties could reduce taxes, increase services, or both. Contributions to the State could pay for big game management on private lands. And habitat improvements on public lands, such as enhanced forage production and water development, would benefit livestock. There is another potential boon: improved ability to lease private lands for hunting. Hunting access on public land would no longer be free and the onus of charging for hunting will have been absorbed by the FS and BLM. The payoff? The game is no longer win-lose. It could become a win-win game where more players can maintain or improve their overall position.

### Social and Cultural Acceptability

Clawson (1975) suggested that forest policy issues are analyzed by considering: (1) physical and biological feasibility and consequences, (2) economic efficiency, (3) economic welfare as equity, (4) operational and administrative practicality, and (5) social or cultural acceptability. I find no insurmountable barriers to fee-hunting in the first four, leaving fee-hunting to be accepted or rejected solely on social and cultural considerations. Hunters and state fish and game departments are apt to be the arbiters. Acceptance will not be immediate and will require a concentrated educational effort to explain and explore the ramifications.

Economically there is a loser: the hunters who pay. Some say "this will make hunting a rich man's sport." This is effective rhetoric but considerably less telling when the fee is considered as a percent of the cost of hunting. The real issue is survival of big game hunting on public land at present levels. The poorest hunter is one without opportunity — including a place to hunt and a quarry to pursue.

Hunters, with other taxpayers, pay for public land management and, currently, expenditures exceed receipts. In one sense hunting may be considered partially paid for because other commodities are similarly subsidized by taxpayers at large. It may be reasonable, therefore, that hunters pay fees set just high enough to insure comparability with other commodities.

Leopole (1949:177) stated that hunting had three cultural values: "split-rail" values or experiences reminiscent of distinctive origins and evolution; recognition of the "soil-plant-animal-man food chain;" and "sportsmanship." He concluded that:

Wildlife managers are trying to raise game in the wild by manipulating its environment, and thus to convert hunting from exploitation to cropping...how will it affect cultural values? ...the split-rail flavor and free-for-all exploitation are historically associated...Perhaps the stubborn resistance of the 'one-gallus' sportsman to be converted to the cropping idea is an expression of his split-rail inheritance. Probably cropping is resisted because it is incompatible with one component of the split-rail tradition: free hunting.

The argument lingers: the essence fades. Stand by a FS road in elk country just before hunting season and watch the parade of trucks (many with 4-wheel drive), recreational vehicles, campers, trailer houses, and horse trucks or trailers. Visit the camps. Marvel at the equipment. Leopold's one-gallus hunter has changed. Yet the vivid and appealing imagery remains — free men,

public free country, free hunting! Of course, the "free lunch" was never, at least in recent times, free (Jackson 1980). It just cost less and the taxpayers and landowners paid the bill without knowing it or, at least, without loud complaint.

If hunters want to hunt in present or greater numbers, they should pay, at least, direct and opportunity costs of producing big game. Supply is thought to be governed by price as guided by Adam Smith's (1776) invisible hand of supply and demand. Demand for free hunting is increasing. But whatever effectiveness it has had in insuring huntable surpluses of big game is apt to diminish as planning intensifies and opportunity costs increase. Demand expressed in revenue to land holders would tend to have opposite effects.

elk hunters increased dramatically from 1930 to 1980 (Potter 1982). This was also true for hunters of mule deer until the decline in both deer and hunters in 1965-1978. But hunter numbers remained high enough to contribute to decreases in success rates (Connolly 1981). Hunter success seems inversely related to hunters per animal pursued. Further, hunter numbers stabilize when success drops to 5-10 percent (USDA FS 1975). Though limiting hunters is politically and economically difficult, some states have done that. Others are scrambling to avoid the inevitable — limiting hunter numbers. Projections (USDA FS 1975) of a 66-percent increase in demand for big game hunting by 2020 indicates that further restrictions lie ahead even if present big game numbers are maintained. Increasing demand for hunting from 1930 to 1983 was met by increased big game numbers, improved access, manipulation of open seasons, bag limit reductions, and declining success rates. Such options are being exhausted. The mechanism that distributes most scarce goods in our society — charging a fee — is essentially untried on public lands. If it is desirable to constrain hunter numbers on public land, fees would have that effect, at least temporarily.

Increases of \$3-7 in the cost of hunting licenses have caused temporary declines in elk licenses sold. Lesser increases had little influence (Potter 1982). There is little experience to help predict what would happen to hunter numbers on public lands if the fees described herein were instituted. In Texas, where much higher fees than \$3-7 are charged for hunting on private lands, demand for hunting exceeds supply and is probably growing (Teer et al. 1983). The "law" of demand (Samuelson 1973; when a good's price increases, and other things are held constant, less will be demanded) indicates that, in the short-run, fewer people would hunt and declines would increase with price. Opportunity to hunt would depend on ability or willingness to pay these additional costs or both. Over the long run, hunters would likely rebound with the increased demand anticipated.

What are those interested in big game hunting on public lands to do? They can strive to maintain "free" hunting and current or increased numbers of big game. This seems likely to continually lose effectiveness. Or hunters can pay for producing big game at levels that support hunting. This may be the most effective way to sustain big game hunting on public lands. If the hunter pays, does the hunter lose? there would be a loss in "split-rail" values, but other cultural values would survive. If this fiscal contribution enhances the survival of big game hunting on public lands, the hunter is a clear winner — perhaps the biggest of all.

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SELLING HUNTING AND FISHING OPPORTUNITIES  
ON PUBLIC AND PRIVATE LANDS - SHOULD IT BE SUPPORTED?

William A. Molini  
Director  
Nevada Department of Wildlife

The topic of this issue debate is particularly timely and pertinent for two reasons. The first is the present administration's (and even now the American public's) captivation with budget reduction which translates, to a need for decreased federal government expenditures and increased Treasury receipts. The second is the faltering economic condition of traditional natural resource related commodities, primarily livestock grazing, timber and agriculture.

The first situation has become manifest in a strong philosophy, if not policy, that the user of federally provided goods and services should pay fair value for these services. Considerable discussion from the federal government has centered on charging a fee for the use of the public lands, and, in fact, I view this as the central issue of this discussion.

The second reason has resulted in a situation where western ranching operations are hard pressed to pay their bills through the traditional practice of marketing livestock and therefore many are looking at any and all opportunities to increase their revenue base. Both of these situations have created an atmosphere in which institutions of our society are strongly evaluating the market potential of wildlife. Such circumstances mandate that wildlife managers carefully evaluate the ramifications of selling hunting and fishing opportunities before determining whether such actions are good either for wildlife or the users of wildlife.

The concept of the user of goods or services paying for those goods or services in an amount dictated by supply and demand is the basic foundation of our socio-economic system. Therefore, we are well conditioned to this concept and in most aspects of our human experience we give no thought to user fees. Hunting and fishing is a notable area of exception to this fact, however, and people in the west cling tenaciously to this last vestige of the pioneer ethic of free resource use. Of course over the past 80 or so years people have come to accept hunting and fishing license fees, but if you believe that they fully accept the concept of supply and demand market forces, just try and raise license fees.

Let me first address briefly the topic as it applies to private lands. As already mentioned, western cattle ranchers are currently on the horns of a serious economic dilemma primarily caused by low market demand for their product, coupled with high costs of doing business. This is also true for many other producers of agricultural products. Many of these private ranch and agricultural lands support huntable populations of wildlife, at least seasonally, and some also have outstanding fishing opportunities. The majority of these private land owners have not traditionally charged fees for hunting and fishing, and while some of these private agricultural lands have been closed to public trespass, many have not. Most of those which have been closed have still accommodated hunting and fishing mainly by friends of the owner. That these lands

have traditionally accommodated a portion of the hunting and fishing demand is an important consideration.

I believe that the business of supporting fee hunting and fishing even on private lands, must be approached carefully for the following reasons:

First is the inherent risk of the diminishment of the historical, and legal tenant that wildlife resources belong to the public and therefore have no private ownership and are not a commodity to be traded or sold. The title of this session's topic embodies this basic principle in that it carefully addresses selling hunting and fishing opportunity not selling fish and wildlife resources. In fact, the statutes or regulations in all states of which I am aware, preclude the selling of wildlife and therefore, in a technical legal sense, a landowner can only charge an access fee to be upon his land for the opportunity to hunt or fish.

Secondly, our forefathers in the conservation movement wrested wildlife from the market place and in so doing saved many wildlife species from the brink of extinction and firmly entrenched the applicability of the public trust concept to wildlife. In fact it was the efforts of these farsighted people, giants of conservation, like Theodore Roosevelt and others who, by eliminating market hunting, put wildlife on the track of recovery to provide for us the wildlife heritage which we enjoy today.

We all clearly recognize that habitat is the key to wildlife existence, abundance and diversity, and the general contemporary thought is that if wildlife can provide significant economic return to the landowners, that they will endeavor to increase, at least marketable wildlife, through habitat preservation and improvement. While I am in essential agreement with this thought, I again caution that we must move into such an advocacy arena with a solid philosophical and legal structure to keep politics, as driven by economics, from impinging upon the canons which constitute the foundation of our wildlife management system.

I would like now to turn my attention to the issue of selling hunting and fishing opportunities on public lands. The primary focus here will be on those lands held in public trust by the federal government and under the management jurisdiction of the Bureau of Land Management and the United States Forest Service, however, most of the arguments put forth here are applicable to other public lands on which hunting and fishing are significant activities.

The public lands provide habitat for the full array of wildlife species which occur in the western United States, but of major concern for this discussion are the game species of wildlife and fish. Most big game populations are dependent, at least for a portion of their seasonal habitat requirements, on public lands and many small game species and fisheries resources are wholly or partially dependent on public land habitats as well. Therefore, the abundance of fish and wildlife and attendant hunting and fishing recreation opportunity is largely dependent upon the management of public land habitats. It is pertinent to note that of all the resources produced on the public lands, that only wildlife is under the management jurisdiction of the states. While the legal tenants reserving wildlife jurisdiction to the states has been challenged, this principle remains broadly and solidly accepted across the spectrum of government.

Under the present federal administration there has been a strong philosophical determination that users of public lands should pay for this use and that the primary benefactors of public land goods should pay appropriately for these goods. While this concept itself fits neatly into the framework of our socio-economic system, it is the application of the concept which is flawed.

The basic proposal which has surfaced from this philosophy is that hunters and fishermen, should pay a fee to engage in their chosen pursuit on public lands and the revenue from this fee should be returned to the responsible land management agency, in the state where collected, to pay for fish and wildlife habitat maintenance and improvement. While this proposal sounds reasonable on the surface, a comparison of this concept to other user pay systems on the public land will show it to be fraught with inequity.

Currently, only commercial users pay a use fee on public lands. While this category encompasses many uses ranging from timber harvest to pinenut picking, the major commodity producers on public lands are the timber, mining and livestock industries. I am going to focus on livestock producers, not because I feel that they warrant being singled out compared to other commodity uses, but because I am most intimately familiar with this industry on public lands and because I believe that their situation well illustrates the points which need to be considered and which are applicable to most other commodity uses. Ranching, however, is, in many cases, far more compatible with fish and wildlife, than are other commodity uses.

The livestock industry does indeed pay a user fee and has done so for about 50 years. The concept behind this fee is somewhat analogous to the concept of a hunting and fishing user fee, i.e., the public land grazer pays a fee for grazing his livestock and a portion of this fee is returned to the land management agency for administration of the grazing program and for maintenance and improvement of the range resource. There are several outstanding flaws with application of this concept. First, the fee receipts, at current rate, do not begin to cover the costs of administration of the program. Currently, as established by executive order #12548, the fee is set at \$1.35 per annual unit month (AUM - forage necessary to support one cow and calf under six months of age, or one cow or one bull for one month) while the average cost to administer the program on BLM lands is \$2.87 and is slightly higher on Forest Service lands or about \$3.40 (USDA-USDI, 1986). The overall average then for both agencies is somewhere in the neighborhood of \$3.00 per AUM which means that for every AUM of public land forage consumed, the U.S. taxpayer, which includes some 17 million hunters and 36 million fishermen (U.S. Fish & Wildlife Service and Bureau of the Census, 1980), subsidizes this commercial use by \$1.65 more than the commercial producer pays for producing the commodity from which he makes a profit.

Considering that hunters and fishermen constitute a significant segment of the taxpayer base, it is interesting to note that in the area encompassed by this Association, about 53 percent of the population fishes and 22 percent of the population hunts, while only a fraction of 1 percent of the population is involved in livestock production. Furthermore, only 2 percent of the forage consumed by cattle in the United States comes from public lands (USDA-USDI, 1986).

Not only does the sportsmen incur a direct cost through federal taxes to support the livestock industry, but improper livestock grazing can, and too often, does diminish

the productivity of the land and therefore reduces its ability to support fish and wildlife. This is especially evident in riparian ecosystems throughout the west, and these areas provide key habitat to a substantial array of wildlife (Thomas, et. al., 1978). The diminished ability of the land to support fish and wildlife represents another cost to the fisherman and hunter in terms of their support of commodity production from the public lands.

Now, the argument is often put forth that grazing fees or timber receipts are not a fair measure of the costs incurred by the commodity producers to harvest these important products from the public lands. The common scenario in terms of livestock production, for example, is that there exists on public rangelands a standing crop of forage (captured solar energy, if you will) that is of little value if the livestock producer is not there to harvest the crop for its societal value in terms of pounds of red meat. The livestock producer must put into place the necessary facilities, i.e. base ranches, fences, water developments, corrals, loading chutes, etc. in order to initiate an operation to harvest this otherwise potentially wasted crop. Now one could pursue a number of avenues of argument on this subject, but basically there is some truth to this point. Facilities and livestock control, certainly much of which is paid for by the producer is necessary to harvest this crop. Well, here there is a strong analogy with the business of hunting and fishing.

I have often had the feeling from public land managers that they consider the state wildlife agencies to be getting a free ride. That the land management agency produces and manages the habitat, at some cost to the government, and that the state then creams off license fees to allow the hunter or fisherman to go on public lands and harvest the wildlife produced and supported by the "federal habitat". There is probably some truth to this scenario, but consider, if you will, the cost of putting in place the facilities and the program to provide a framework within which fish and wildlife can be safely harvested to ensure their perpetuation and a sustained yield over time.

The budget for the Nevada Department of Wildlife is used here for illustrative purposes. The Nevada Department is, in most ways, typical of western state wildlife agencies except that it is the smallest in the west and Nevada is the largest public land state in the west outside of Alaska. The current budget for the Department to maintain a comprehensive wildlife management program including law enforcement, game and fishery management, habitat protection, information and education and administrative services is 7.5 million dollars. While not all of this money is expended on the program for public lands, since 87 percent of the land area of Nevada is in public ownership, I would estimate that approximately 80 percent of the budget is expended to effect the wildlife management program on public lands. I cannot imagine that the federal government could initiate a similar program for any less money. About 97 percent of the Department's budget is currently funded by hunters and fishermen through license fees and Federal Aid in Wildlife and Fisheries Restoration revenue.

The point here is that first, such a system is necessary to perpetuate recreational hunting and fishing, and secondly, the sportsmen already pays for this system and thereby pays his fair share for the protection, preservation and enhancement of wildlife resources both on public and maybe to a slightly lesser degree, on private lands.

The final major argument which must be made is, if a hunting and fishing user fee is initiated for public lands, how can the sportsmen expect to benefit from this fee? A common argument of the proponents of this system is that he will gain standing to have a stronger voice in the public land management decision-making process. While this may realistically be the case, it should not be, as the sportsman is already making a significant contribution in general taxes, in losses of wildlife opportunity because of habitat impacts from commodity production, and in state license fees. The sportsman should have solid standing now and his interests, as represented by the state wildlife agency, should receive at least equal consideration with all other public land uses. I maintain that, with the exception of certain favored commodity uses, this is the case.

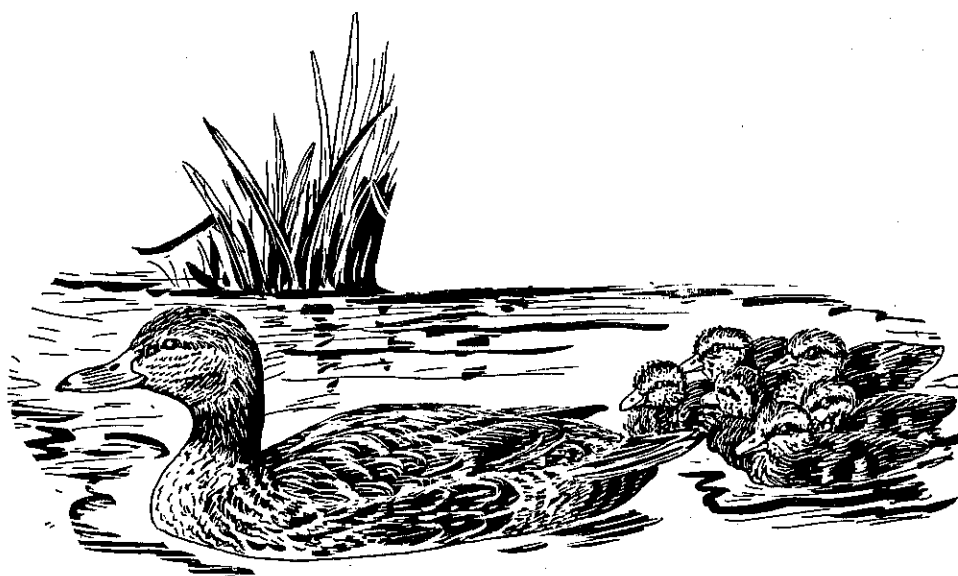
What tangible benefits might the sportsman realize from the payment of his user fee? Improved range carrying capacity for big game? More productive trout habitats? Hopefully the answers would be yes. But again upon examination, most of the wildlife habitat "improvements" would be actions to stop or rehabilitate habitats damaged or degraded by commodity production. I have evaluated the opportunities for wildlife habitat improvement in Nevada and can honestly say that the vast majority of those opportunities are to stop or rehabilitate degradation caused by some form of commodity production. Where then is the equitability in asking the hunter or fisherman to pay more to use and enjoy the public lands for which he is already paying?

Public lands do indeed produce an array of resources and goods which are valued by society including those with commodity and noncommodity value. The public lands should be managed under a strategy which is based on societal demands for the products of the land. I believe that the information has been collected, and is at hand, to show that society demands far more than food and fiber from its public lands, and in fact the demands are far greater for the noncommodity products, open space, clean air, water, and fish and wildlife.

If our sociopolitical system determines that government should subsidize those traditional industries that make the greatest use of public land commodities, so be it. But at least the system should be up front and should not put forth the ruse that the hunter or fisherman is getting a free ride and that therefore he must endure a public land user fee to pay his fair share of the public land management bill.

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## ALL IS NOT WELL ON THE RANGE

Steve Moen, Chair  
Public Lands Restoration Task Force Steering Committee

Dave Luman, Member  
Public Lands Restoration Task Force Steering Committee

### Introduction

Did you know:

- \* That 70 percent of the rangelands on BLM and National Forest lands are in poor and fair condition as opposed to good and excellent condition because of overgrazing by livestock. By overgrazing we mean grazing that results in loss of native vegetation and soil, and reduced streamflows and water quality.
- \* That 95 percent and more of the available forage is typically allocated to livestock; the remainder to wildlife and feral horses and burros?
- \* That fishing opportunities have been reduced by 60 to 90 percent on National Forest lands because of livestock grazing, according to the American Fisheries Society?
- \* That subsidized grazing on BLM and National Forest lands benefits 27,000 permittees, which represents less than 2 percent of the livestock producers in the United States. Among these "favored few" are oil companies; land investment partnerships; feed lot operators and agribusiness companies; and doctors and lawyers who engage in ranching as a weekend avocation (never mind the tax breaks). Three percent of the permittees control 40 percent of the livestock grazing on the public lands in the West.
- \* And that 225 million acres in the West, including public rangelands are experiencing severe desertification? Much of this is caused by overgrazing by livestock.

This is important to you for two primary reasons:

- (1) It takes your tax dollars to provide the annual subsidy of \$40 million, since grazing fees cover only 40 percent of the cost of administering the program; you pay the rest!
- (2) The impact of current levels of livestock grazing on native vegetation, soil and water is devastating, although there are few quantitative figures available. The reduction of fisheries expenditures attributable to the National Forests alone is estimated at \$111 million annually because of livestock grazing. Riparian (streamside) habitat constitutes

less than 2 percent of the public rangelands but contains 75 percent of the wildlife.

### Public Lands Restoration Task Force Formed

Because of the impacts mentioned here (and as illustrated by the slides shown by Dan Guthrie) the Public Lands Restoration Task Force (PLRTF) was formed in July 1985. It is an operating branch of the Oregon Division of the Izaak Walton League. Funding comes from the League's National Executive Board (1/3), National Endowment (1/3), and the Oregon Division with additional memberships and donations (1/3). That, plus a lot of volunteer effort on the part of PLRTF members.

### Actions of Task Force

Activities of the PLRTF have included:

- \* Preparation of a special grazing report in February, 1985 (4,000 copies were distributed). This report is being updated and will be available in the fall.
- \* Legislation has been prepared and discussed with several members of Congress. Its main provisions were included in the July 1986 resolution adopted by the Izaak Walton League in National Convention in French Lick, Indiana, as follows:
  - 1) Identify, protect and restore riparian ecosystems through adequate funding and direction to land management agencies;
  - 2) Determine suitability and unsuitability of all rangelands for livestock grazing based on criteria that include characteristics of vegetation, soil, and water quality and quantity, and restrict livestock grazing to those lands classified as suitable;
  - 3) Incentives for permittees to improve rangelands;
  - 4) Where overgrazing has created unacceptable conditions, livestock numbers should be reduced or grazing halted completely until the range resources can be rehabilitated. Unacceptable conditions generally include those lands classified fair to poor;
  - 5) Implement a systematic reallocation of vegetation that would fully protect and meet fish and wildlife requirements;
  - 6) Allocate range improvement funds to:
    - restore soil and watershed health;
    - rehabilitate vegetative resources;



- restore riparian area values;
- mitigate fish and wildlife losses;

before spending funds to increase livestock carrying capacity;

7) Strictly enforce permit and lease requirements;

8) Require livestock permittees to pay fair market value for federal forage.

9) A cap should be placed on the number of Amental Unit Months (AUMs) allowed for each individual permittee.

In addition, a resolution was passed at the 1985 National Convention that called for the abolishment of grazing advisory boards, transfer of their function to multiple use advisory councils.

- \* Participation in a demonstration management area with BLM, Society for Range Management, Oregon Trout, and local ranchers.
- \* Field trips and meetings to discuss rangeland management with BLM, Forest Service, ranchers, and members of conservation/environmental groups, and with the BLM National Advisory Board.
- \* Radio talk show and television public service announcements.

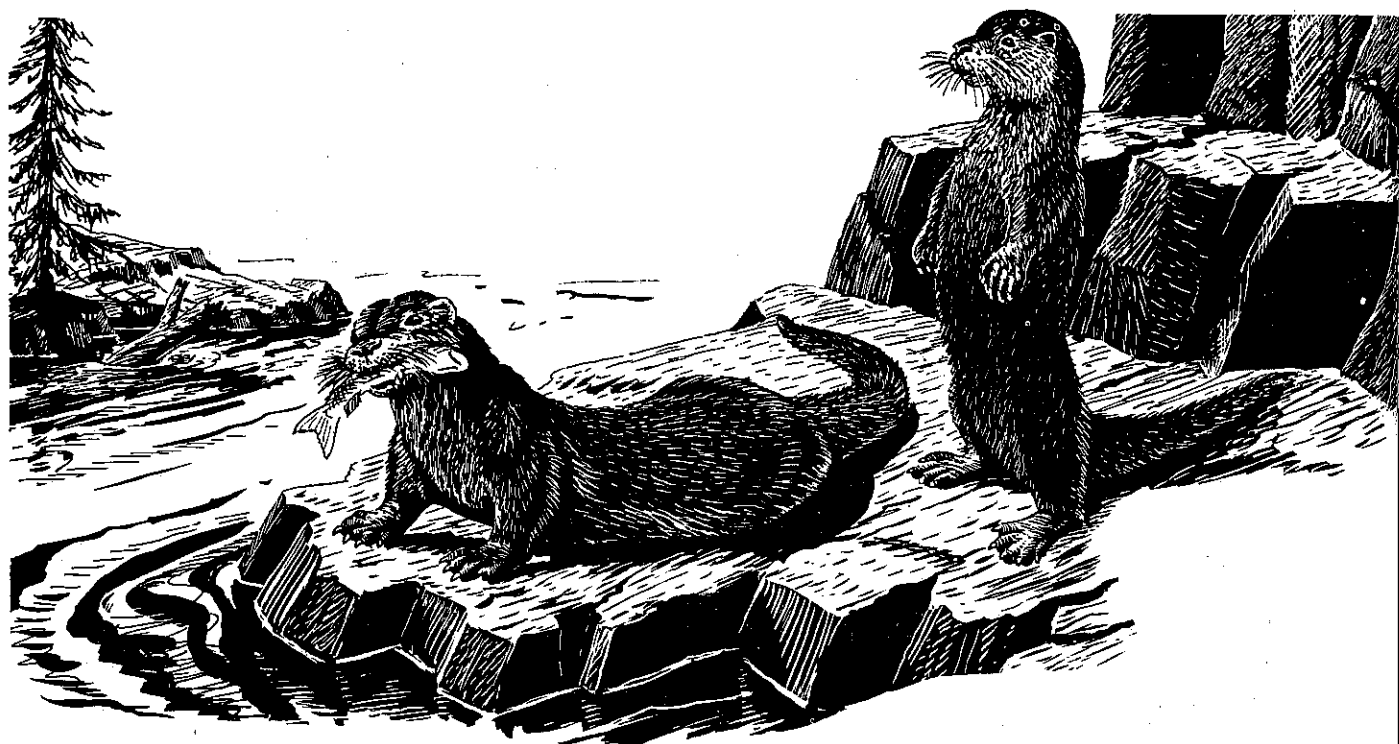
#### Future Activities

Future activities will include all of the above with emphasis on creating public awareness because that is where the issue will be decided--in the public arena. As Abraham Lincoln said, "Public sentiment is everything. With public sentiment, nothing can fail. Without it, nothing can succeed."

We don't mean to denigrate the ranchers but to put them in proper perspective. There are some who care about the health of the land as you and I, and there are some who are pressed by current circumstances to forget about the land and the heritage of their children and grandchildren, and maximize current dollar output at the expense of tomorrow's return.

And with a common property such as the public rangelands, there is little incentive for the permittee to conserve. A reduction in livestock use hits him where it hurts most--in the pocketbook. But there is a growing public demand to be recognized and accommodated: Fish, wildlife and outdoor recreation are legitimate uses of the public rangelands. And these interests, as well as the long term ability of the rangelands to produce forage for livestock, means that we must restore the soil, water, and native vegetation to a more productive state, and allocate more of the harvestable surplus of the vegetation to fish, wildlife and outdoor recreation. We believe that an informed public will accept no less. You can help by action through your civic, business,

professional, sportsmen's and environmental groups. And we'd be pleased to sign you as a member of the Public Lands Restoration Task Force. Whatever the role, your help is needed--now.



# PROFESSIONALISM AND ETHICS: SOME ISSUES OF INCREASING CONCERN FOR FISHERY BIOLOGISTS

Peter A. Bisson

Aquatic Biologist, Weyerhaeuser Company

## What's the Problem?

The problem is that fishery biologists are becoming increasingly involved in matters of professionalism and ethics, and all too often do not have the proper experience or the formal training to make the "right" choice. A number of factors have contributed to creating this situation, including, for example, competition for dwindling research funds, expansion of the biological consulting industry, pressure for biologists to become more involved in policy decisions, and a general lack of close scrutiny of professional behavior in the fishery sciences. The reader can doubtless add many more situations to this list. Growing concern for standards of ethical and scientific conduct has prompted the adoption of codes of ethics by organizations such as the American Fisheries Society, The Wildlife Society, and the Society of American Foresters. But while these codes of ethics are revised from time to time, they are by necessity general in nature and not always helpful in resolving problems that fall into the "gray area" of professional conduct where the distinction between what is proper and improper may be blurred. Adherence to the codes by society members is, for the most part, voluntary. Whether we like it or not, fishery biology is one of the least regulated technical professions. The following table compares various aspects of regulation among different professional groups:

Standards that Professionals Have Imposed on Themselves (from Monroe 1983)

Standard	Professional Group*					
	PHYS	CPAs	ATTY	ENGN	FB/WB	FORSTR
1. A graduate degree is <i>required</i> to practice in the field	YES	NO	YES	NO	NO	NO
2. An apprenticeship is <i>required</i> to practice in the field	YES	YES	NO	NO	NO	NO
3. Certification is based on <i>examination</i>	YES	YES	YES	YES	NO	YES/NO
4. Professional Society <i>reviews</i> and <i>certifies</i> college programs in field	YES	YES	YES	NO	NO	YES/NO
5. A <i>license</i> is required to enter field	YES	YES	YES	YES	NO	NO
6. There is a professional <i>conduct review board</i>	YES	YES	YES	YES	NO	NO
7. Continuing education is <i>required</i> to maintain professional status	YES	NO	NO	NO	NO	NO
8. There is a rigid, specific, <i>code of ethics</i>	YES	YES	YES	YES	YES/NO	YES/NO

\*Professional Groups: PHYS, physicians; CPAs, Certified Public Accounts; ATTY, attorneys; ENGN, engineers; WB, wildlife biologists; FB, fisheries biologists; FORSTR, foresters

Lack of regulation places an enormous responsibility upon the individual to uphold high standards of conduct in his or her professional career. There is general agreement that fishery biologists do behave in a professional and ethical manner, yet there are recurrent problems that have been the subject of considerable recent debate. In order to address some of these issues a panel discussion was held at the 1986 Western Division AFS meeting in Portland, Oregon. Panelists included scientists from academic, public agency, consulting, and private industry backgrounds. As expected, there was a diversity of opinion among panel members over the topics. However, the panelists concurred that certain issues deserved further discussion and debate among fishery professionals. The purpose of this paper is to highlight those problems and summarize some of the ideas raised by the panel members.

### The Problem of Education

Where does the responsibility for training young fishery workers to be conscientious professionals lie? Can ethical conduct really be taught in schools? Do we need continuing education to maintain high standards of professional behavior after graduation? These are questions that are likely to provoke disagreement and for which there are no easy answers. Almost without exception, the panelists agreed that fishery graduates are often ill prepared to deal with real-world situations requiring ethical judgments, or are generally unaware of who to turn to for professional advice. Some suggestions were:

1. Universities need to take more time to educate graduate students in the philosophy of science.
2. Many problems stem from lack of application of the scientific method. Students should be taught to be more rigorous in designing their studies, so that their results will not be biased by preconceived conclusions and absence of controlled hypothesis testing.
3. Continued education or training of some sort after graduation is important in order to give career fishery workers an opportunity to discuss, clarify, and reinforce their professional standards.
4. Scientific integrity can be enhanced by broadening one's background in other disciplines in order to gain a better perspective of resource management problems.
5. There should be a more widely available source of information and guidance pertaining to ethical matters for practicing fishery biologists.

Further information on the topic of education and training can be found in Fletcher (1977), Lackey (1979), Royce (1984a, 1984b), Thomas (1985), and in an excellent booklet on professionalism and ethics for beginning scientists published by Sigma Xi (1986).

## The Problem of Loyalty

Over the past decade growing numbers of fishery biologists have found employment with organizations whose primary objective may not be the conservation and management of fish populations. Examples include the Forest Service, Soil Conservation Service, Corps of Engineers, private industry, and environmental consulting firms. These scientists may occasionally find themselves in situations where they are asked to defend a policy, practice, or proposal that they feel conflicts with the goal of protecting fish populations. At the very least, most environmental biologists have felt pressured at one time or another to take a stand on a controversial issue. Conflicts between allegiance to one's employer, loyalty to the fishery resource, and external pressure to publicly advocate a position (however just) without knowing all the facts can contribute to confusion when deciding on the proper course of action.

How can we identify conflicts of interest? When does responsibility to the common good supersede allegiance to an employer or client? When is "blowing the whistle" on an employer or client justified? Is it right for fishery workers who have been trained as scientists to be asked to participate in policy decisions that involve competing political interests? How confidential is "proprietary information" when it appears to be at odds with the welfare of fish and wildlife populations? At the heart of these questions is the issue of loyalty -- an issue that touches virtually all arenas of professional employment: academia, federal and state agencies, consultants, and industries. Concerning this problem the panelists raised the following points:

1. Too often, the distinction between the staff requirement of supplying technical information and the line requirement of prescribing management actions is lost. Fishery biologists are often not equipped to make the policy decisions inherent in most line organizations.
2. It is unethical for employers to ask staff members to go beyond their technical competence in making policy recommendations.
3. Interest groups should not pressure fishery workers to take stands on matters that are poorly understood.
4. Being a maverick within an organization can confer some integrity, but care must be taken to avoid committing political suicide.
5. There needs to be a clear statement of AFS policy on the protection of "whistle blowers" from unfair retaliation by employers or clients.
6. There is often no one to turn to within organizations for unbiased advice on potential conflicts of interest.

For additional discussions of the loyalty question the reader is referred to papers by Hanson (1976) on proprietary information, Banzhaf et al. (1985) on conflicts of interest and whistle blowing, and Kennedy (1986) on career development and loyalty within different professional subcultures.

## The Problem of Honesty

In very many cases, tough decisions involving professional and ethical judgment come down to telling and acting the truth. This theme runs through most of the canons of codes of ethics. For example, in the detailed code of ethics of The Ecological Society of America, 18 of the 23 canons directly or indirectly proscribe dishonest behavior. Violations can range from using illegally copied computer software, to falsely advertising professional services, to injuring another scientist's reputation by untrue or biased statements, to disseminating erroneous or exaggerated claims concerning the effects of certain actions on the environment. Points raised by the panelists included:

1. Integrity is bolstered by acting on one's own convictions, even though being honest may result in unpopular interpretations and recommendations.
2. Fishery biologists too often do not clearly distinguish between personal opinion and verified scientific observation, resulting in the repetition of unproven "facts".
3. Outside peer review of scientific studies should be more widely practiced in many organizations.
4. Lack of sufficient financial support from funding agencies, employers, and clients may make it impossible to arrive at definitive conclusions, in turn making it very difficult to formulate objective management recommendations.
5. Honesty cannot be taught in school. It must come from individual commitment.

For additional reading on the subject of truthfulness the reader is referred to a stimulating and controversial book by Broad and Wade (1982). A good summary statement on the importance of truthfulness is also found in the handbook Honor in Science (Sigma Xi, 1986, p. 39):

"...there remain two fundamental reasons why scientists should be concerned with the ethics of their research. The first reason is that without the basic principle of truthfulness -- the assumption that we can rely on other people's words -- the whole scientific research enterprise is liable to grind to a halt. Truthfulness may or may not be the cement that holds together society as a whole, but certainly it is essential in science. Secondly, whereas truthfulness in a wider context can be maintained and enforced by the institutions of the society we live in, scientific research is a specialized activity, each scientist working largely on individual experiments and analysis on the fringes of knowledge. Truthfulness -- honesty -- therefore has to depend primarily on individual scientists themselves."

#### ACKNOWLEDGMENTS

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PROFESSIONAL FISHERY ETHICS IN  
THE BUREAUCRATIC WORLD OF REALITY

William S. Platts  
Past President, American Fisheries Society

Professionalism and ethics have been discussed for years within the American Fisheries Society, but their identity and incorporation into the Society's mode of operation has been slow and on an informal basis. The professional acceptance of the fisheries profession has been slow in many agencies, especially the federal agencies. In many agencies it was not accepted until legal mandates and public pressures recently forced it upon them. The terms tied to our profession such as ethics and integrity, were also difficult for the agencies to define and to use. Because they do represent the best vocabulary around, these words had to be tied into their mode of operations, but often with different interpretations.

We also have trouble with the identity of "professionalism" because without degrees, levels, or types, the word has little meaning. If you have a terrific right hook (in boxing not golf), bat 400, or have just hired on with any professional agency (from medicine to prostitution) you can call yourself a professional. In some occupations where standards are easily quantified, both the initiation and degree of professionalism are readily identified. If you were Larry Bird with the Boston Celtics and just signed a multi-million dollar contract, your level of basketball professionalism has been well defined. This doesn't necessarily, however, define the need of the basketball profession to the well being of society. Without medicine there would be much suffering. Without the spectator sport of basketball we would probably not sit on our "butts" much.

The levels of attainment in the fishery profession are not so clearcut because performance and achievement are difficult to enumerate. Especially when many achievers are quiet, timid, and productive without fanfare, while some of their colleagues are stealing every idea and product they come up with, so they can go on to their own fame and glory.

We assume, that today we are professionals, but can you remember the day you became one, or are you sure that you soon may become an unprofessional. Professionalism, to me at least, requires complete dedication to the profession, with the persons ability, productivity, commitment, ethics, and integrity then determining the level of professionalism attained. Professionalism or professionals are not in short supply; ethics, commitment, and integrity are what is in short supply and the reasons for this are discussed. All of us professionals like to believe we are as pure in ethics and integrity as the "wind driven snow", but this may not always be the case as this article goes on to explain. The thesis of this paper is that many fisheries specialists must interject more ethics, integrity, and commitment into their mode of operations than is social and politically expedient. How to do this and not end up a career casualty is an art in itself.



## THE JUNGLE

To survive in the bureaucratic jungle, and still maintain a high degree of integrity, has little to do with science - it's an art. Survival with integrity must be learned as it doesn't come natural or easy. The structure and function of the bureraucracy, which mainpulates itself for the desired image, can enhance or inhibit the fisheries specialist's ability to act professionally with integrity. The level that the fisheries discipline or the fisheries resource has attained within the bureaucracies scope of vision, plays an important part in determining the levels of enhancement or inhibition applied to the professional focus. Building commitment to an organization requires acceptance of organizational values, and fisheries has been slow in gaining acceptance. Fisheries resource awareness is quite new in many bureaucracies and even in these days of low grazing fees and deficit timber sales is often still ignored in the favor of other resources. Therefore, it has not gained the standing of the other resources.

With timber and range at the top of the political pecking order, and they intend to stay there, fisheries has had a hard time getting its share of the sun. If God suddenly came to earth as a fisheries biologist in any of the federal agencies (not including the U.S. Fish and Wildlife Service), even with all this persons capabilities this person would have great difficulty traveling the ladder to success. One main reason is that the fisheries resource is still being classified as an economic and political constraint to the use of other resources. This occurs even though fisheries often has more social and economic benefits. Until balance is attained in the eye of the resource manager and the user, fisheries specialists will continue to have difficulty coping with ethical and integrity values. Kennedy and Mincolla (1985) found that 50 percent of the fisheries scientists in the U.S. Forest Service gave a possible future resignation reason as - "because fisheries resources are of too low priority in the agency".

Let's face up to the fact that, because of organizational culture, the Bureau of Land Management has always placed their red meat program over and above all other resources. The U.S. Forest Service has followed suit with priority on getting logs to market. These targets have often been defined as "the work ethic" to abide by. Bureaucratic organizations have historically gone the direction of applied power and ingrained inbreeding, often regardless of whether the direction abides by the laws and regulations set down by Congress or the States. If you doubt this, examine the long series of lost court battles and appeals won by "outsiders" against bureaucratic agencies. These losses have had dramatic results and the public, through pressure and legislation, has required the federal agencies to diversify their resources and apply balanced management.

Branzhaf and others (1985) outline canons for Forestry professionals to abide by. In summary, the canons say that a Forestry specialist will perform with unqualified loyalty to the employer and if unable to reconcile loyalties to self, employer, society, and profession, it is wise to disengage from service. The opposite of this is inferred in Kennedy and Mincolla (1985), where they state that 40 percent of entry fisheries managers in the U.S. Forest Service identify with colleagues outside of their organization. I would classify loyalty to an unethical employer managing public resources, a cop-out. In our

fisheries profession loyalties to an unethical employer having little integrity kills professionalism. You can accomplish little outside of the bureaucratic organization, however, and changes required for better fisheries management occurs when you stay within the organization and work for it. A professional must not cut and run from these types of situations, but must remain within and encourage changes to effect compliance and balance within the agencies' mandates. Once the decision is made by the professional to stick it out, then the mode of operation must fit the situation.

Bureaucratic agencies demand loyalty and this is to be expected. To progress within the system, careerwise, you must belong to the "family" and "kiss the necessary rings" to gain the sponsor(s) necessary to move you ahead. State fisheries specialists have much more success getting into this position than federal fisheries specialists, because state fish and game departments are more closely orientated to the fisheries resource. Regardless of federal or state classification, the awards, whether they be monetary or career ladder, are almost always given from within the agency. The professional fisheries specialist is often faced with some hard decisions as the awards usually go to those who play the game, whether it's fair or not. Too high a level of job ethics or personal professional integrity can lead to career suicide. Kennedy and Mincolla (1985) found that 66 percent of fisheries/wildlife specialists were extremely too very strong in professional commitment compared to 45 percent of range conservationists and only 20 percent of foresters. Therefore range conservationists and foresters have a much easier time molding to the organizational clone, as their professional commitment is not nearly as high. The ability of the fishery specialist to match the needs of science within the social and political constraints, in the decision making processes, often forces those with high professional integrity and accomplishment into the wall of vulnerability.

#### LIVE AND DEAD HEROES

In these times of intensive planning, goal changing, distrust among the disciplines, and maneuvering to seize or maintain power, there are obstacles placed in front of maintaining high ethics and integrity. Bureaucracies are tailor made to place integrity in the way of decision making. You can go "down the tube" from a career standpoint by being right all the time. Showing defiance to illegal or poorly planned decision making can provide a threat to the power base and thus fisheries specialists must handle this without rocking the boat to where it sinks.

Most bureaucracies are lead at the top by personnel close to retirement age. This vast experience is needed and crucial to keeping on-going programs going smoothly. This group, however, is often 10 to 20 years behind the times and the emphasis is more on preserving the "status quo" than progressing "full speed ahead". Those professionals who are ahead of the game, and especially those professionals who are unfortunate enough to be 20 years ahead of their time, suffer miserably under these bureaucratic constraints. These original futuristic thinkers cannot usually handle the built-in resistance within the organization. The examples of this are countless. The South Fork Salmon River, Idaho, "blowout": and the Craighead Yellowstone Park grizzly bear studies will go down in history as prime examples of bureaucratic family "ousting". In the South Fork Salmon River story, those who pushed for "status quo management" (get the logs out) and badly damaged this river system, almost

unanimously went on up the career ladder. Those employees who were ahead of their time, identified the problem, and provided the solutions, were marked and either put in far-away boxes or drummed out of the bureaucracy. The Craigheads, who had the data and the foresight to predict the future grizzly bear conditions (which came true), violated the bureaucratic style of "everything is rosy"; and the Craigheads were kicked out of the Yellowstone. Case histories of this type show that ethics and integrity do not always bring immediate success, but over the long haul they are the only thing that survives the test of time. This doesn't give all that much satisfaction to the "done away with" heroes, as dead heroes do not go on to win critical battles. Live heroes who have found the art of survival with effectiveness go on to win critical battles and develop progress in management of the public resources.

#### THE WALLS

It's easy, and I have done it, to "badmouth" the bureaucracies and condemn them for their inability to manage resources, especially the fisheries resource. The bureaucracies are, however, the "only game in town", and the only avenue available to maintain and build productive fisheries resources on public lands. The only alternative is to learn to work and survive within the bureaucracies and do less end runs on the outside. We must learn to play the inside game. To work within the bureaucracies one must use all the ethics and integrity possible without going through the "irreversible wall". This is the farthest wall out and it forms the boundary of the circumference around you that delineates that area in which the bureaucracy allows you to participate without being fined. The closer you get to the wall, the bloodier you become; and to cross over it is automatic firing. Within this major wall are little walls. The closest one to the center is the "family wall". To cross outside this wall, you no longer have the right genes and, therefore, are "shunned" out of the family. To work beyond this wall you don't have to "kiss the rings anymore" because it wouldn't help if you did. Beyond this wall integrity is often much easier to keep. Another small wall, just beyond the family wall, is the "career ladder wall"; to go beyond this wall is career suicide.

You have to know where each of the walls is at all times, especially the irreversible wall. Some fisheries specialists have worked along this wall consistently and have made great strides for the fisheries profession. Other fisheries specialists run so scared, or put career status ahead of professionalism, that they sit on the center post and have yet to even know there is something out there to bump into. These people (biostitutes) are of little value to improving fisheries resources. The placement of the "wall of no return" varies over time and is especially sensitive to political change. What is so encouraging over the past decade is that the "wall" is getting farther and farther away. Progress is made best in little steps.

Because fisheries resources are slowly gaining their deserved stature, there will someday be plenty of area within this wall to work effectively. This speaks well for some of the present leadership now at the top of the agencies. Walls are also forming around other resource specialists, such as the range and timber disciplines. This brings concern and frustrations of the type they haven't historically faced before. They also are having some problems handling the constraints, especially the range profession. The "riparian wall" has and will bloody many people before its placement has been identified

well enough to keep disoriented souls from running into it.

Many professionals strive for high ethical standards and personal integrity. Some even believe they have attained it without crossing any walls. If you fit into the last case, immediately re-evaluate with more objectivity. In the past, however, many of the great contributions in the fisheries field were made because professionals were willing to run head on into the wall for what they so strongly believed in. This was quite a sacrifice in those bureaucracies who give out their rewards to those that automatically "go along" with the present system of political and expedient pathways.

#### THE STABLE METHOD

We fisheries specialists must learn to work effectively within the bureaucracies, especially in federal agencies, where we are seldom allowed to move into decision making positions. Fisheries doesn't fare much better in many state agencies. Directors or commissioners are mainly wildlife biologists or political appointees. In federal agencies fisheries specialists are used under the "stable method"; that is, they are brought out of the stable when needed, and then usually "put up wet" prior to the final decision making.

When the "stable door" is opened, this is the time for great accomplishments, but, the territory to be covered and the information routes available often cause a dilemma. Branzhaf and others (1985), in the canons they present for the forestry profession, state that a forestry specialist will not voluntarily disclose information concerning the affairs of the member's employer without the employer's express permission. Where timber and range is King, Queen, and Prince, and there is no wall, the zombie approach may work quite well. But what do you do as a fisheries specialist when this same employer, over your council, is going to destroy a valuable fishery resource to gain some added logs or reduce some costs in a timber sale that is already deficit? These are not good situations but we have all been there before. All ones finesse must come into play within the confines of the "irreversible wall". Usually we must comprise some of our allegiances, hang on to all the ethics and integrity possible and live to fight another day. I know this is hard to swallow, but as I said before, dead heroes may help with local battles, but they do not go on to win future wars. If we have bloodied ourselves on the inside part of the irreversible wall, we have given it our best shot.

After spending 25 years within the bureaucracies running head on into the bloody walls, the best counsel I can give the younger specialists is to continue to be firm on ethics and personal integrity, as they cannot be traded, and move the walls farther and farther away from us. Our destiny is for these walls to fade away - and they will, suddenly to appear around some other resource, who up to this time were beyond this type of constraint. As managing agencies move towards balanced resource management, we will become part of the "family" and even some day in the future, even though we are a strange breed, we will spawn the lieutenants and provide the "Godfather". As the fishery resource is moved away from its past political bureaucratic constraints, we will find avenues to decision making positions open to us. The more constraints we eliminate, the more balance we attain in the resource, the more we will build ethics and integrity into the fishery profession.

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## WHY RESTORE UPRIVER SALMON AND STEELHEAD STOCKS IN THE COLUMBIA RIVER

Douglas DeHart

Fishery Biologist, National Marine Fisheries Service

The Northwest Power Planning Council has estimated the decline in numbers of adult salmon and steelhead produced in Columbia Basin to lie in the range of 7 to 14 million fish. They attribute 5 to 11 million of this loss to the effects of hydroelectric development. As the passage of the Northwest Power Act has focused new attention on salmon and steelhead restoration, the question of if and how to address the devastating loss to historic upriver production has become a major one.

There are a number of strong arguments for pursuing upriver restoration despite the undeniable costs and difficulties. Many of these stocks have particularly desirable characteristics including size, time of river entry, condition at river entry, and ocean distribution. Restoration of upriver stocks results in full utilization of many miles of available spawning and rearing habitat. Perpetuation and restoration of upriver stocks maintains species diversity even in conjunction with large-scale hatchery programs by allowing management in an inter-related mix of hatchery and natural production.

Further, there is an obligation which comes with hydroelectric development to restore and protect affected resources. Protection and restoration of upriver stocks appears to be feasible at a "fair" or acceptable cost in the context of a cost of doing business. This is to say that it appears possible to restore Columbia River fisheries to an appreciable degree while, in the words of the Northwest Power Act, providing for an adequate, efficient, economical, and reliable power system." The projected costs of the Northwest Power Planning Council's Fish and Wildlife Program, while considerable, are small in relation to the annual revenues of power producers and appear unlikely to prevent realization of a reasonable return on investment in hydroelectric facilities.

Finally, there is another reason to pursue restoration of upriver stocks, and I believe it to be the best reason. That is the importance of what I will call a "portfolio" approach to multi-stock management with an analogy to securities investments. Such an approach to population management stabilizes resource and harvest by avoiding the risk of

dependence on a few hatchery stocks. Combining a range of investments in protection and mitigation increases potential return and reduces risk just as does the selection of a stock portfolio. In the simplest example, when there is a risk involved, it is desirable to combine several investments whose potential success have a very low degree of correlation or are perhaps even negatively correlated. Not only does this reduce the risk of no return on your investment (in either securities or fish restoration projects) but by doing so increases the likely return. Considerable attention has been paid to this area by investment counselors and calculation methods are available which evaluate investment performance by utilizing standard deviation on return as an assessment of risk. In fact, a very interesting general analogy can be drawn between multi-species fisheries management and the securities market. Both are extremely complex and react to many more factors than can be reasonably assessed and predicted by managers. Investment analysts have noticed that a consideration of the Dow-Jones average as a so-called random walk in the statistical sense comes surprisingly close to simulating the actual long-term fluctuations of the Dow on approximately ten-year cycles. Similar cyclic fluctuations of abundance occur in fish populations, presumably driven by a range of interacting environmental factors, even to the point of often approximating ten-year cycles.

The strategy of the 1960s and 1970s in managing Columbia River fish production was largely one of minimizing cost and maximizing ocean harvest by depending on a few successful stocks. These consisted primarily of extensive fall chinook and coho hatchery programs operating downstream of most effects of the Columbia River hydroelectric system. The actual result of this seemingly conservative "sure thing" approach was that first coho production and then tule stock fall chinook production crashed followed by a drastic restriction of the ocean fishery. In retrospect, this can be seen to be a very high risk approach as well as having the effect of abandoning upriver users.

The present strategy of the regional fishery agencies is much more complex and costly but has many of the desirable attributes of a "portfolio" approach. The present strategy puts substantial significance on the restoration of upriver stocks from both management and legal perspectives. Reduced juvenile passage loss is a fundamental part of that strategy. The substantial mortality occurring in hydroelectric reservoirs can be reduced through flow enhancement, downriver transportation, and timing of hatchery releases. Mortality in hydroelectric turbines can be reduced through spills, operational limits, mechanical bypass facilities, and transport.

Another key factor is the quality of hatchery fish and their resultant contribution. This can be influenced through stock

selection, timing, nutrition, and disease control. A third aspect of the current restoration strategy is stock diversity resulting from emphasis on numerous locally adapted stocks. A mix of hatchery and wild production can be maintained through hatchery supplementation of natural production by outplanting and reintroduction of naturally-produced fish into the hatchery brood stock. A fourth factor is habitat improvements to increase natural production capacity through tributary passage improvements (ladders and screens), tributary flow enhancement, and physical modifications to spawning and rearing habitat. The result of these several factors is increased production through new and improved hatchery production, supplementation of natural production by outplanting, and increased survival.

Each of the cooperating groups involved in Columbia River fisheries restoration has a role to play in implementing this strategy. The Northwest Power Planning Council's Fish and Wildlife Program, implemented primarily by the Bonneville Power Administration, has emphasized mainstem flow enhancement (the Water Budget) and tributary improvements. The Program is now moving toward hatchery improvements and increased production. The hydroelectric project operators are in the position to pursue mitigation hatchery improvements, spills, mechanical bypass, and transportation. The fish and wildlife agencies need to take an aggressive role in hatchery improvements, outplant programs, management of hatchery/natural production mixes, habitat improvements, protection of adult escapement, and provisions for tributary flows.

There has been some significant progress in initiation of upriver restoration efforts in the past five years. The Water Budget provides some protection for mainstem flows in low-to-critical flow years. Large-scale tributary restoration projects are underway in the Yakima and now also in the Umatilla drainage. Bypass facilities are now in use at five mainstem dams to reduce turbine mortality and are in some stage of planning or development at most of the other eight mainstem dams below Grand Coulee and Hells Canyon. Present schedules call for most of these facilities to be completed by approximately 1990 to 1992. Spills for juvenile fish passage have increased at many projects in recent years. Hanford Reach upriver bright fall chinook have substantially increased in numbers. Upriver steelhead stocks, aided by transportation, have also shown substantial increases. The hatchery facilities of the Lower Snake Compensation Plan are now largely in operation. The Magnuson Act, the U.S./Canada Treaty harvest agreement, and ongoing production planning under the Federal Court administered U.S. v. Oregon process have given fishery managers substantial new capability and direction in management activities.

The situation is still critical for most upriver chinook stocks but improved ocean survival over the last several years has



provided a breathing spell. The most dramatic result has been the rapid increase in numbers of steelhead and upriver bright fall chinook. Spring chinook returns have also shown significant improvement. The improved return rates over this period are allowing time for Snake River summer and fall chinook production programs to begin to work. This has also provided more time to work on the problem of improving survival and return rates of spring chinook from upriver hatcheries but we need to move quickly in this area. There is also substantial opportunity for enhancement of sockeye returns which is being largely ignored.

When Gordon Haugen first talked to me about this technical session last winter, he asked should we restore upriver stocks. We are giving it our best shot. The question now is will we succeed. Beyond the technical problems involved, there is the very real danger of stopping too soon. The benefits of this effort are, to a large degree, all or nothing. The largest increments of harvest will come from the later increments of survival and production improvements. The key is to not simply increase production, but to sharply reduce the role of the Columbia River dams as the major "harvester" or taker of the salmon and steelhead resource. The result will be a very substantial increase in harvestable surplus and thus in available yield to all user groups.

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IDENTIFICATION OF FACTORS LIMITING SMOLT PRODUCTION:  
THE KEY TO SUCCESSFUL HABITAT MANAGEMENT

Peter A. Bisson  
Weyerhaeuser Company, Tacoma, WA 98477

Increased production of salmonid fishes is the desired goal of many western stream enhancement projects. Where the species of interest is anadromous, greater smolt yield from a watershed is the ultimate measure of the success of habitat restoration. Stream enhancement projects are often not followed by critical evaluations of their effectiveness in achieving desired goals. As a result, we have relatively little knowledge of the benefits derived from widespread habitat management programs. Some followup studies have shown that increased smolt production has not occurred following stream restoration.

In order to engage in cost-effective habitat management, it is necessary to accurately recognize the key factors limiting smolt production. Where such factors are not successfully identified, enhancement projects risk failure. There are currently several barriers to identifying important limiting factors: (a) excessive reliance on professional judgement in the absence of sound data; (b) errors in extrapolating findings from limited reach surveys to entire drainages; (c) oversimplification of complex ecological situations; (d) focusing exclusively on one aspect of freshwater life history (e.g., restoring spawning gravel); and (e) failure to consider the importance of certain critical factors (e.g., food availability) that are not directly linked to the condition of physical habitat.

There is no a priori reason to believe that the same limiting factors apply equally over a broad geographical area. Therefore, recognition of key constraints on smolt yield will require detailed and accurate information from the area of concern, knowledge of the life history patterns of the species of interest, an appreciation of the complexity of the system, and a perspective that is basis oriented. This kind of information will not be easily obtained. Short cut approaches to habitat management should be applied with caution and with an understanding of their limitations.

## LIMITING FACTORS - THE NEED FOR A BASIN FISH HABITAT PERSPECTIVE

J. R. Sedell, F. H. Everest, and G. H. Reeves  
USDA Forest Service  
Pacific Northwest Research Experiment Station  
Corvallis, OR

Forest land managers and fisheries biologists are information-poor when cutting units or enhancement projects are placed in a basin fishery contest. They have examined fish habitat, fish species distribution, population estimates, and smolt outmigrants in four basins ranging from 60 to 300 km<sup>2</sup> in size. These basins have different geologies, land use, and natural disturbance histories. It was found that small habitat areas for both summer and winter juvenile salmonid rearing were disproportionately more productive. Many sub-basins which had been initially considered to be productive by professional biologists were not. Areas of high densities often have the potential to yield very few smolts when considered from a basin perspective.

Smolt output patterns also indicate the importance of a few areas within a drainage. Fisheries resource and timber land managers are engaged in a give-and-take within a basin for the same resources. Information of fish utilization of habitats and smolt outputs helps focus the discussions in order to prioritize the fisheries needs within a basin. Such information is a necessity when considering the type and location of fish habitat restoration and maintenance projects within a basin. A premium is placed on detailed past and present stream habitat inventory information.

FACTORS LIMITING PRODUCTION OF OUTMIGRANT  
SALMONID FROM CARNATION CREEK  
BEFORE AND AFTER LOGGING

L. Blair Holtby and Gordon F. Hartman  
Pacific Biological Station  
Dept. of Fisheries and Oceans  
Nanaimo, B.C. Canada

Sufficient life history data for coho salmon have been collected from Carnation Creek, British Columbia (15 years or 13 complete life cycles) to have enabled us to put together a detailed empirical model of smolt production. This model was used to examine the relative importance that variability in 1) climate (e.g. temperature and discharge), 2) biological variables (e.g. spawner density) and 3) physical stream configuration (e.g. gravel quality and stream stability) have had in determining the observed variations in smolt production. The most important limit to smolt production is the over-winter survival of sub-yearlings. Their survival rate is strongly size dependent and is therefore determined by density dependent processes over the preceding summer and by variations in the length of the growing season. Logging related changes in winter and spring temperatures through their effect on coho emergence timing account for most of the nearly two-fold increase in smolt production that has been observed in the aftermath of logging. Effects of summer flow conditions on smolt production appear to be indirect. Prolonged summer low flows reduce the growth rates of sub-yearlings over the summer leading to higher over-winter mortalities and reduced smolt production the following spring. The production of smolts is strongly buffered against variations in biological variables through density-dependent growth and mortality at various life stages. With stable stream conditions and constant climate, smolt production was not sensitive to large changes in spawner density. The empirical models were developed before there were marked changes in stream stability. Logging-related degradation of the stream is accelerating and there is some evidence that our models are now over-estimating smolt production.

## A REVIEW OF PRESENT MANAGEMENT

Malcolm H. Zirges

Program Leader, Oregon Department of Fish and Wildlife

Since the title of this session is "An Alternative to Present Salmon Management", I seem to have the role of straight man with the job of describing present salmon management. This is not something I am happy to do since I am not happy with present salmon management--and I don't know anyone who is. Salmon managers in the northwest are today faced with the task of fairly distributing too few fish among too many fishermen, while at the same time trying to protect the productivity of a number of depressed stocks.

The story really has three parts. First, I want to run through a quick review of the setting--how salmon behaviour makes management difficult, the condition of the stocks of salmon fished off Oregon, and the development of the ocean salmon fisheries. Next, I will describe the evolution of our management approach--including, I hope, impressing you with the complexity of present management. And finally, I feel I should pass on some idea of the performance of these management measures.

I won't belabor the issue of performance since others on this panel will surely comment on what they think of present management. But at this point I do want to set the stage for my talk and the rest of the panel by reminding you of several of the goals that have been stated for fish management. Oregon Administrative Rule 635-07-510 tells the Oregon Department of Fish and Wildlife that it shall adopt management plans "appropriate to achieving optimum populations and production of fish in waters of the state while maximizing the benefit to Oregon citizens", while the Magnuson Fisheries Conservation and Management Act (MFCMA) provides us with several goals such as Standard 1--"Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery", Standard 5--"Conservation and management measures shall, where practicable, promote efficiency in the utilization of fishery resources", and Standard 7--"Conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication". Please keep these goals in mind as I try to review present management.

One of the most wondrous aspects of salmon behaviour, their extensive ocean migration that often carries them far from their natal streams, also results in mixing of stocks on the ocean fishing grounds. This means that fishermen cannot tell a Rogue River chinook from a Klamath River chinook--and will catch a mix of depressed as well as healthy stocks.

This is a key problem because there will probably always be a number of depressed salmon stocks along the Pacific coast. It seems that as soon as one weak stock recovers another starts the downhill slide.

This problem has been further exaggerated by the production of

young salmon by the millions in hatcheries. For example, government hatcheries have recently released nearly forty million young coho salmon per year into ocean waters from the Columbia River south. This in effect creates super-healthy stocks--stocks of high abundance that can sustain high fishing rates--and which if not fished hard will return to release sites as embarrassing surpluses.

So a tug-of-war has developed between managers seeking to protect depressed stocks and fishermen who want to catch abundant stocks. And there are a number of notable examples of each category. In 1986, the Pacific Fisheries Management Council (PFMC) was faced with protecting weak runs of Klamath River chinook, Oregon coastal natural coho, and Washington coastal coho, while at the same time Rogue River chinook, Columbia River bright chinook, and a number of hatchery coho stocks were quite healthy.

And the fishing fleet is hungry. Before hatcheries, salmon in the ocean were pursued primarily by full-time commercial trollers with a smattering of hardy recreational fishermen. But that has changed. Increasing regulation has made it difficult for full-time commercial trollers to make a living while tax laws have encouraged week-enders. And the recreational fishery is blooming--both due to the easy availability of hatchery-produced coho, and because recreational fishing boats and gear have improved. Gone are the days when a relatively modest fleet in turn had a modest impact on a large and relatively robust salmon resource.

Something had to be done, and concern for depressed stocks, whether expressed in policy such as the Oregon wild fish policy or legally through court-mandated ocean escapement goals to meet allocation or actual spawning needs, has produced what is known as weak stock management. Fishing regimes are now tailored to reduce harvest rates to what the weakest stocks can sustain.

Since abundance of a given weak stock is typically different in different areas, the stage was set for managers to mix and match time and area closures and other traditional management methods in order to get at as many of the healthy-stock fish as possible. A key word here is "traditional" which means indirect management methods. The fishing regime adopted by the PFMC for the salmon fisheries off the coasts of Washington, Oregon, and California in 1986 is a classic potpourri of indirect means of limiting the effectiveness of fishing effort in catching fish. It included time and area closures, gear restrictions, and bag limits.

Managers must identify salmon stocks that require protection, identify where and when they are caught, consider social issues such as court-mandated indian vs non-indian sharing formulas and commercial vs recreational reallocation, and then develop a fishing regime that reduces harvest rates to some acceptable level. But how easy a job has this been? Not easy at all, and it is getting worse.

For 1986, the PFMC management area was blocked out into four major management areas with six subareas, the fishing season was broken into dozens of time periods, different areas were given different quotas, minimum size limits were different between some areas, gear restrictions differed between some areas, and

In some areas fishermen could only land certain ratios of chinook and coho. It required one and one-half typed pages to describe the commercial regulations, plus a full page of footnotes. The recreational regulations only required one page of description plus a page of footnotes. You can imagine the problem of developing, analyzing, and then tracking the results these regulations. And you can imagine the chagrin of a fisherman trying to discover when it was legal to fish.

This complexity of regulations is becoming bewildering as well as restrictive. And now that managers have spread out their full bag of indirect fisheries management methods, what has been the result--the bottom line? A commercial troll fisherman now faces a severely restricted and regulated number of days on the ocean. Worst of all he must face the uncertainty of not knowing when the quota will be filled ending his season suddenly. Traditional markets for commercially-caught salmon are beginning to say "no thank you" to the erratic supply from the Pacific coast. Short, unpredictable seasons are cutting the pockets off of a fishery that has traditionally provided employment and income in virtually every port along the Oregon coast.

Recreational fisherman in a number of areas can expect barely two months of fishing as well as other restrictions. And the problems of uncertain season length apply to them as well--and to others in coastal communities. Imagine the frustration of a charter-boat owner who must cancel bookings because a quota was met early, or a motel owner booked solid for the two month fishing season but nearly empty the rest of the year. Tourism is important along the Pacific coast, and salmon management affects tourists.

Fishery management just isn't fun anymore. The army of which I am a part, and it now includes quite a crowd up to and including the Secretary of Commerce, must count every fish into the bag or fish plant and compare totals against quotas here and quotas there. And woe to us if we don't let a group get its full quota share. Perhaps present management is the best that can be done under the circumstances. The answer depends upon your perspective. If the goal of management is only to come to some sort of legally fair division of the allowable catch--and then to make sure that only that number of fish are caught--then it is working more or less. But if management is ever to approach the goals I listed earlier on, then something's got to change.

Under present management, fishermen suffer because they must face unstable seasons with unpredictable opening and closure dates which in turn makes planning difficult, disrupts fishing patterns, and destroys markets. Managers suffer because they find that all their time, energies, and resources go into management processes such as regulation formulation and enforcement while little remains for improving data and studying fish. And finally, the salmon resource suffers because quota-induced fleet concentrations, missed quotas, and hit-or-miss fisheries cause uneven harvest of available stocks. I look forward to change.

## A RATIONAL ALTERNATIVE TO PRESENT SALMON HARVEST

Carl E. Bond

Professor Emeritus of Fisheries, Oregon State University

I hope today to restate some of the ideas about changing our method of harvesting salmon commercially, some of the reasons I think a change is necessary to protect wild stocks, and some of the impacts that could result over the next few decades.

As we all know, some of the greatest difficulties in managing fisheries have come from our poor ability to distinguish individual stocks and to tailor the harvest to take the crop of each stock while allowing escapement for spawning. The more cryptic the stocks and their migrations, the more difficult the task becomes. Pacific salmon may be cryptic in the ocean, but conveniently sort themselves out on spawning migrations so that fisheries managers can learn the timing and characteristics of stocks and allocate harvest from a reasonable base of knowledge. This, of course, is well known, but little use has been made of the opportunity to manage in this way in this state and adjoining areas in several decades.

The fishery has been largely displaced to the ocean where the mixing of stocks is obscure to unknown; where wild stocks that should not be fished at all are harvested at the same rate that might be proper for other wild stocks, but on the other hand, might be too low for underfished hatchery stocks. Random distributions and clumped distributions of both fish and fishermen compound the problem. Many parallels have been drawn between this type of management and such theoretical activities as managing cattle harvest by machine-gunning the critters on the range and hoping the desired lots will be miraculously slaughtered at the predetermined rate.

Not only is the ocean fishery largely non-selective, it tends to bring to market fish of a smaller average size than those taken in terminal fisheries. Troll-caught coho salmon in Oregon are harvested early in the seasons at weights about half the mature weight; some are taken at less than four pounds. In 1984, troll-caught coho landed in Oregon weighed an average of 5.6 pounds, whereas Columbia River gill-netted fish averaged 7.9 pounds, a 41 percent increase. Chinook taken in the third year of life at eight to ten pounds are half the weight of mature fish in the fourth year.

In addition, regulations on the troll fishery that require release of under-sized fish or the release of a given species in certain areas or seasons diminish the overall population and potential harvest because of the mortality suffered by the released fish. This hooking mortality is estimated to be 30% of the shaker coho and 15% of the released chinook. There are reasons to think that there are inefficiencies in the troll



fisheries that reduce the poundage landed per unit of effort or per unit of money spent. According to a study by ODFW (1985) 50% of the troll catch is landed by 11 to 12% of the vessels landing fish, and 90% is landed by around 40 to 50% of those vessels. (Vessels landing fish since 1980 have made up from 24 to 90% of those holding permits.) The same report gives a salmon troller budget showing a gross revenue of \$35,000 and a net return of \$5,305. An interesting exercise is the division of the total ex-vessel value of salmon landed in Oregon for a given year by the number of vessels landing salmon in that year. For 1983, the figure obtained is \$778 per vessel.

From the standpoint of the consumer, the advantages of having a troll fishery is that bright fish are available for an extended period during the summer.

The alternative to the non-selective ocean fishery, of course, would be a fishery pursued near the terminus of migration of the salmon stocks. There would be some disadvantages to this in that the period of harvest, especially on the coast, would be skewed toward late summer and fall, and not all fish landed would be ocean-bright.

Regardless of adjustments that would have to be made in marketing, a terminal fishery would greatly favor salmon management with the following advantages:

1. Terminal harvest can be selective as to area and stocks fished so that runs can be monitored constantly to prevent over-fishing or under-fishing. We can start operating on a base of knowledge built up over decades of stream surveys, and by the time a terminal fishery is phased in, information on the timing of runs and the segregation of stocks could be sufficient.

2. Fish caught in a terminal fishery would be at full adult size, thus increasing the total poundage landed.

3. There would be a potential for landing a greater number of fish than the troll fishery. Fish in excess of the numbers needed for spawning escapement could be harvested, and there might be an adjustment upward in numbers available because there would be no loss from hooking mortality.

4. Efficiency of shore-based harvest facilities can be high, as can nearshore ocean fisheries set up at river mouths with known and selected stocks as targets.

Looking to the future, we might see the day when in this area the marine fisheries for salmon will consist of a well-regulated recreational fishery plus whatever trolling or seining that could aid in the terminal harvest of segregated stocks.

The estuarine and freshwater fisheries could employ traps and racks for wild stocks and ladders or racks at release points for hatchery stocks. Other means such as gillnets, beach seines, wheels, etc. could be used in specific locations. Recreational fisheries could be pursued in a manner consistent with the overall goal of rational management of individual stocks.

We should be able to foresee a greater salmon supply in the

future, partly from a greater abundance of wild fish from well-managed stocks rearing in rehabilitated streams, as well as from a greater abundance of fish from aquaculture. Some of these reared fish will be from salmon ranching, some from pen-rearing, and some from enhancement of wild stocks in selected localities. Much of the supply from aquaculture will come to our markets from Europe, or from eastern states and provinces. How much will depend on our willingness and ability to compete. It will depend on the speed with which we are willing to admit that changes are already upon us. There are only a few buffalo hunters left.

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## ALTERNATIVE FISH HARVEST

Douglas W. Dompier

Fish Biologist, Columbia River Inter-Tribal Fish Commission

Terminal Fisheries - An alternative to present salmon management or is it.

The tribes of the Columbia River system have always had terminal fisheries, currently have terminal fisheries, and will have terminal fisheries in the future.

Historically the Yakima, Umatilla, Warm Springs, and Nez Perce fished in all the drainages that flow through their reservations and ceded lands. In addition, historical documents show that terminal fishing also occurred in other drainages of the Columbia such as the Willamette and Cowlitz.

Current terminal fisheries occur on a handful of rivers such as the Klickitat, Yakima, Deschutes, Tucannon, John Day, Catherine Creek, Clearwater, and Rapid River.

Future fisheries will once again occur in all drainages that flow through the reservations and ceded lands.

Tributary fisheries are very important to the tribes for a number of reasons. All tribal members do not have sites or gear for mainstem fishing. The return of the fish to the rivers embodies the culture and way of life for the tribes. Besides these fish providing for subsistence fishing, they also hold a special meaning to the tribes of a resource that will always be there for future generations.

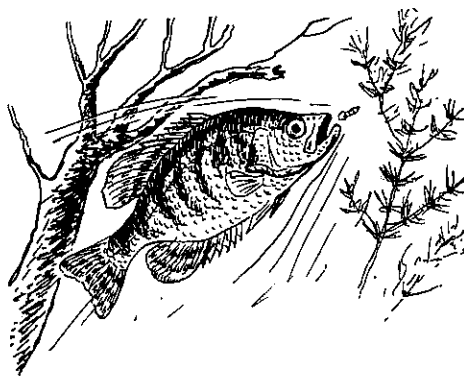
So why the big uproar over tribal fisheries? It can't be their terminal fisheries so it must be the mainstem. Past fishery management attempted to remove tribal fisheries from the mainstem Columbia River through various methods. Records of the 1950's describe fish agency support of mainstem dam construction to no hatchery facilities on Indian reservations. To fully understand the dilemma that now faces fishermen both tribal and non-tribal, the practices of the past 30 years must be examined and modified.

The dams are constructed and will not be dismantled. Therefore, a major change must occur with fish production. Fish production can no longer be used to control fisheries but as a management tool to expand and provide productive mixed stock and terminal fisheries. One need only use a little common sense to realize that if you rear fall chinook you will not have spring or summer

chinook returning. If you release the fish below the dams they will not return above the dams. Fish released at hatcheries or adult traps will not return to the natural habitat to reproduce.

The tribes will continue to allocate their share of the harvest at their usual and accustomed sites including the mainstem and tributaries. Terminal fisheries will be planned as one component of the harvest. Fish production will no longer be used to subvert mixed stock fishery or treaty rights. Fish production will be changed and the proper species reared and released back to the rivers.

It is also important to remember that in order for the tribes to get their share, the non-Indians need to get their share. Proper management can provide for both mixed stock and terminal non-Indian fisheries.



## REACTION OF THE RECREATIONAL FISHERY TO THE PROPOSED TERMINAL FISHERY

Frank Warrens

Charter Boat Operator, Portland, Oregon

From the point of view of the recreational user group, alternative management of the salmon resource as compared to the present system most certainly warrants investigation.

For interested individuals who are not directly involved in either the management or the regulatory process, it requires a great deal of background to comprehend the complexity of current salmon management schemes. There are basic given conditions which dictate the various management scenarios. For example; sharing allocations between users of available harvest, placing constraints on harvest of weak stocks, treaty obligations, escapement goals and time tables, timing of seasons, and so on. Of most importance to the recreational fishery, however, is the need to return to a stable and predictable sport season, minimally from Memorial Day through Labor Day.

Realizing that a radical shift in the method of harvesting salmon by the commercial industry would meet with predictable resistance by that group, the introduction of terminal fishery may never entirely replace commercial trolling for salmon. This point will likely be amplified by my troll fishing counterpart.

The key issue for salmon managers should be enhancement of the resource both public and private. They should prioritize harvest scenarios that maximize the highest and best use of our salmon on a broad economic base, particularly when the resource is in short supply.

## PROS AND CONS OF UPRIVER SALMON AND STEELHEAD STOCKS: THE ECONOMIC REALITIES

Michael J. Scott

Senior Research Economist, Battelle Pacific Northwest Laboratories

Restoring or otherwise mitigating past losses in upriver Pacific Northwest salmon and steelhead stocks is a complex problem with complex solutions. Restoration requires coordinated action of multiple government agencies responsible for hydroelectric power, flood control, irrigation, land management practices, and sport, commercial, and Indian fish harvest. It will also take a major expenditure of society's resources, resources that might be devoted to other uses. Whether you are an enthusiastic supporter of fish restoration, an opponent concerned with the lowest possible price for hydropower, or merely a worried rate payer of a utility served by the Bonneville Power Administration, you ought to be concerned that the planning for restoration of salmon and steelhead stocks now going on in the Northwest provide restoration in a cost-effective manner.

As a professional economist, I have been asked to address the economic realities behind the salmon and steelhead protection, mitigation, and enhancement program. In so doing, I would like to focus on the Columbia River Basin Fish and Wildlife Program of the Northwest Power Planning Council, which currently provides the principal regional framework within which fish losses caused by hydroelectric power development are to be mitigated. The hydropower responsibility for past salmon and steelhead losses in the Basin is currently estimated by the Power Council at between 5 and 11 million adult salmon per year.<sup>(a)</sup> It is not necessarily possible that the entire 5 to 11 million can be restored under today's environmental and harvest conditions.<sup>(b)</sup> Economic Reality No. 1 is that the ratepayers and U.S. tax payers might not be willing to pay for levels of restoration approaching 5 to 11 million salmon and steelhead if they knew the real cost. To cite one example, in a recent study of one of the Mid-Columbia main stream dams, we estimated that smolt protection using a submerged traveling screen system at one powerhouse would cost between \$8.50 and \$30.00 per smolt, or \$500 to \$1,550 per fish surviving to adulthood.

It is not at all obvious how large the total cost might be for a comprehensive protection, mitigation, and enhancement program. The responsibility for implementation of the Columbia River Basin Fish and Wildlife Program is divided among several parties, including the Bonneville Power Administration, the Army Corps of Engineers, U.S. Bureau of Reclamation, a number of private utilities, several Indian tribes, and others. A quick check by telephone with the responsible agencies last week indicated that no comprehensive estimate of the cost of fish protection, enhancement, and mitigation has been done of the Council's original plan and that only partial

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(a) Northwest Power Planning Council, 1986 b, p.1. This range is the subject of some controversy.

(b) Ibid., pp. 7-13

information is available on the costs of the 1986 suggested amendments to the plan. Economic Reality No. 2 is that there is currently no estimate of the cost of restoring the Columbia Basin's salmon runs. An estimate of these costs, by project, needs to be provided at the earliest possible date to permit rational planning.

Economic Reality No. 3 is that system-wide planning will probably be necessary both to prevent the waste of resources used in mitigation and to set priorities. To make this point, I have chosen as an example two habitat improvement projects filed in the Northwest Power Planning Council's Applications for Amendments (Northwest Power Planning Council 1986a). The first project involves making additional habitat available to upriver spring chinook and summer steelhead in the Little Salmon River drainage of Idaho as offsite mitigation for losses due to downstream hydroelectric power development. According to its sponsors, the project is expected to produce an additional 160,000 spring chinook smolts and 80,000 additional steelhead smolts, yielding an estimated additional 1,600 adult chinook and 800 adult steelhead. The present value of the cost of the project, requiring 8 years to implement, would be about \$393,000. The second project involves habitat improvement for the Mohawk Subbasin of the Willamette River in Oregon. This project is expected by its sponsors to yield about 3,500 adult chinook salmon, 6,500 steelhead, and 29,000 resident trout at a cost of \$923,000.

Both projects fit within subbasin plans and have been well-coordinated with agencies in the local geographic area. Both request Bonneville Power Administration funding. The BPA, however, is faced with dozens of such requests. Which should be funded first?

The first part of Table 1 shows initial benefit-cost calculations for the two projects under current downstream survival conditions for smolts. The Mohawk habitat improvement shows a higher net benefit, partly because it is a larger project, but also because the ratio of benefits to costs is higher. Under current conditions, benefit-cost criteria suggest that the Mohawk project would contribute more fish and more net value to the restoration of the Columbia Basin stocks. If the two basins (Mohawk and Little Salmon) are viewed in isolation from each other without a system plan, however, the Little Salmon habitat improvement project might be done first.

A second point about system planning is made in the second part of Table 1, labelled "Improved Downstream Survival". It is hoped by many people in the enhancement business that the average smolt survival rate per mainstream dam during seaward migration can be improved from today's 80 percent value<sup>(a)</sup> to the Council's goal of 90 percent per project.<sup>(b)</sup> In that case, the benefits of habitat enhancement on the Little Salmon River would more than double due to increased smolt survival through 8 mainstream dams. There would be no change in Mohawk benefits, since smolts from the Willamette do not encounter any mainstream Columbia or Snake River dams. The Little Salmon project, which is shown in Table 1 to be economically marginal if built before the improvements in main steam fish passage, becomes far more cost-effective relative to the

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(a) Northwest Power Planning Council 1986b, p. 8.

(b) Mahar, 1986.

Mohawk project if it is built after the main stem improvements. Obviously, what is done for protection, mitigation, and enhancement in one part of the Columbia Basin system will affect other parts of the system and may affect the overall sequencing of projects. This is true regardless of whether a dollar value is attributed to the fisheries benefits because it arises out of the biological interactions of the system. In my example, I have shown one of the simplest interactions, but more complex ones involving several stocks competing for habitat, genetic changes, etc. will also be present as Columbia River stocks increase. Clearly, a system planning perspective will be needed to avoid conflicting restoration activities.

TABLE 1 Relative Benefit-Cost Analysis of  
Two Habitat Improvement Projects

	<u>Mohawk River Subbasin Habitat</u>	<u>South Fork Salmon River Habitat</u>
<u>Current Conditions:</u>		
Discounted Benefits	\$2,872,000	\$455,000
Discounted Costs	<u>923,000</u>	<u>393,000</u>
Discounted Net Benefits	\$1,949,000	\$ 62,000
Benefit/Cost Ratio	3.4	1.2
<u>Improved Downstream Survival</u>		
Discounted Benefits	\$2,972,000	\$1,167,000
Discounted Costs	<u>923,000</u>	<u>393,000</u>
Discounted Net Benefits	\$1,949,000	\$774,000
Benefit/Cost Ratio	3.4	3.0



Economic Reality No. 4 is that the demand among sportsmen, commercial fisherman, and Indians for genetic preservation of the salmon and steelhead stocks of the Pacific Northwest can be expected to be extremely limited and indirect. To see why this is so, consider a simplified equation which shows the economic value of an increase in one of the stocks.

$$V_t = P_{1t} * q_{1t} + P_{2t} * q_{2t} + P_{3t} * q_{3t} + \int_t^T G_\tau [q_\tau - (q_{1\tau} + q_{2\tau} + q_{3\tau})] * [W_\tau] * e^{-r\tau} d\tau \quad (1)$$

where

$V_t$  = value of the stock increase, time  $t$

$P_{1t}$ ,  $P_{2t}$ ,  $P_{3t}$  = value per fish in the commercial, sport, and Indian fisheries.

$q_{1t}$ ,  $q_{2t}$ ,  $q_{3t}$ ,  $q_t$  = number of fish caught in the three fisheries, and fish in total run (less natural mortality)

$G_\tau$  = generalized production function for future catch of adult salmon (a function of the size & genetic characteristics of current and future escapement).

$W_\tau$  = weighted average economic value of fish produced in the future from current escapement.

$r$  = discount rate

$\tau$  = future time period.

The principal value of genetic diversity in Equation (1) is incorporated in the function  $G$ . Stocks well-adapted to a given stream, whether native wild stocks or merely naturalized (out-planted hatchery stocks that spawn naturally), are expected to survive migration and reproduce more successfully than outplanted stocks from other river systems or hatchery fish that are not well-adapted (Riggs, 1986). Well-adapted stocks are also considered to be more resistant to disease. However, since it is not obvious whether he will share equitably in future stock increases, the fisherman may only have indirect interest in the genetic makeup of escapement. The fact that a fish is wild or naturalized, rather than hatchery-reared, would not likely influence its price per pound on the commercial market. Whether sport fisherman and Indians place a special value on catching wild and naturalized fish (as opposed to hatchery fish) is an open question. This is especially true since many of the "wild" stocks are really naturalized ex-hatchery stocks (Riggs, 1986).

If, however, the main value of genetic adaptation is one of more effective reproduction and survival, it follows that it will be difficult to persuade fishermen to forego the harvest of hatchery fish in order to preserve wild runs that they do not recognize as being "different." It will also be hard to persuade electric rate payers that preservation of wild stocks at a high cost per fish is preferable to replacing these stocks with larger hatchery

stocks at a low cost per fish. It may not be obvious to the layman that preservation is cost-effective mitigation.

### Summary

Restoring or mitigating Pacific Northwest salmon and steelhead runs is likely to require a major expenditure of society's economic resources. Regardless of whether there is ever a requirement for formal benefit-cost analysis of proposed protection, enhancement, and mitigation strategies or projects, good public stewardship demands that we perform only those remedial actions whose value to society (however measured) is positive. Budget constraints will likely cause a premium to be placed on those actions whose value, net of cost, is the highest.

Four economic realities underlie the restoration program. The first is that complete restoration may be so costly as not to be politically possible. The second is that the cost is unknown but must be computed in order to plan for restoration. The third is that system-wide effects and subsystem competition for restoration dollars will probably mandate some form of system-wide planning, to which subbasin plans will have to conform. The final reality is that markets and fishermen are blind to the pedigree of individual fish, making the preservation of specific wild stocks in the context of mixed-stock fisheries and hatcheries difficult to accomplish.

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CAN FISH HABITAT (SUBSTRATE) BE USED AS A MEASURE  
OF ENVIRONMENTAL CHANGE, OR,  
HOW MUCH CAN YOU CLOSE THE REDDROOM DOOR  
BEFORE THE FISH POPULATION IS GONE?

Donald M. Martin

Nonpoint Source Coordinator, U.S. Environmental Protection Agency  
Idaho Operations Office, Boise

Fisheries and water quality in Idaho have suffered severely from the impacts of sediment from nonpoint sources such as agriculture, logging, and mining activities; such impacts are not unique to any state in the Northwest. Yet all states are required by the regulations of the Clean Water Act to have and implement an antidegradation policy in their water quality standards, and such a policy should provide for adequate protection of designated beneficial uses (i.e. fisheries) from point and nonpoint sources of pollution.

Recent activities in Idaho indicate a new trend toward quantifying acceptable levels of impact to fish habitat from nonpoint source activities as a viable use of the antidegradation concept. These efforts have taken the form of using the degradation of fish habitat (spawning, summer or winter rearing) as a measure of impact on fish populations, the protected beneficial use.

RELATIONSHIPS AMONG FISH POPULATIONS, SEDIMENT DEPOSITION  
GEOMORPHOLOGY AND LAND MANAGEMENT PRACTICES IN  
THE SOUTH FORK SALMON RIVER, IDAHO

Russ Thurow, Rick Edwards and Dave Burns

Idaho Department of Fish and Game (Thurow),  
and U.S. Forest Service, Payette National Forest  
(Edwards and Burns)

Embeddedness and salmonid densities were measured independently by different groups of workers in the same stream reaches. Embeddedness and maximum densities of steelhead trout, cutthroat trout and chinook salmon in 10% embeddedness increments were significantly related ( $P=0.01$ ,  $r=-0.99$ ). Steelhead, cutthroat and chinook densities for all locations were significantly related to embeddedness ( $P=0.01$ ,  $r=-0.62$ ). Bull trout densities were significantly related to embeddedness ( $P=0.01$ ,  $r=-0.49$ ).

The relationship of embeddedness to fish density was similar to that described by other researchers. Embeddedness was related to various watershed characteristics, such as watershed size and stream gradient; land disturbance, such as acres of road; and modeled sediment yield. Road acreage and modeled sediment yield could both independently account for about two-thirds of the observed variation in mean embeddedness. When geomorphic characteristics such as land types were averaged together during sediment modeling, significant loss of model credibility occurred.

CURRENT EFFORTS TO BETTER DEFINE FISH HABITAT RELATIONSHIPS  
AND USE OF MODELING IN THE US FOREST SERVICE

Paul Brouha  
USDA Forest Service, Washington, D. C.

The Forest Service is responsible for the management of fishery habitat resources within the 191 million acres of National Forest Lands. These lands contain 128,000 miles of streams and 2.2 millions acres of lakes and reservoirs. In excess of 46.5 million angler days and 118 million pounds of commercial and subsistence fish are produced annually from the National Forests. Much of this resource use occurs in the eight western states where there is 48% public ownership of land. Most of these lands are managed under a multiple-use concept and are subject to grazing, logging, mining, and hydropower development uses in addition to the recreation and commercial fisheries use.

Sport fishing is the second most popular outdoor recreation activity in America. Over 50 million anglers engage in some type of sport fishing. They spend over 850 million days and over \$17.3 billion annually in pursuing their sport. The popularity of sport fishing is increasing, and is expected to increase 90% by the year 2030. As private land access, particularly near urban centers, becomes increasingly restricted, National Forest lands provide one of the greatest opportunities for increased public angling.

Fish habitat and population data are obtained by Forest Service fisheries biologists for all National Forest lands. These data are utilized to determine existing conditions, identify discrepancies between existing and desired conditions, and develop management opportunities and strategies to address these discrepancies. The Forest Service Fish Habitat Relationships (FHR) is the data, knowledge, and procedures used in quantitative fish habitat planning and evaluation. In 1983 a national fish ecology unit was established in Ft. Collins to assist regions in development of these quantitative processes, to provide technology transfer, and to coordinate the application of new management concepts from the National Forest Management Act.

In describing current efforts to better define FHR and use of modeling in the Forest Service, I would like to present my comments in three sections: Technical Developments, Management Applications, and finally Policy Developments and Needs.

### Technical Developments

As a general principle FHR has developed on the basis of management needs - issues, concerns, opportunities. FISHSED, a habitat suitability model to relate salmonid response to sediment changes, developed in response to the issue of road and logging - induced sedimentation of the low energy streams and rivers surrounding the Idaho batholith. COWFISH, a habitat suitability model to relate salmonid response to riparian habitat and stream channel morphology changes attendant to grazing of livestock, developed in response to the concern that there were insufficient numbers of fishery biologists to work in aiding range conservationists evaluate riparian and stream fish habitat quality. The model was developed to permit range managers and other non-fishery personnel to

initially evaluate whether habitat management problems existed and whether to contact a zone fishery biologist for further assistance. Other FHR models have developed the same way - you might call it a symptomatic approach!

This approach may be likened to filling the squares in a crossword puzzle. We fail to get the broader view of how an ecosystem functions and in many cases we risk applying the wrong analytical tool - just because it's handy! We also get an inaccurate perception of what FHR is all about. Let me review FHR and components to put everyone here on an equal footing:

Goal: Integrate fish habitat inventory and evaluation into project and Forest level interdisciplinary resource planning and management.

Objectives:

1. Test a land-aquatic habitat classification that is compatible with other land and resource classifications to facilitate integration with multi-resource land and water planning.
2. Develop and standardize inventory techniques that are needed for the development of predictive fish biomass models.
3. Develop fish habitat capability models that can be used to:
  - a. Estimate the natural and managed (present and future) productivity of fish habitat,
  - b. Address the cumulative effects and longevity (recovery) of management actions,
  - c. Assess activities at the Forest, watershed, and project level, and,
  - d. Monitor implementation of Forest Plans.
4. Develop an aquatic information and database system that is compatible with Data General computer equipment.

The problem we face in the regional development and application of these objectives is inconsistency. Because of lack of adequate funding overall and a lack of perceived management utility by line officers of some objectives, i.e., habitat classification and standardized inventory techniques, as well as a lack of completed inventories, we have not been able to develop and apply these most basic building blocks of FHR. As a result of this inconsistent application our success in applying the habitat capability models may not be what we'd hoped because we haven't known enough about the ecosystem under evaluation to address the factors limiting fish production!

As the speakers in Fred Everest's session earlier this morning have pointed out, the identification of limiting factors is not an easy task that can be approached in a "cookbook" manner. Nor can factors limiting smolt production automatically be assumed to be one thing or another.

There are, for example, seasonal variations in limiting factors that may change the preferred location of a critical habitat evaluation or monitoring reach. Bryant (1982) reported that coho salmon, dolly varden trout and cutthroat trout habitat and reach use in an Alaskan coastal stream varied dramatically from season to season. Others (Pollard-personal communication) have noted the same phenomenon for chinook salmon and steelhead in Idaho streams. Additionally, spatial analysis through application of a geographic information system (GIS) may be needed to complete cumulative effects analysis. Finally, limiting factors may change gradually over time as habitat diversity resulting from large wood debris present in a stream, deteriorates and is not replaced because of riparian timber harvest. In addition to causing changes in presence of woody debris and stream sedimentation, timber harvest may alter stream bank stability, water temperature and flow regime, light incidence, nutrient availability, and litter fall. Other development activities and forest or rangeland uses such as livestock grazing, hydropower development, and mining are being recognized as each having major potential impacts to fisheries in certain areas. Presently new habitat and bio-economic models addressing these habitat factors are under development.

These models will enable resource managers to predict and demonstrate not only the changes in habitat carrying capacity from alteration of habitat quality, but also the resulting potential changes in quantity and value of recreation or commercial use produced. These models will be used in the decision-making processes to address project-level tradeoffs as well as cumulative effects of many projects in third order and larger stream drainages.

#### Management Applications

Models are expressions of explicit hypotheses rather than implicit assumptions and they aid the biologist in synthesizing the many parts of his analysis into a whole (Salwasser, 1984). They can also serve the resource manager as a decision "risk analysis" tool. The modelled output can display trends over time and the likely "cost" to an affected resource from a set of proposed management actions. We all must realize that models developed for a species whose habitat requirements are not well defined have a high likelihood for error. The outputs must be presented in this context in the decision-making process and close monitoring applied to avoid the consequences of a wrong decision.

The relationship of habitat quality and bio-economic models to National Forest management is illustrated on figure #1: Models are applied at two levels -Forest Planning and project planning. In Forest Planning models are used to aid the analysis of alternatives and to assist the resource manager in defining objectives, standards and guides. At the project level models are used similarly but in a much more site-specific fashion to assist in selecting the preferred alternative, setting constraints, and defining mitigation measures to ensure objectives are met and that outputs and effects are as desired. Monitoring information then feeds back to evaluate and calibrate model coefficients and to refine concepts and hypotheses.

## Policy Developments and Needs

Having briefly reviewed technical developments and management applications it is appropriate to discuss the attendant present policy developments and needs to fully incorporate FHR into National Forest Management:

### **\*CUMULATIVE EFFECTS**

Cumulative effects may be defined as the combined incremental effect upon a species and its habitat resulting from multiple land uses over space and time. Briefly, cumulative impact analysis is required by the National Environmental Policy Act of 1969 (NEPA) and the Council on Environmental Quality (CEQ) regulations. The National Forest Management Act provides the Forest Service with direction on how cumulative effects analysis should be performed. Because application of this analysis technique has been slow, the courts have assisted in defining the bounds of the process ("Mapleton" decision 4/84). In that case the court found the analysis must include consideration of the actions of others. Region 6 of the Forest Service has developed a generalized process to accomplish cumulative effects analysis in response to "Mapleton".

From a policy standpoint, a proposed change to the Forest Service Manual has been drafted to require "multi-project environmental analysis as necessary to determine cumulative effects of activity scheduling." It further directs the analysis of "cumulative effects when factors such as the hydrologic capacity of a watershed, visual quality standards, or wildlife cover" or fish habitat "thresholds have the potential to be exceeded." Finally, it requires monitoring of effects of project implementation to insure standards or thresholds stated in the Forest Plan are not exceeded. Inconclusive discussions have been held concerning policy options for management of intermingled and checkerboard ownership lands within the National Forest where private land management activities have caused cumulative impacts that restrict Forest Service management latitude.

### **\*MONITORING**

Monitoring is a required function of the Forest Land Management Planning process to determine if goals, objectives, regulations, requirements, and standards and guidelines are being achieved. A national framework has been proposed to provide common direction of the monitoring and evaluation process. As proposed, monitoring is separated into three types and an evaluation step. The three monitoring types are (1) implementation monitoring, (2) effectiveness monitoring, and (3) validation monitoring. Implementation monitoring is the broadest level with extensive coverage of most projects. As we progress from implementation monitoring to effectiveness monitoring and then to validation monitoring, the scope is narrowed and the intensity increased. Approaches change from qualitative to quantitative as we work through this progression. Monitoring of water quality and fish habitat will likely be applied on a stratified sample basis in an interagency, interdisciplinary framework. Region 1 of the Forest Service has been developing this concept with for Idaho and Montana EPA Regions 8 and 10. \* Nonpoint sources and Best Management Practices (BMPs).



WATERSHED/STREAM CLASSIFICATION FOR MANAGEMENT  
OF ANADROMOUS FISH STOCKS AND THEIR HABITATS  
IN SOUTHWESTERN OREGON

Christopher A. Frissell, William J. Liss, and Charles E. Warren  
Oak Creek Laboratory of Biology  
Department of Fisheries and Wildlife  
Oregon State University, Corvallis, OR

Following over two decades of serious declines and local extinction of native runs of fall chinook, coho, and steelhead in coastal rivers of southwest Oregon, Oregon Department of Fisheries and Wildlife in 1985 initiated a planning effort for protection and restoration of these populations. Because of the region's complex variation in geology, topography, and stream characteristics, a comprehensive classification system - which identifies key links between watersheds and streams, and maps zones of similar habitat potential - could provide a framework for organizing and integrating many aspects of planning, management, and research. Such aspects include estimating present and potential production, reconstructing causes of stock declines, determining escapement needs, identifying watershed management practices necessary to protect habitat quality, and planning enhancement activities.

Our strategy is to apply a hierarchical classification system that relates variation in site-specific habitat features to watershed characteristics. In the study area, bedrock geology strongly controls topography, soils, vegetation, groundwater, and mass erosion processes. Resistance and weathering patterns of rock types likewise determine drainage density, valley width, stream gradient, channel shape, and bed composition. Floods, clear-cut logging, farming, and development have severely impacted fish habitat, but these impacts vary between different geologic/geomorphic zones and landtypes. These zones also differ in historic productivity of anadromous fish. As the study progresses, geologic maps, historic photointerpretation, and field data will be synthesized in reports and maps delineating watersheds, landtypes, and corresponding stream habitat units. Allied research may examine life history diversity of local stocks in relation to habitat pattern in space and time.

ANALYSIS OF FISH HABITAT IMPACTED BY MINING, AND  
OPPORTUNITIES FOR RESTORATION IN THE PANTHER CREEK DRAINAGE OF IDAHO  
by

Dudley W. Reiser, Michael P. Ramey, Janet M. Peters, and Paul DeVries  
Bechtel, Inc.  
San Francisco, California

Panther Creek, a tributary of the Salmon River, historically supported large runs of chinook salmon and steelhead trout. The runs were eventually eliminated in the early 1960's and today the drainage remains largely uninhabitable due to toxic conditions in Panther Creek imposed by mine drainage. Although much of the toxic materials can be linked directly to specific point sources (e.g., mine adits, isolated waste rock piles), a substantial amount of the contaminants are unaccounted for and can be attributed to non-point source contamination. Sources of this material are likely the exposed waste rock piles, tailings dam, and underground seepage.

In 1984, Bechtel National, Inc., was contracted by the Bonneville Power Administration (BPA) to conduct a multi-disciplinary study focused on eliminating the sources of toxic effluent entering Panther Creek. As part of this project, the fisheries habitat was quantified above the sources of mine contamination (to serve as an index to what could be restored should the contaminant problem be controlled), and engineering alternatives were formulated and costed for eliminating the source of the toxic problem.

This paper presents a summary of both of these facets. From an engineering prospective, it is felt that both point and non-point source contaminants can be controlled to a sufficient degree to allow the restoration of anadromous fish runs into the Panther Creek drainage. However, the cost for this effort is high, ranging from \$3.7 to 8.1 million depending upon the various alternative.

EFFECTS OF DOMESTIC LIVESTOCK GRAZING ON MONTANE STREAMS:  
AQUATIC MACROINVERTEBRATES

John N. Rinne and T. Tharlson

Research Fisheries Biologist and U.S. Forest Service Volunteer  
USDA Forest Service, Rocky Mountain Station  
Forestry Sciences Laboratory  
Arizona State University  
Tempe, Arizona 85287

Abstract

Aquatic macroinvertebrate populations in reaches of a montane stream within areas removed from domestic livestock grazing were lower than in reaches of stream where cattle grazing was present. Differences were not consistently significant ( $p = 0.05$ ) and could be as easily attributed to lack of pretreatment data and linear changes in stream habitat as to presence or absence of cattle grazing. Results of study emphasize the necessity of pretreatment/baseline information and an ecosystem (watershed) approach to studying the effects of grazing on aquatic habitats and their biota.

Introduction

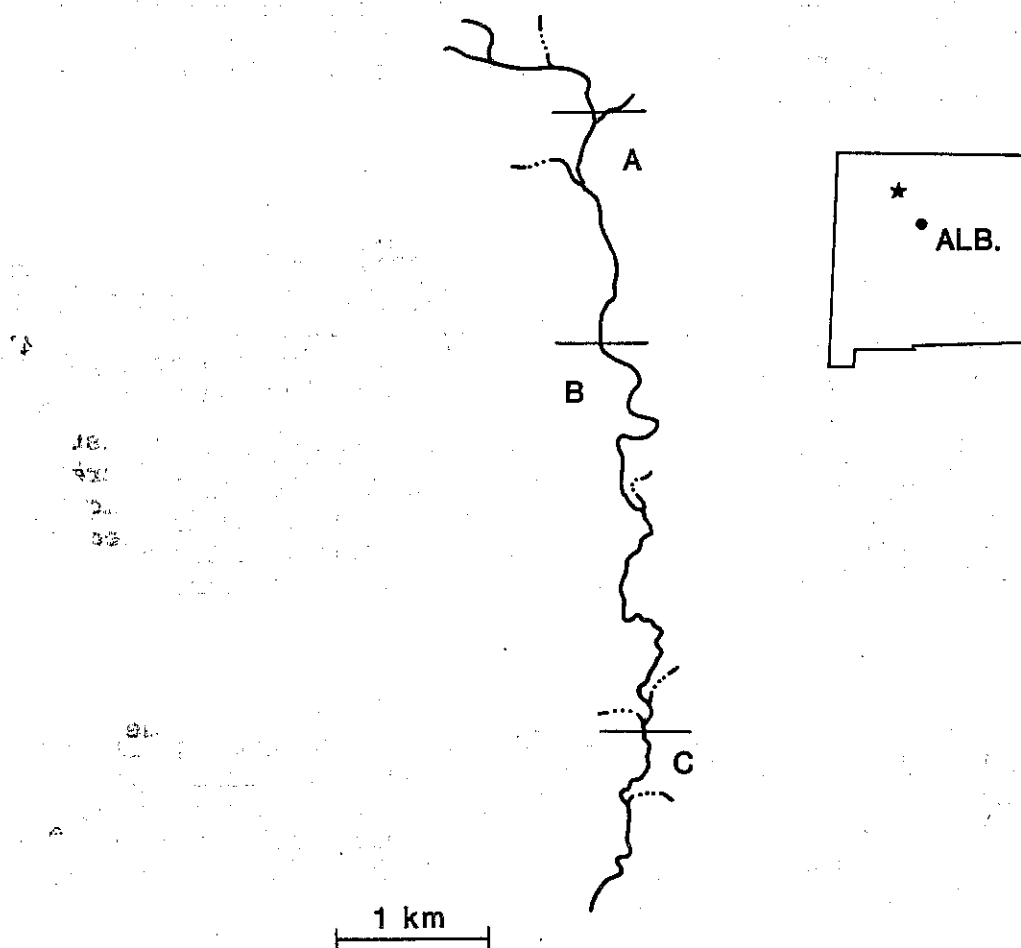
The potential for respective uses of National Forest lands to conflict is ever-present. In the last decade, domestic livestock grazing has been suggested to have contributed significantly to the widespread deterioration of riparian-stream areas (Platts, 1982; Kauffman and Krueger, 1984; Skovlin, 1984). Because of the concern between conflict of use, the Rio de las Vacas in northwestern New Mexico was variously fenced by the U.S. Forest Service in the early 1970's to exclude domestic livestock grazing and thereby improve instream and nearstream habitat. Effects of grazing removal on these variables were examined independently by the Rocky Mountain Station (USDA) a decade following this management activity. This paper is a preliminary report on the effects of cattle grazing on aquatic macroinvertebrates in this montane stream.

Study Area

Two cattle grazing exclosures (ca. 1 km in length) encompassing the stream were established in 1972 and 1975 (Fig. 1, A). The exclosures were separated from a lower grazed area (C) by private land holdings (B). The exclosures are within the Cuba Community allotment (ca. 11,000 ha) where grazing strategy has been season-long (June 1 to October 31) since 1949 at the average annual rate of 2,688 animal unit months.

## Methods

Aquatic macroinvertebrates were sampled in reaches of stream in ungrazed (Fig. 1, A) and grazed (Fig. 1, B, C) areas during summer (low) flow. Surber samples (# 1024 mesh) were randomly taken in riffle habitats in 1982. Because of variability in 1982 data, an attempt was made in 1983 and 1984 to stratify samples within substrate composition categories and relative to velocity and depth of water. In the laboratory, invertebrate samples were picked and sorted, identified to the lowest practicable taxon using keys in Merritt and Cummins (1984) and Usinger (1956). Densities and biomasses (see Smock, 1980) were calculated and compared between the differently-managed areas.



## Results

Eight orders, 39 families, and 71 genera of aquatic macroinvertebrates were collected and identified during the study (Table 1). Densities of macroinvertebrates were significantly greater in the grazed area than in the ungrazed in 1982 and 1983 and, although greater in the grazed area in 1984, were not significantly different (Table 2). Estimated biomass was consistently greater and more variable in the reaches of stream in the grazed than in the ungrazed area, but only significantly so in 1982. Separation of the 1984 samples into upper (B) and lower (C) grazed areas, however, resulted in significant differences between invertebrate samples from the ungrazed areas (A) and samples taken in the lower grazed area (C). Differences between samples from within the ungrazed area (A) and those of the upper grazed area (B) taken in 1984, however, were not significantly different at the 0.05 level.

## Discussion

Macroinvertebrate densities were highly variable in the Vacas; however, the data serve to point out, as do selected water quality and fish data (Rinne, in manuscript), that linear changes in physical-structural stream habitat may significantly affect water quality and stream biota. To illustrate, in 1984, densities of aquatic macroinvertebrates in the ungrazed area were not significantly different from pooled, downstream, disjunct, grazed (reach C, Fig. 1) and continuous, upstream grazed (reach B, Fig. 1) samples. However, separation of the 1984 samples into upper (contiguous-grazed) and lower (disjunct-grazed) sampling localities (Fig. 1) emphasized the greater densities of macroinvertebrates in the downstream, disjunct, grazed areas (Table 2). Significantly greater total alkalinity in the downstream reaches of stream (Rinne, in manuscript) combined with the increased solar radiation and water temperatures resulting from the lack of riparian vegetation (Rinne, 1985) equally could have enhanced macroinvertebrate populations. The differences in densities and biomasses therefore could be as easily attributed to the increased alkalinity, temperature, and dissolved solids in the water column in the lower, disjunct grazed areas as to the effects of cattle grazing.

In light of the stream continuum concept (Vannote et al., 1980) and watershed principles (Hynes, 1975; Likens, 1984) it is perhaps surprising that there were any significant differences in aquatic macroinvertebrate populations between grazed and ungrazed areas of the Vacas. Further, it may well have been that the areas sampled naturally were different structurally and in macroinvertebrate fauna prior to fencing. Lack of any pretreatment data, however, precludes unequivocally stating that removal of grazing by fencing did not enhance macroinvertebrate populations.

In summary, as has often been done in the past, the results of this brief case history study could have been misrepresented. In doing so, reliability and defendability of results both would suffer. The results of this case history study emphasize the importance of pretreatment definition of variation in biotic and abiotic factors within potential study areas prior to implementing

respective treatments and ensuing research. Future grazing effects research must be conducted on a watershed basis, over an extended period of time with adequate pretreatment information (Rinne, in manuscript). Such an approach will not only increase the reliability of results but will be beneficial to resolving conflicts of multiple-use management.

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Table 1. Taxonomic listing and densities ( $n/m^2$ ) of aquatic macroinvertebrates collected in grazed (G) and ungrazed (U) reaches of the Rio de las Vacas, 1983-84.

TAXA	1983		1984	
	U	G	U	G
<b>Ephemeroptera</b>				
<u>Ephemerella inermis</u>	85	55	84	116
<u>Paraleptophlebia</u> sp.	32	29	11	34
<u>Ameletus</u> sp.	14	47	30	67
<u>Baetis</u> sp.	68	86	172	553
<u>Cinygmula</u> sp.	0	0	32	258
<u>Tricorythodes minutus</u>	40	396	4	45
<u>Epeorus longimanus</u>	19	11	256	85
<u>Siphonurus</u> sp.	0	0	0	1
<u>Ephemerella drunella grandis</u>	0	0	0	2
<u>Rhithrogena</u> sp.	0	0	0	1
<b>Diptera</b>				
<u>Culicoides</u> sp.	11	11		
<u>Palpomyia</u> sp.	22	38		
<u>Hydrophorus</u> sp.	0	11		
<u>Hemerodromia</u> sp.	11	0	0	8
<u>Prosimulium</u> sp.	22	0		
<u>Simulium</u> sp.	17	11	69	134
<u>Tabanus</u> sp.	14	11	2	1
<u>Calopsectra</u> sp.	19	87		
<u>Cardiocladius</u> sp.	14	32		
<u>Corynoneura</u> sp.	57	119		
<u>Cryptochironomus</u> sp.	0	22		
<u>Hydrobaenus</u> sp.	38	32		
<u>Microtendipes</u> sp.	36	18		
<u>Paratendipes</u> sp.	0	95		
<u>Pentaneura</u> sp.	11	11		
<u>Polypedilum</u> sp.	0	22		
<u>Prodiamesa</u> sp.	0	11		
<u>Tanytarsus</u> sp.	0	11		
<u>Tendipes</u> sp.	0	28		
<u>Hexatoma</u> sp.	11	33		
<u>Ormosia</u> sp.	16	0		
<u>Tipula</u> sp.	0	22		
<u>Chironomidae</u>			252	711
<u>Hexatoma</u> sp.			2	10
<u>Maruina lanceolata</u>			2	1
<u>Picranota</u> sp.			4	0
<u>Ceratopogonidae</u>			11	22
<u>Deuterophebia</u> sp.			2	0

Table 1. Continued.

TAXA	1983		1984	
	U	G	U	G
Diptera (continued)				
<u>Molophilus</u> sp.			6	1
<u>Ulomorpha</u> sp.			0	1
Trichoptera				
<u>Brachycentrus</u> sp.	11	0	6	3
<u>Agapetus</u> sp.	11	0	30	15
<u>Glossosoma</u> sp.	15	0	54	61
<u>Helicopsyche</u> sp.	200	109	65	183
<u>Hydropsyche</u> sp.	47	78	265	318
<u>Stactobiella</u> sp.	11	0		
<u>Lepidostoma</u> sp.	46	0	0	6
<u>Nectopsyche</u> sp.	0	18		
<u>Oecetis</u> sp.	11	11	2	6
<u>Asynarchus</u> sp.	11	11		
<u>Grammotaulis</u> sp.	11	0		
<u>Hesperophylax</u> sp.	15	0	0	8
<u>Polycentropus</u> sp.	0	22	0	2
<u>Amphicosmoecus</u> sp.	2	9		
Plecoptera				
<u>Alloperla</u> (super genus)	0	11		
<u>Hastaperla</u> sp.	0	27		
<u>Amphinemura</u> sp.	19	11	26	16
<u>Isoperla</u> sp.	0	11	4	20
Unidentified Genus	6	22		
<u>Pteronarcella badia</u>	0	11	6	1
<u>Chloroperla</u> sp.			17	10
<u>Claasenia</u> sp.			17	2
<u>Nemoura</u> (super genus)			0	1
Hemiptera				
<u>Ambrysus</u> sp.	22	18	2	24
Odonata				
<u>Ophiogomphus</u> sp.	22	19	2	2
Lepidoptera				
<u>Parargyractis</u> sp.	22	11	0	5



Table 1. Continued.

TAXA	1983		1984	
	U	G	U	G
<b>Coleoptera</b>				
<u>Helichus</u> sp.	11	11		
<u>Cleptelmis</u> sp.	11	0		
<u>Dubiraphia</u> sp.	22	30		
<u>Heterelmis</u> sp.	11	0		
<u>Optioservus</u> sp.	25	11		
<u>Stanelmis</u> sp.	11	0		
Elmidae			136	168
<u>Stenopelmus</u> sp.			2	0
Dryopidae			0	2
<b>Terrestrials</b>	<b>88</b>	<b>24</b>	<b>15</b>	<b>10</b>

Table 2. Average density and biomass of aquatic macroinvertebrates in grazed and ungrazed areas of the Rio de las Vacas, 1982-84. The number of samples is designated by N and significant (single letter) and highly significant (double letter) differences as determined by t-tests are indicated. Ranges are in parentheses.

Year	Treatment	Number/m <sup>2</sup>	Biomass (g/m <sup>2</sup> )	N
1982	Grazed	1897 <sup>aa</sup> (786-5216)	2.03 <sup>d</sup> (.41-3.71)	10
	Ungrazed	787 <sup>aa</sup> (43-1691)	0.57 <sup>d</sup> (.001-2.5)	20
1983	Grazed	1035 <sup>b</sup> (701-2451)	1.01 (.31-3.04)	10
	Ungrazed	550 <sup>b</sup> (108-1412)	0.69 (.02-2.61)	10
1984	Grazed Upper	1509 (905-2058)	----	5
	Lower	4375 <sup>c</sup> (2522-6283)	----	5
	Ungrazed	1541 <sup>c</sup> (765-2974)	----	5

grazed  
of samples  
significant  
Ranges

## ROLE OF DETRITIVOROUS FISH IN NEW MEXICO RESERVOIRS

Richard A. Cole, Robert A. Deitner, Robert J. Tafanelli,  
Gabriel A. Desmare and Paul R. Turner  
Department of Fishery and Wildlife Sciences  
New Mexico State University

### INTRODUCTION

Detritus feeding fishes, including bottom feeders in the genera Carpion, Cyprinus, Ictiobus and suspension feeding fishes in the genus Dorosoma, often contribute largely to the biomass of warm-water reservoirs, particularly in gulf and east coast drainages in the United States (Jenkins 1967, 1979; Grinstead et al. 1978). These fish feed largely on detritus (see reviews by Leidy and Jenkins 1977; Ploskey and Jenkins 1983). Juvenile and adult detritivorous fish stomachs average 75 to 85% filled with detritus, with the rest being small invertebrates. Thus, a potential for competition for food with invertebrate-feeding sportfish occurs wherever detritivorous fish become abundant. Leidy and Jenkins (1977) indicated that these species commonly contribute greatly to the total fish biomass of reservoirs. In the belief that removal would benefit sportfish, gizzard shad (Dorosoma cepedianum) have long been managed with toxins where they comprised over 50% of the fish biomass. In at least one documented instance, a positive response occurred in the sportfishery (Zeller and Wyatt 1967) for several years following toxin application.

Most larval sportfish are obligate plankton feeders (Durbin 1979) that may be negatively influenced by gizzard shad when shad become overly abundant. Many juvenile and older sportfish depend on benthic invertebrates also consumed by bottom detritivores. Reservoirs with great amounts of allochthonous organic loading may be more likely to support large biomasses of detritivorous fish. Oglesby (1977) noted that fish biomass in high exchange-rate reservoirs varied with precipitation and hypothesized that allochthonous organic matter washed from the watersheds was partly responsible. Jenkins (1967, 1979) found that high exchange rates favored detritivorous fishes in multivariate analyses of fish biomass in reservoirs. Aggus (1979) generally reviewed the possible influence of allochthonous organic loading.

As part of a study conducted to develop process models to simulate reservoir energy flows culminating in fish production, we initiated a study of six New Mexico reservoirs in 1980, four of which were inhabited by detritivorous fishes and two of which had no detritivores. We estimated loading of organic detritus and primary production in the reservoirs as well as the production of invertebrates and fish in all groups. Preliminary results of the study confirm a great contribution of detritivorous fish to the fishery.

## ROLE OF DETRITIVOROUS FISH IN NEW MEXICO RESERVOIRS

Richard A. Cole, Robert A. Deitner, Robert J. Tafanelli,  
Gabriel A. Desmare and Paul R. Turner  
Department of Fishery and Wildlife Sciences  
New Mexico State University

### INTRODUCTION

Detritus feeding fishes, including bottom feeders in the genera Carpiodes, Cyprinus, Ictiobus and suspension feeding fishes in the genus Dorosoma, often contribute largely to the biomass of warm-water reservoirs, particularly in gulf and east coast drainages in the United States (Jenkins 1967, 1979; Grinstead et al. 1978). These fish feed largely on detritus (see reviews by Leidy and Jenkins 1977; Ploskey and Jenkins 1983). Juvenile and adult detritivorous fish stomachs average 75 to 85% filled with detritus, with the rest being small invertebrates. Thus, a potential for competition for food with invertebrate-feeding sportfish occurs wherever detritivorous fish become abundant. Leidy and Jenkins (1977) indicated that these species commonly contribute greatly to the total fish biomass of reservoirs. In the belief that removal would benefit sportfish, gizzard shad (Dorosoma cepedianum) have long been managed with toxins where they comprised over 50% of the fish biomass. In at least one documented instance, a positive response occurred in the sportfishery (Zeller and Wyatt 1967) for several years following toxin application.

Most larval sportfish are obligate plankton feeders (Durbin 1979) that may be negatively influenced by gizzard shad when shad become overly abundant. Many juvenile and older sportfish depend on benthic invertebrates also consumed by bottom detritivores. Reservoirs with great amounts of allochthonous organic loading may be more likely to support large biomasses of detritivorous fish. Oglesby (1977) noted that fish biomass in high exchange-rate reservoirs varied with precipitation and hypothesized that allochthonous organic matter washed from the watersheds was partly responsible. Jenkins (1967, 1979) found that high exchange rates favored detritivorous fishes in multivariate analyses of fish biomass in reservoirs. Aggus (1979) generally reviewed the possible influence of allochthonous organic loading.

As part of a study conducted to develop process models to simulate reservoir energy flows culminating in fish production, we initiated a study of six New Mexico reservoirs in 1980, four of which were inhabited by detritivorous fishes and two of which had no detritivores. We estimated loading of organic detritus and primary production in the reservoirs as well as the production of invertebrates and fish in all groups. Preliminary results of the study confirm a great contribution of detritivores to fish biomass and production in certain reservoirs, and indicate that detritivores under certain conditions can have a great impact on the availability of invertebrate foods for sportfishes. Fluctuations in watershed runoff appeared to contribute to the development of high abundances of detritus-feeding fishes and depress sportfish density. Possibly as a consequence of increasingly fluctuating

climates along an east-west gradient in the U.S., relative biomass and production of detritivores appears to increase along a gradient from eastern watersheds to western watersheds based on our results and those reported by Leidy and Jenkins (1977).

#### METHODS Sampling fish

Six reservoirs were sampled from 1980 to 1983 to evaluate reservoir habitat and production of reservoir fishes. Fish populations were sampled each summer using experimental gill nets (1, 1.5, 2.0, 2.5 and 3.0-inch mesh) in a stratified random design. Reservoirs were sampled with gill nets set in groups of three; one net set within the shore zone, one net set offshore at the surface, and one net set offshore on bottom. All three nets usually were set within 100 to 300 m of each other, depending on reservoir size. On each day of sampling one group of nets was used to sample the upper reservoir while another group was used to sample the lower reservoir. On each day the nets were moved to new, randomly located areas within each half of the reservoir. Each reservoir was sampled 3 days in sequence (18 experimental net sets in total).

Gear efficiencies were estimated in small reservoirs or coves of larger reservoirs under similar conditions of climate and water quality. The same gill nets used to sample whole reservoirs were fished over five- to six-day periods at constant rates to estimate a depletion rate and a density by extrapolation (Zipfin 1956). Catch rates per unit of estimated fish density were used to back-calculate fish densities in each reservoir. This approach was used instead of cove rotenone estimates (Hayne et al. 1967, Aggus et al. 1980) because representative coves are scarce in New Mexico reservoirs. Density and biomass estimates of fish too small to be effectively estimated by the gear (usually less than about 250 to 300 mm) were estimated by back calculation from mortality estimates of populations in certain reservoirs where each species was abundant. For rarer species, the mortality rate of a closely related abundant species was used (about 80 to 85% of the fisheries were comprised of abundant species). Age and growth was estimated for each species and production was estimated for each species from the formula  $P = B (G)$  where  $P$  = production,  $B$  was the mean biomass calculated from two sequential summer estimates of biomass (from length-weight relationships), and  $G$  was the population growth rate. Summer sampling was conducted because it was the most representative period for biomass determination based on studies such as those of Jenkins (1979). Growth studies indicated similarities among the same species in different reservoirs, which suggested mortality rates were similar.

Phytoplankton and Zooplankton were sampled seven times annually from 1980-1983 (phytoplankton for 2 years and zooplankton for 3 years) with greatest intensity during the growing season from March through October. Biomass was determined through standard methods of estimating density and size relationships (length and width) and calculated a volumetric relationship from the dimensions. Production was estimated with P:B multipliers determined from the literature (Waters, 1977 and Wetzel, 1982) and confirmed through intensive

study in three New Mexico reservoirs.

Zoobenthos were less intensively sampled than zooplankton. A pilot study in fall 1979 indicated that zoobenthos were generally an order of magnitude less productive than the zooplankton. Zoobenthos were sampled seasonally (9 to 15 samples each season) only at three of the reservoirs from 1982-83 (Bear Canyon, Caballo, and Elephant Butte) and extensively sampled elsewhere (spot samples with 9 to 15 samples made per reservoir). Zoobenthic biomass was estimated from wet weight determinations. Production was estimated from a P/B ratio derived for benthic invertebrates (Waters 1977).

#### Reservoir Morphometric, and Organic Loading

The morphometry of each reservoir was established from mapping or from agency-gathered data (U.S. Bureau of Reclamation or U.S. Army Corp of Engineers). Organic loading was estimated for the four largest reservoirs from U.S. Geologic Survey monitored tributaries and mean estimates of particulate organic matter concentrations derived from representative locations in New Mexico by the U.S.G.S. For the two smaller reservoirs, filled by unmonitored temporary runoff, the loadings were estimated from precipitation runoff relationships derived from similar watersheds in New Mexico and from U.S.G.S. estimates of organic concentrations in such runoff. Variations in estimated loadings of organic matter were greatly dominated by variation in discharge rather than by variation in concentration of organic matter. All data were converted to carbon estimates of relationships between wet, dry, organic and carbon weights in the organisms studied (Cummins and Wuycheck 1971).

### RESULTS AND DISCUSSION

#### Limnology and Organic Loads

Table 1 shows that the surface water temperatures of the six reservoirs studied varied slightly from about 21° to 24°C during summer months over the sampling period. Oxygen concentrations at the surface were generally near saturation. However, bottom temperature and oxygen varied among reservoirs, depending mostly on whether the reservoir stratified. While Lake Sumner and Caballo Reservoir mixed well and maintained relatively high O<sub>2</sub> concentrations near bottom, the remaining four reservoirs had substantial oxygen depletion near bottom.

Table 1. Mean area, depth slope, temperature (C°) and oxygen concentration (mg/liter) in the six study reservoirs.

RESERVOIR	MEAN	MEAN	MEAN	SURFACE		BOTTOM	
	AREA (HA)	DEPTH (M)	PERCENT SLOPE	TEMP	O <sub>2</sub>	TEMP	O <sub>2</sub>
BEAR CANYON	10	3.0	8.9	21.4	9.3	13.8	0.5
CLAYTON	47	6.3	8.1	20.8	7.5	15.4	0.7
LAKE SUMNER	840	4.7	0.6	23.7	8.4	22.7	4.8
UTE	1181	6.6	9.1	24.4	7.7	19.0	1.0
CABALLO	1689	4.6	0.6	23.6	7.8	20.8	3.6
ELEPHANT BUTTE	7510	13.5	4.8	23.6	7.9	16.1	0.8

Mean organic loads (Table 2) were determined more by watershed inputs than by primary productivity. The fraction of the organic loading from temporary runoff was high in the smallest reservoirs and lowest in some of the larger reservoirs, where permanent river flow contributed substantially. Leaf litter was a minor contribution, even in the smallest reservoirs.

Table 2. Mean yearly (1980-82) organic loads by source (g C/m<sup>2</sup>/yr).

RESERVOIR	LEAF LITTER	RIVER INPUT	TEMPORARY RUNOFF	PLANT PRODUCTION	% FROM WATERSHED
BEAR CANYON	1	0	789	450	64
CLAYTON	T	0	635	366	64
LAKE SUMNER	T	27	117	23	86
UTE	T	12	125	81	63
CABALLO	T	42	48	19	83
ELEPHANT BUTTE	T	65	17	61	57

#### Production of Herbivore-Detritivores

The mean annual production of organisms that were predominantly herbivores or detritivores, summarized in Table 3, indicated that invertebrate zoobenthos comprised, at most, 11% of the total estimated herbivore-detritivore production. Invertebrate zoobenthos production in the four large reservoirs averaged only 1% of the total production. Where benthic, detritivorous fish occurred, including carp (*Cyprinus carpio*), river carpsucker (*Carpiodes carpio*), and smallmouth buffalo (*Ictiobus bubalus*), their estimated production comprised 7% of the total herbivore-detritivore production, about equal to the average fraction contributed by zoobenthic invertebrates in the two reservoirs without detritivorous fish. Thus the detritivorous fishes appeared to displace the invertebrate detritivores in the four reservoirs where both groups occurred. Zooplankton production appeared to be negatively

influenced by gizzard shad production. The relative productions of zooplankton and gizzard shad were negatively correlated (-.88) in the four reservoirs where both groups occurred.

Table 3. Mean annual herbivore-detritivore production from 1980 to 1982.

RESERVOIR	INVERTEBRATE		FISH		TOTAL
	ZOOPLANKTON	ZOOBENTHOS	CARP AND SHAD	SUCKER	
BEAR CANYON	21.9	2.8 <sup>1</sup>	0	0	24.7
CLAYTON	74.3	2.4 <sup>2</sup>	0	0	76.7
LAKE SUMNER	7.9	0.1 <sup>2</sup>	12.4	2.3	22.7
UTE	10.4	0.1 <sup>2</sup>	5.2	1.1	16.8
CABALLO	13.6	0.4 <sup>1</sup>	5.8	0.9	20.7
ELEPHANT BUTTE	20.6	0.1 <sup>1</sup>	0.8	1.2	22.7

<sup>1</sup>sampled intensively over 6 seasons.

<sup>2</sup>sampled intensively only one season.

#### Production of Carnivorous Fish

Benthic feeding sportfish production was greater in the two small reservoirs where zoobenthos averaged nearly 10 times greater production than in the large reservoirs and detritivorous benthic fish were absent (Table 4).

Table 4. Mean annual production of fish that eat benthic invertebrates (kg/ha/yr in 1980-83) in the six reservoirs.

	SMALL RESERVOIRS		MEAN OF FOUR LARGE RESERVOIRS <sup>1</sup>
	BEAR CANYON	CLAYTON	
CRAPPIE	82		5
SUNFISH	77	296	17
CATFISH	12	73	19
BLACKBASS (30%)	92	40	10
SPORTFISH	263	409	51 <sup>1</sup>
CARP AND SUCKERS	0	0	29 <sup>2</sup>
TOTAL	263	409	80.0
RATIO OF FISH TO ZOOBENTHOS (gC/M <sup>2</sup> /YR)	1.3	1.8	4.9

<sup>1</sup>Sumner, Caballo, Ute, and Elephant Butte.

<sup>2</sup>Calculated as production based on benthic invertebrate foods assuming it was proportional to reported stomach contents of about 25% (Leidy and Jenkins 1977).



The estimated production of zoobenthos and the estimated demand for zoobenthos food indicated that zoobenthos feeding fishes probably fed partly on alternative foods, probably zooplankton, because zoobenthos production was insufficient. Even if the zoobenthos production was 100% ingested, the growth efficiency would have been more than twice the maximum expected (about 40%) for the two smaller reservoirs and nearly 10 times the maximum expected in the larger reservoirs.

Using a maximum growth efficiency of 40% (see review for Leidy and Jenkins, 1977) the demand for a maximum growth was estimated and contrasted with production of food materials as shown in Table 5. For zooplankton, the greatest demand was by gizzard shad based on their estimated stomach content (Leidy and Jenkins 1977) and their large biomass in the New Mexico reservoirs. Young sportfish demanded only 10% as much as the shad because of their much smaller biomass, and a smaller amount was demanded by young bottom detritivorous fishes. In total, a mean of 15.6 g C/m<sup>2</sup>/year of the zooplankton was demanded by fish during the study and 13.1 g C/m<sup>2</sup>/year was available. A small deficit resulted, indicating that zooplanktonic feeding fishes grew close to maximum rates. Data reported by Cole et al. (1985) indicate that the average young fish of all species and older shad grew more rapidly in the four New Mexico reservoirs than many other places have reported (e.g. Carlander 1969, 1977).

Table 5. Estimated mean food demands for invertebrate-feeding fish and invertebrate food available (g C/m<sup>2</sup>/yr) in the four large reservoirs with detritivorous fish.

	DEMAND <sup>1</sup>	AVAILABLE	DIFFERENCE
ZOOPLANKTON			
SHAD	13.6		
YOUNG SPORTFISH	1.3		
YOUNG CARP & SUCKERS	0.7		
SUBTOTAL	15.6	13.1	2.5
ZOOBENTHOS	6.0	0.2	5.8
TOTAL	21.6	13.3	8.3

<sup>1</sup>Estimated for a 40% growth efficiency.

Zoobenthos demand was, however, in excess of the calculated supply of zoobenthos. Thus, zoobenthic-feeding fish apparently switched to less satisfactory zooplanktonic foods, resulting in slower than average growth rates for centrarchids and catfishes, once they reached the first year of age.

Overall demand exceeded supply by 62%, and average growth rates of all zooplankton-feeding fish was moderate to above average, with great variation among species and age groups.

The excess demand for available invertebrate foods by forage fish indicated an imbalance between predators and forage fish. Table 6 shows the differences in production of piscivorous fish in reservoirs with and without shad forage. Although the piscivore production was expected to be greater in the two smaller reservoirs because their organic loads were greater, the difference in piscivore food-conversion efficiency was dramatic. Where shad were present average piscivore efficiency was about one third of the average efficiency that occurred where there were no shad. In the two smaller reservoirs young sportfish made up almost all of the forage and were more efficiently used than a forage base comprised mostly of older gizzard shad. Thus, gizzard shad older than one year provided poor forage. By the end of their first year, the average gizzard shad attained lengths over 200 mm, in excess of 25% of the length of the largest piscivores (700mm).

Table 6. Mean production of piscivorous fish (kg/ha/yr in 1980-83.

FISH	SMALL RESERVOIRS		MEAN OF FOUR LARGE RESERVOIRS <sup>1</sup>
	BEAR CANYON	CLAYTON	
BLACKBASS (70%)	153	88	23
WHITE BASS			35
WALLEYE		36	18
TOTAL PISCIVORE	198	124	76
SHAD "FORAGE"	0	0	630
PISCIVORE/TOTAL <sup>2</sup>	0.32	0.19	0.08

1 Sumner, Caballo, Ute and Elephant Butte.

2 Potential forage was estimated to be the sum of all young of year fish production plus older shad production where it occurred.

However, Table 7, indicates that there was variation among the mean sizes of gizzard shad forage among the four reservoirs and the efficiency with which the total gizzard shad production was converted to piscivore production. The conversion efficiency was inversely correlated with mean shad size ( $r = 0.99$ ) and ranged from a nearly complete use in Elephant Butte Reservoir to very limited use in Lake Sumner and Ute Reservoir. The growth rate and total biomass of shad was a function of the concentration of organic loadings in the four mainstream reservoirs. Because of its relatively great depth, organic loading was diluted to 6 g C/m<sup>3</sup> in Elephant Butte Reservoir, compared to 35 g C/m<sup>3</sup> in shallow Lake Sumner. The mean size of shad was positively correlated ( $r = 0.97$ ) with the mean concentration of organic matter in the four reservoirs. Cole et al. (1985) showed that the growth rates of piscivores in all four

reservoirs with shad are close to maxima reported, indicating that their density is somehow limited before age 1. Such limitation could be responsible for the inefficient consumption of the shad before shad grew to inedible sizes.

Table 7. Mean predator conversion of prey production (%) and mean size (1980-83).

RESERVOIR	PRED <sup>1</sup> /PREY <sup>2</sup>	SHAD MEAN WT(G)
LAKE SUMNER	3%	19.6
UTE	5%	17.5
CABALLO	20%	12.2
ELEPHANT BUTTE	45%	6.1

<sup>1</sup>Whitebass and walleye production.

<sup>2</sup>Shad production.

The efficiency with which food resources were converted to sportfish production was importantly influenced by detritus-feeding fishes in lakes where shad occurred. Although lakes with detritivorous fish, in theory, should support nearly ten times the production of piscivores the mean difference was not that great in the four large reservoirs. Considering that the smaller reservoirs were nearly nine times more productive and the presence of detritus-feeding fish should have increased conversion efficiency by about the same amount, all six reservoirs should have averaged similar piscivore production. In fact, piscivore production in the larger reservoirs averaged only half of the piscivore production in the smaller reservoirs. The large reservoir piscivore production was about 5 times higher than expected if no detritivorous fishes were present, however, indicating that their net effect was positive even if they were not consumed as efficiently as small game fish were in the two small reservoirs.

#### Organic Loading and Predator-prey Ratios

Comparisons of our results with data reviewed by Leidy and Jenkins (1977) indicated that an east-west gradient in fish production relationships occurred across the southern U.S. New Mexico mean fish production, exceeded the production of reservoirs in more easterly river basins (Table 8). The next most productive basin was the Arkansas basin (just east of New Mexico). Reservoirs in those river basins draining to the eastern Gulf of Mexico and the South Atlantic were least productive. This west-east trend follows a precipitation gradient from 35 cm/yr in the west to nearly 100 cm/yr in the east. The sportfish production tends to vary much less than total production along this

gradient. Thus the greater amount of production measured in New Mexico was nearly all in the form of detritivorous fish.

Table 8. Mean reservoir fish production (kg/ha/yr) in our study (New Mexico Area) compared to production estimates reported by Leidy and Jenkins (1977)<sup>1</sup> for other river basins.

	TOTAL PROD.	%SPORTFISH	SPORTFISH PROD.
NEW MEXICO MEAN	770	30	230
LEIDY & JENKINS (1978)			
ARKANSAS RIVER	705	52	366
WHITE RIVER BASIN	335	72	240
RED RIVER	310	68	210
LOWER MISSISSIPPI	400	68	272
GREEN & CUMBERLAND RIVER	300	72	216
GULF & SOUTH ATLANTIC	180	75	135

<sup>1</sup>The production estimated by Leidy and Jenkins (1977) was doubled based on findings of Aggus (1980).

Variation in the contribution of detritivores to fish biomass along an east-west gradient may relate to the annual reliability of runoff and relative amounts of organic loadings that originate in watersheds. In New Mexico, annual runoff is highly variable; from 1976 through 1983 in three large New Mexico watersheds monitored by the U.S. Geological Survey high annual runoff rates exceeded low annual runoff rates by up to 160:1. Assuming that the concentration of organic matter in runoff remains relatively constant, the organic loading of reservoirs in those watersheds could have varied by 100:1 over a decade. Because variation in runoff is inversely correlated with total annual runoff in the U.S., the annual fluctuation in loading is likely to be less in the southeastern U.S.

In high runoff years, when organic loads are high, the growth of detritus-feeding forage fishes is rapid and large biomasses of fish too large to consume by sportfish accumulate by the end of the growing season. In subsequent years, when loading rates are low, little organic matter is available for zooplankton production and young fish of all species are severely food limited. Because the detritivores have accumulated a large reproductive advantage (high biomass and high fecundity per unit biomass) their young and about 15% of the adult consumption competitively dominate, and most young game fish starve. Drenner et al. (1982) found gizzard have the potential for filtering total reservoir volume in two reservoirs within 56 to 130 hours. Such intense feeding is likely to have an impact on zooplankton, which have regeneration times of at least 200 hrs.

The high early mortality of young sportfish results in a low density of rapidly growing piscivorous fish in older age groups. The density of older

sportfish is so limited that it generally is incapable of regulating entry of young shad, carp and suckers into adult stocks. An improved predator-prey ratio may result if the annual organic loading were somehow stabilized. Under stabilized loading conditions, the piscivore biomass may gradually increase to a more effective control level like that in the southeastern U.S. where runoff fluctuates less.

#### Management Implication

The basic management question is whether a larger fraction of the fish production in New Mexico reservoirs can be turned from detritivores to sportfish. One long-term consideration is improved rangeland management, because overgrazing appears to aggravate erosion rates by as much as 50% (Branson 1975). In the shorter term, it may be possible to maintain a higher potential sportfish production through control (through toxin application or, possibly, mechanical removal) of detritivores, particularly during low-flow periods when detritivores compete most effectively with young sportfish. This could be done in combination with seasonal stocking of the smaller threadfin shad (Dorosoma petenense) (which usually die in winter in New Mexico reservoirs). The threadfin shad may effectively compete with gizzard shad and increase the overall forage availability, thus allowing larger stocks of sportfish to accumulate and gain increasing control over gizzard shad, common carp and suckers. Swingle and Swingle (1967) found a 150% increase in sportfish production following threadfin shad introduction. Where sportfishing is particularly intense, protecting large size classes of piscivores may also be warranted.

#### Conclusions

Detritivorous fishes in New Mexico accumulate to large fractions of total fish biomass and fish production partly because of allochthonous organic loading derived from watersheds. Carp and suckers appeared to reduce production of benthic invertebrates while gizzard shad appeared to reduce production of zooplankton, thus both groups of detritivorous fishes appear to reduce the availability of invertebrate foods for certain sportfish. Large biomasses of detritivores may accumulate rapidly when years of exceptionally high organic loading occur. Once established they may limit survivorship of young sportfish by consuming invertebrate foods critical in early life history. Thus piscivore production is confined to small populations of rapidly growing individuals. Control of detritivores in low-water years appears to be useful wherever fishing effort is intense.

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# The Use of Hydraulic Simulation to Evaluate Habitat Improvement Structures

Timothy S. Hardin

Hardin-Davis, 2910 NW Miller Lane, Albany, OR 97321

## Introduction

Habitat improvement structures and physical habitat simulation (PHABSIM) are techniques that have steadily gained in popularity and notoriety over the past 5-10 years. With very few exceptions, these two techniques have remained totally separate. One has been used primarily to restore habitat in degraded streams by altering the channel shape, and the other has been used to recommend optimum flows, with the assumption that the channel shape is constant. The two can be used together. Hydraulic simulation is a potentially powerful tool for the evaluation of instream structures. Some of the potential benefits from merging the two techniques are:

1. Defining microhabitat: Habitat structures do not generally change macrohabitat features such as water quality or temperature, but they do change microhabitat features such as depth, velocity distribution, substrate quality, and cover. By choosing a particular kind of structure, the investigator has already made a judgment regarding the type of microhabitat improvement needed. Usually, the objectives are stated in a general way only. Use of PHABSIM forces a more precise definition of the objectives.

2. Predicting hydraulic effects: If a structure is to be effective, it has to change the hydraulics of the stream. PHABSIM programs can be used in conjunction with engineering equations or empirical relationships to determine how high flows will act in concert with the structure to change the channel configuration, and to predict the hydraulic conditions near the structure at normal low flows.

3. Predicting habitat change: All habitat-improvement work has the same general goal. PHABSIM simply attempts to make a numerical estimate of the amount of habitat gain in terms of weighted usable area (WUA). Habitat preference curves define microhabitat in terms of key variables, and hydraulic equations predict how much those key variables will change.



4. Cost-benefit analysis: Once the amount of habitat gain can be predicted, the estimated cost of the structures can be calculated and used in cost-benefit analysis. If several possible structures are considered, this analysis can be used to choose the most cost-effective structure.

5. Monitoring and evaluation: To get a measure of the effectiveness of a structure, one can simply model the site before and after placement. It is possible to get a first-year evaluation, or to monitor habitat changes over several years as the channel reaches equilibrium.

### Study Area

St. Vrain Creek is a tributary of the South Platte River in northeastern Colorado (Figure 1). It is moderately steep, with large cobble substrate, and is predominantly riffles and runs, with some shallow pools. The discharge is dominated by snowmelt; low flows of 10 -20 cfs occur in winter, highs of 300-500 cfs in spring, and 20 - 100 cfs in the summer and fall. The creek is riddled with agricultural diversions, so that some areas are barely wet in the summer.

The portion of St. Vrain Creek between Lyons and Longmont, Colorado, has some sections that support a fair trout fishery, but many areas have been subjected to dewatering, gravel mining, overgrazing, and channelization. Above Lyons, the St. Vrain is a good fishery for brown and rainbow trout. However, in 1981, a new reservoir was planned that would eliminate 6 miles of this fishery. As a possible mitigation plan, a proposal was made to improve the trout habitat in the degraded section, using an increased base flow plus instream structures.

### Methods

The first step in the study was to collect field data for the WSP model (Trihey and Wegner 1981) to describe existing habitat. It was then possible to model some typical types of improvement structures. Three of these structures simulated on the St. Vrain will be discussed here.

Boulder simulation: Boulders create habitat by breaking up the velocity distribution, creating scour pools, and providing cover. The technique for simulating them is fairly simple. Using a scale map of the cross sections, boulders can be scattered through the site. When a boulder is dropped in, it can

have different effects, depending on where it lands.

A boulder directly on the transect line is modeled as an island. It does not create any habitat, and may even take some away, because it causes velocity to speed up on either side. Downstream of the transect line, a boulder has no effect on the hydraulic model. It does change the cover code for that cell. Upstream of the transect line, a boulder slows the velocity in its wake, and may create a scour pool. I increased the roughness value in the wake to slow the water, and estimated the depth of the scour pool as 1.2 times the median diameter of the boulder. The simulation was run twice, once with scour pools, and once without, to see how much of the habitat change was due to the velocity distribution, and how much was due to the assumption that new pools would be created.

Log weirs: When a weir is placed at a riffle-run transect, it slows the water upstream, and creates a plunge-pool downstream. With the WSP model, two dummy transects were needed just upstream of an existing transect (Figure 2). The first one was raised and leveled to represent a log dam. Just upstream, a second one was put in to model the shallow, dammed area. The existing transect, which was now downstream of the log, needed to be lowered. In this example, I estimated the depth as 1.25 times the height of the log above the streambed, based on an empirical formula (Stuart 1960).

With the coordinates re-drawn, WSP would not work, because critical flow (a small waterfall) occurred at the log. The solution was to break the site in half, and use the log as a control for the upstream section. A weir formula gave the starting water surface elevation for any flow:

$$H = \frac{Q^{2/3}}{2.26 L^{2/3}}$$

where H= height of water above the top of the log (ft)

Q = discharge (cfs)

L = length of the weir (ft)

Wing deflectors: A wing deflector was the most complicated of the three to model, because it was necessary to simulate high flows repetitively until a stable channel shape occurred. Just upstream of an existing transect, a dummy transect was inserted. The coordinates defined the shape of a triangular wing dam with a height equal to one-half the bankfull depth. The scour will occur just downstream of the wing, and the amount of scour will depend on the dominant discharge and the associated tractive

force. The dominant discharge, which is roughly the 1 in 1.5 year recurrence flow, was estimated from USGS hydrological data. Tractive force is a measure of the energy acting to move bed particles. At a particular point in the channel, tractive force can be written (Hardin and Bovee 1983):

$$T = \frac{28 n^2 v^2}{R^{1/3}}$$

where T = unit tractive force  
 n = Manning's n, or roughness value  
 v = velocity in ft/sec  
 R = hydraulic radius (ft)

The procedure was to simulate two discharges: the dominant discharge (Qd), and a lower discharge (Qm) at which tractive forces are just large enough to move existing bed particles. Coordinates at a transect were then re-drawn to simulate a wing deflector. The two discharges were run with WSP, and tractive forces were calculated in the region of the deflector. Wherever critical tractive force was exceeded, the bed profile was lowered, and WSP was re-run. Ultimately, a depth was reached where tractive forces were too low to cause further scour. The depth of scour at each point was taken as the average between that caused by Qd and Qm. This channel shape was then used for habitat simulations.

## Results

Six reaches were studied, each with six types of structures (Hardin 1982). The discussion here is limited to two areas, one natural and one mined. The results of this type of modeling are families of WUA curves, because each structure creates a slightly different study site.

In the natural section, all methods worked to increase WUA for adult brown trout at low flows. The boulder treatment predicted the largest increase, about 1300 sq ft per 1000 linear ft. Next came the wing dam, and then the log weir. When costs were approximated, the log weir appeared to be the most efficient

In the mined section, boulder and wing dam treatments again gave the highest increase in WUA. The log weir provided a very slight increase. In terms of cost, the wing dam, which was the least economical in the natural section, was the most economical

in the degraded section.

The difference in economics between the two sections is probably due to the fact that the mined section is very wide, so that large numbers of boulders are needed. The wing dam narrows the channel where it is placed, and also adds a kind of habitat, a deep pool, that is completely lacking in the degraded section.

### Discussion

It is possible using PHABSIM to predict habitat increase, and predict a return on the investment. Several problems are apparent with this type of approach to habitat structures. For example, some of the hydraulic equations are largely untested; therefore, the channel shapes that were calculated may not be right in every instance. But in practice, one has to make a prediction about future channel shape. The foundation for such predictions may be labeled intuition or experience, but it is all ultimately based on hydraulics.

WUA may not always equate to an increase in production. This is an entire subject in itself. However, if the two cannot be equated in a study, it means that microhabitat has been incorrectly defined, in which case, more study of the target species is needed. Alternatively, it may mean that microhabitat is not affecting production, in which case, habitat structures may not be the correct approach.

At the time this analysis was done, cost was a major hindrance. All of the simulations were done on a mainframe computer, using a big range of flows and numerous life stages. Furthermore, there were six different alternatives for each site, and some had to be run many times to get the right channel configuration.

### Future Applications

Disadvantages, especially cost, limited the application of these methods at the time the study was done. However, recent developments in the PHABSIM model have led me to re-evaluate the concept of predicting and monitoring habitat change. PHABSIM is now more flexible. One is not limited to WSP or IFG-4 alone; the two can be used together on the same site. The 1-flow IFG-4 lends itself to modeling habitat structures much more so than the 3-flow method. Other models, such as MANSQ, might be useful for

reconnaissance level work in some applications.

PHABSIM has also become less expensive to run, because many of the programs now exist in microcomputer versions. They are just as time-consuming, if not more so, but the machine costs are not such a problem.

The existing data base is huge. In the last five years, hundreds of IFIM studies and hundreds of habitat improvement projects have been done. A large amount of information exists on approximate roughness values behind boulders, or amount of scour caused by a given size of deflector. Some of this information could be organized, and perhaps some of the formulas presented here could be refined.

The most promising application is in monitoring of habitat improvement projects. One can omit the theoretical testing of potential structures, and simply select a design that worked on a similar stream. But before putting the structures in, it would be relatively inexpensive to measure the pre-project habitat using one of the PHABSIM techniques. After the structure is placed, the site can be re-measured and the results compared.

In the long run the only true measure of success is the additional number of fish produced, but there are all kinds of well-known problems associated with monitoring changes in fish populations. It might take five years before the effectiveness of a structure could be known with any certainty. Meanwhile, an estimate of benefits using PHABSIM could have been obtained in the first year, or perhaps in the first month.

### Summary

The technology exists now to predict habitat changes before a structure is put in. Practically any structure can be simulated, but the more complex the hydraulics, the more expensive and uncertain the simulation.

To monitor and evaluate habitat changes empirically, PHABSIM has been under-utilized, and shows a lot of promise. To do a before-and-after study of a habitat improvement structure would cost little, and would give a quick index of the effectiveness of the structure. I think we could learn a lot about PHABSIM and about habitat structures if we combined the two techniques on future studies.

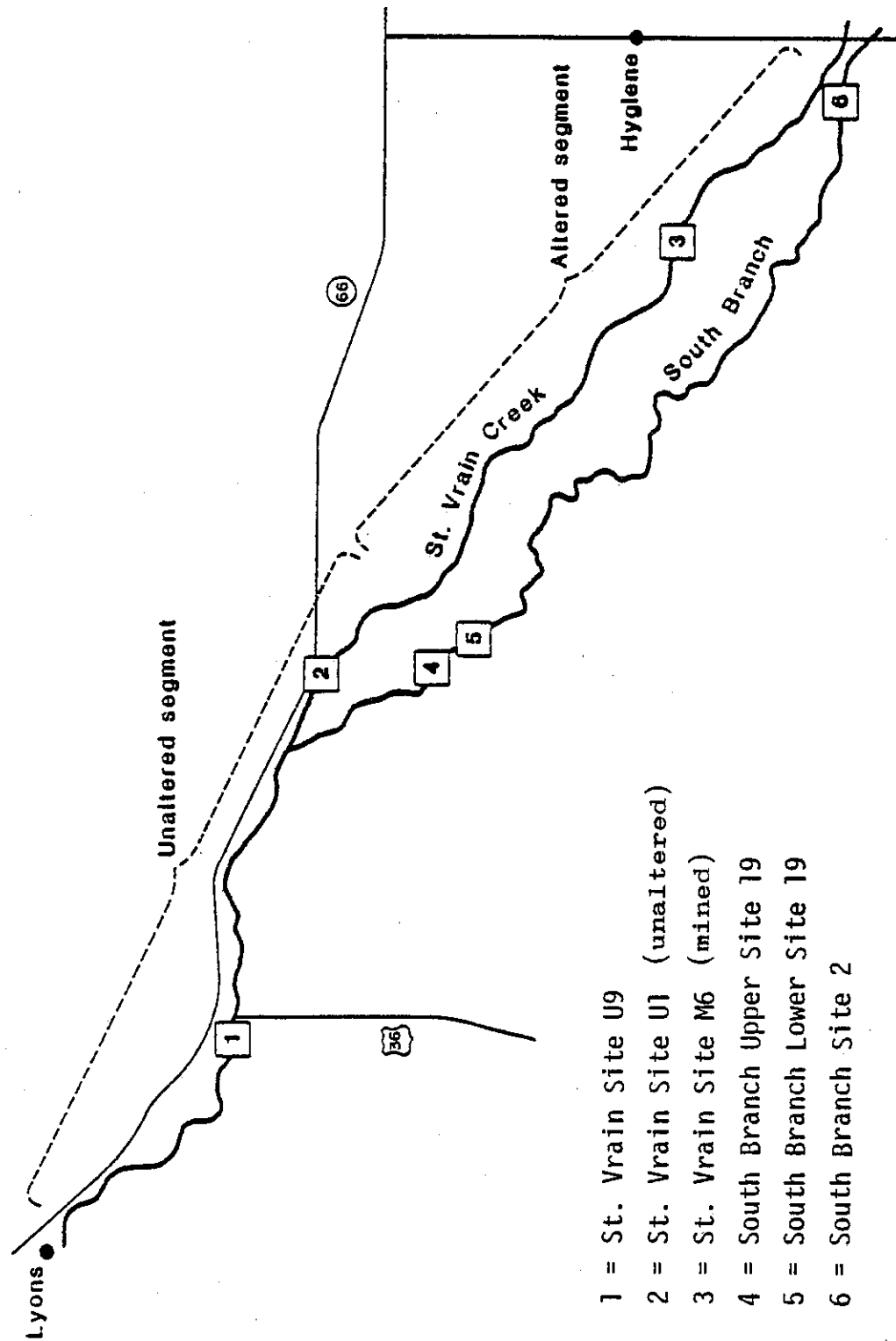
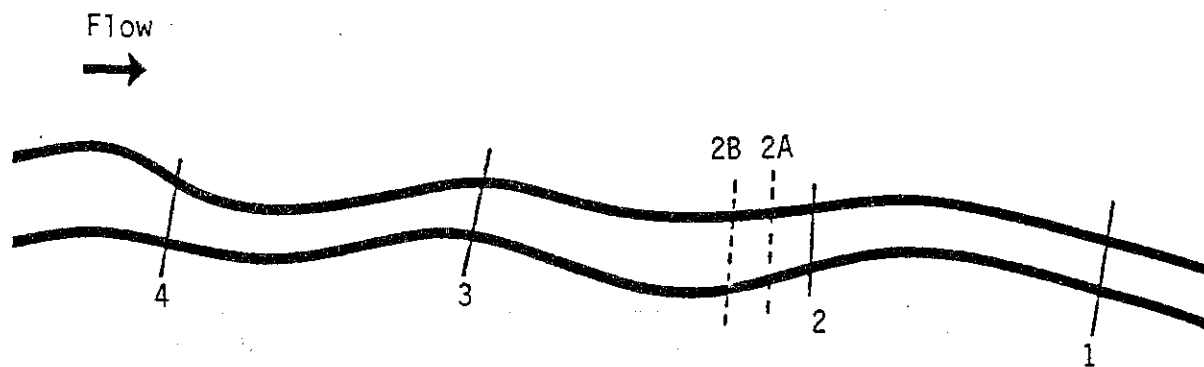
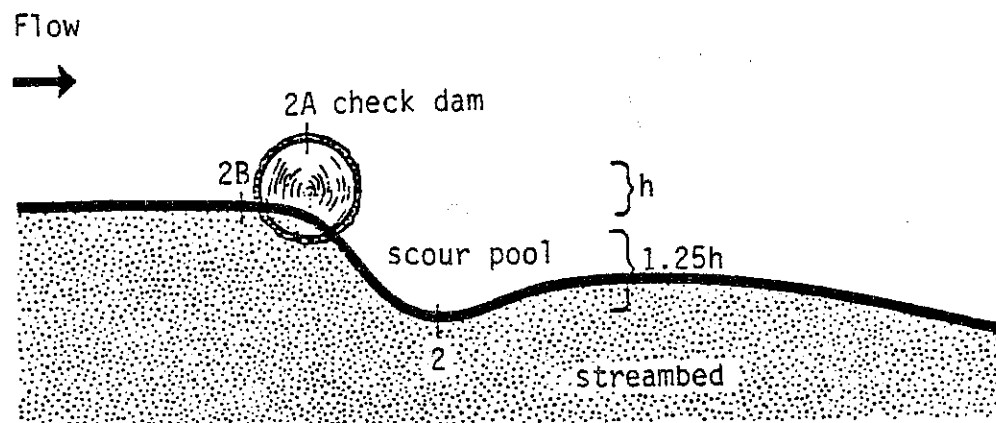


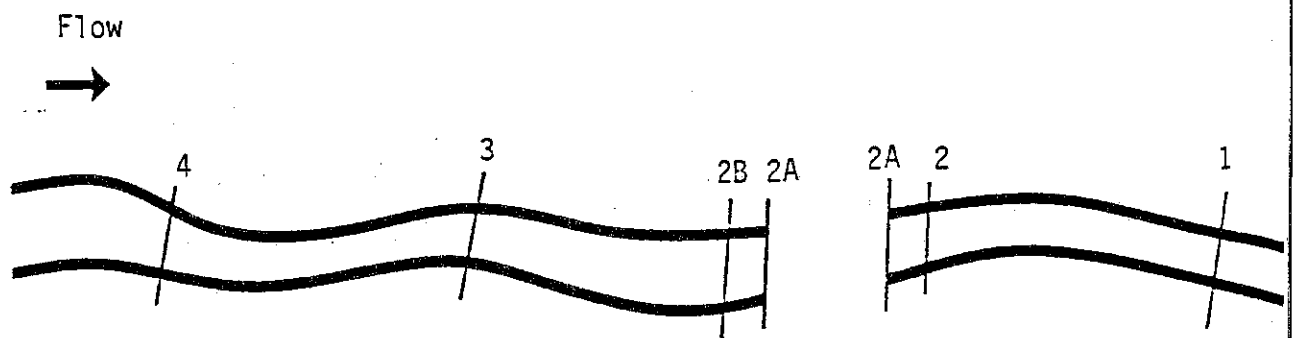
Figure 1. Study area, segmentation, and sites on St. Vrain Creek and the South Branch, between Lyons and Hygiene, Colorado.



1. Two dummy transects (2A and 2B) were established just upstream of transect 2.



2. Transect 2A represents a check dam; transect 2 represents the scour pool downstream.



3. Separate simulations were run for the two portions of the reach divided by the check dam.

Figure 2. Log weir simulation with PHABSIM.

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SELENIUM CONTAMINATION OF FISHES AND THEIR FOODS FROM  
AGRICULTURAL TILE DRAIN WATER IN THE SAN JOAQUIN VALLEY

Michael K. Saiki

Fishery Biologist (Research), U.S. Fish and Wildlife Service,  
National Fisheries Contaminant Research Center,  
Field Research Station, 6924 Tremont Road, Dixon, CA 95620

ABSTRACT

High concentrations of selenium were measured in samples of water, sediment, plants, invertebrates, and fishes collected in 1983 from Kesterson Reservoir, a 1,200-acre storage and evaporation facility in Merced County, California, and from the San Luis Drain, a canal that transports tile (subsurface) drainage from about 8,000 acres of irrigated farmland in Fresno County to Kesterson Reservoir. Selenium concentrations in aquatic biota from the reservoir and drain (here referred to collectively as Kesterson) averaged about 100-fold higher than those from the Volta Wildlife Area, a nearby site that does not receive tile drainage. In some samples of algae, submerged rooted vegetation, chironomids, and mosquitofish (Gambusia affinis) from Kesterson, selenium concentrations exceeded 300 ppm dry weight. Fishes collected in 1984 from canals and sloughs in the Grassland Water District, located adjacent to Kesterson, also contained elevated concentrations of selenium (up to 23 ppm dry weight in green sunfish, Lepomis cyanellus)--indicating that contamination was not confined to Kesterson.

Studies by other investigators have shown that selenium is required in animal diets at trace levels of 0.05 to 0.3 ppm dry weight. However, dietary levels exceeding about 10 ppm are sometimes toxic to poultry, rainbow trout (Salmo gairdneri), and other animals. Thus, selenium at the concentrations present in forage organisms from Kesterson is probably toxic when consumed by sensitive animals, and this toxicity may explain recent observations of dead and deformed embryos of aquatic birds that nest at the reservoir. Preliminary analysis of the reproductive characteristics of mosquitofish from Kesterson also suggest that they give birth to fewer fry than do mosquitofish from the Volta Wildlife Area, and that a higher percentage of the fry produced by Kesterson mosquitofish are stillborn. It is not yet known if fishes from the Grassland Water District suffer from selenium toxicity.

DAILY FOOD CONSUMPTION AND DETERMINATION  
OF ORIGIN OF JUVENILE CHINOOK SALMON  
DURING THE SEAWARD MIGRATION

Michael L. Gross and Dennis W. Rondorf  
U.S. Fish and Wildlife Service  
National Fishery Research Center  
Willard Substation, Cook, WA 98605

Scale characteristics and stepwise discriminant analysis were used to classify juvenile chinook salmon (*Oncorhynchus tshawytscha*) from the Columbia River as subyearling, hatchery yearling or wild yearling for subsequent analysis of food consumption. Accuracy of classification of hatchery yearling and wild yearling scales ranged from 82% to 94% correct. Daily food consumption (mg dry weight food.fish<sup>-1</sup>.day<sup>-1</sup>), daily caloric intake (cal.fish<sup>-1</sup>.day<sup>-1</sup>), and daily ration (food as percent of body weight) were estimated for each group classified by scale analysis.

Daily caloric intake at 14C was 912 cal.fish<sup>-1</sup>.day<sup>-1</sup> (3.8% daily ration) for yearling salmon (hatchery and wild) and 1170 cal.fish<sup>-1</sup>.day<sup>-1</sup> (9.6% daily ration) for subyearling salmon. Daily caloric intake of yearling chinook salmon collected at 9.5C was 306 cal.fish<sup>-1</sup>.day<sup>-1</sup> (1.2% daily ration).

The lower food consumption by yearling chinook salmon compared to subyearling fish was attributed to the tendency of subyearling fish to migrate near shore where insect drift is more abundant, and to migrate more slowly, allowing more time to actively search for food. Separation of hatchery from wild smolts by discriminant analysis of scale characters should prove useful in studies examining physiological or behavioral differences, particularly in smaller river systems where higher accuracy could be expected.

## RESTORATION OF THE ENDANGERED GILA TROUT

Paul R. Turner  
Department of Fishery and Wildlife Sciences,  
New Mexico State University

### ABSTRACT

The restoration program for the Gila trout has gone through several stages since the species was listed as endangered. Restoration efforts in 1970-1974 included transplants of Gila trout from the type locality into three small streams which were historically barren of trout. Passage of The Endangered Species Act and creation of the Gila Trout Recovery Team led to a systematic survey of the Gila National Forest, New Mexico to determine which streams supported genetically pure populations of S. gilae and to evaluate potential restoration streams. Indigenous populations of pure S. gilae were found in five widely separated headwater streams.

Completion of the Gila Trout Recovery Plan in 1979 initiated the third stage in the recovery of S. gilae. The primary objective of the Plan was to insure the maintenance of viable populations in the wild of all five morphotypes (from indigenous populations). The process of accomplishing this objective has required antimycin treatments to eliminate hybrid and non-native trouts and transplants of pure S. gilae from three of the four unreplicated populations. A transplant from the fifth indigenous population is scheduled for 1987 and work has begun on the downlisting package. Completion of the recovery plan requires evaluation of the Gila trout's desirability as a sport species and an aggressive public relations campaign to encourage public acceptance of the next stage in the restoration process. Following completion of recovery plan objectives and downlisting of S. gilae to threatened status, the next stage in the restoration program will include the opening of several streams to regulated fishing for S. gilae and the downstream expansion of headwater populations into lower reaches of several restoration streams.

### INTRODUCTION

The Gila trout, Salmo gilae, a native species of the Gila River drainage of Arizona and New Mexico, has been listed as endangered by the U.S. Fish and Wildlife Service since 1967 (U.S. Fish and Wildlife Service 1983). Various protective and restoration actions during the last 16 years have resulted in sufficient improvement in the status of S. gilae that the downlisting to threatened status is likely within 2-3 years. This paper will review the various stages in the restoration program for S. gilae and provide a summary of recent and proposed recovery efforts.

### STAGE 1 - PRIOR TO 1973

The Gila trout was described as a distinct species in 1950 although propagation and prohibitions on stocking of non-native trout into known S.

gilae habitats had been instituted much earlier by the New Mexico Department of Game and Fish (NMDGF) (Miller 1950). By 1950 the original distribution of the species had been drastically reduced because of hybridization with rainbow trout, Salmo gairdneri, and other factors (Miller 1950; Behnke and Zarn 1976). Because of its precarious status, the NMDGF closed fishing for Gila trout in its type locality, Main Diamond Creek, in 1958 and encouraged ecological studies (Regan 1966). In 1965-1966 the Gila National Forest and NMDGF repaired 108 log stream improvement structures, that were built by the Civilian Conservation Corps in Main Diamond Creek during the 1930's, and constructed new structures to enhance the type habitat (Bickle 1972). The passage in 1966 of the Endangered Species Preservation Act and listing of S. gilae as endangered by the USFWS led to a cooperative study of the Gila trout's life history and an evaluation of several potential restoration sites (Hanson 1971). Growing concern for S. gilae resulted in McKnight and Sheep Corral creeks receiving transplants from Main Diamond Creek in 1970-1972 and preparation of a Gila Trout Management Plan by the Gila National Forest (Bickle 1972).

#### STAGE 2 - 1973-1979

Passage of The Endangered Species Act of 1973 and The New Mexico Wildlife Conservation Act of 1974 initiated the second stage in the restoration of S. gilae (U.S. Fish and Wildlife Service 1983). The first step was the formation of Gila Trout Recovery Team, that originally included representatives from the NMDGF, Gila National Forest, USFWS, New Mexico State University (NMSU) and Arizona Game and Fish Department. Recommendations by the recovery team resulted in stream surveys in 1974-1976 in the Gila National Forest, that documented the status of S. gilae and provided an information base for future recovery actions (Mello and Turner 1980). Taxonomic analysis of trout collected during the stream surveys indicated that pure indigenous populations of S. gilae still occurred in five small headwater streams, Iron, McKenna, Main Diamond, South Diamond, and Spruce creeks (David 1976). In all cases, movement of non-native trout into these streams had been blocked by either waterfalls or dry stream reaches (Mello and Turner 1980).

Based on stream surveys it appeared that the number of age-1 and older Gila trout in 1974-1976 was between 400 and 1,000 fish for the indigenous populations found in Iron, McKenna, and South Diamond creeks and the introduced population in McKnight Creek (Mello and Turner 1980). Although the five indigenous populations appeared relatively secure from human impacts and were widely separated, the potential effects of natural events (e.g. forest fires) and competition with non-native trout were identified as likely threats to the continued existence of several of the indigenous populations. Only the morphotype of S. gilae in Main Diamond Creek was considered secure because it had been previously replicated by transplants into three headwater streams (McKnight and Sheep Corral in New Mexico and Gap Creek in Arizona), that were barren of trout (U.S. Fish and Wildlife Service 1983). The population in Main Diamond Creek also occurred in substantially larger numbers in a 6-km reach of habitat containing over 100 log stream improvement structures. The continued survival of all five

indigenous populations of Gila trout was emphasized in the Gila Trout Recovery Plan that was prepared in 1978 and revised in 1983; the primary objective of the recovery plan was "to improve the status of Gila trout to the point that survival is secured and viable populations of all morphotypes are maintained in the wild" (U.S. Fish and Wildlife Service 1983).

Although no transplants of Gila trout were made in New Mexico during 1973-1979, the U.S. Forest Service conducted research on Gila trout ecology and enhanced the habitat in McKnight Creek by the construction of additional log stream improvement structures and a fence to regulate cattle grazing. Rinne (1978) found that the numbers and biomass of Gila trout in pools of McKnight Creek related mainly to pool volume with percent cover and mean depth of lesser importance. Spawning of Gila trout occurred from April through June during 1978 and 1979 in McKnight, Main and South Diamond creeks when maximum daytime water temperatures were 8°C or greater (Rinne 1980). Fry emerged from redds at 15-20 mm (TL) after incubating for 8-10 weeks. Other published information on the life history and ecology of Gila trout is summarized in U.S. Fish and Wildlife Service (1983).

### STAGE 3 - 1980 TO THE PRESENT

Completion of the Gila Trout Recovery Plan initiated a major change in the recovery program for the species. After considering the status of the five indigenous populations (Mello and Turner 1980) and reviewing potential restoration streams, the recovery team recommended several reclamation projects. Whereas the three earlier transplants of Gila trout had been into small headwater streams that were historically barren of trout and outside of wilderness areas, the recovery team recommended restoration of Gila trout into streams within the Gila Wilderness Area that contained hybrid (Gila x rainbow) and brown trout (Salmo trutta). These projects were prioritized to either enhance or replicate the indigenous populations of Gila trout that were considered to be the most vulnerable to either being impacted by the upstream expansion of non-native trout or the negative effects of unpredictable natural events (e.g. major forest fires, floods, droughts).

The stream reaches selected for the first two reclamation projects were within the Gila Wilderness Area. The absence of suitable waterfalls on these streams made the construction of man-made barriers necessary. In addition, the presence of non-native trout in both proposed restoration streams mandated the use of a fish toxicant. Following a thorough review of the options, the Gila National Forest prepared an environmental analysis report, that described methods for barrier construction and antimycin treatments and identified likely restoration streams.

The Gila National Forest constructed a rock-and-concrete barrier in the headwaters of Iron Creek during the spring of 1981, and an interagency team treated 3 km of Iron Creek with antimycin to eradicate S. trutta. The entire 3-km reach was electrofished and all S. gilae collected were temporarily moved to two floodplain refugia prior to the treatment. Although residual antimycin subsequently killed most S. gilae held in the lower refugium, 38 S. gilae from the upper refugium were successfully reintroduced into upper Iron Creek just below the 210-m intermittent reach that had kept S. trutta from moving upstream into the upper 2 km of stream

(Mello and Turner 1980). The ratio of S. trutta to S. gilae collected by electrofishing and antimycin in the 3-km reach was 9.9:1.0 (Turner and McHenry 1985). Data on the length and age distribution, population density, and standing crop of S. trutta and S. gilae were collected from the 3-km reach for comparison to similar data for S. gilae in the future. Potassium permanganate was metered into Iron Creek at the manmade barrier to neutralize the antimycin and minimize mortalities of S. trutta downstream. This practice was also used during all subsequent reclamation projects.

Although some S. gilae were successfully reintroduced in 1981, no additional S. gilae were transplanted into the treated reach of Iron Creek until 1984 from the population which existed farther upstream. This delay was related to initial uncertainty about the effectiveness of the S. trutta eradication and the assumption that S. gilae would eventually migrate downstream through the 210-m intermittent reach during high flows. It became obvious in late May of 1984 that the eradication of S. trutta had been effective and that the low numbers of S. gilae present in the reach treated with antimycin in 1981 limited reproduction and population expansion. Thus, 105 age-1 and older Gila trout from upstream were transplanted into the treated reach in late May of 1984 to supplement the existing S. gilae population; an additional 51 S. gilae from above the treated reach were released into the lower half of the treated reach in August of 1985. Limited numbers of age-0 S. gilae were found in the upper half of the treated reach of Iron Creek in 1984 and 1985.

A rock-and-concrete barrier was constructed on Little Creek in 1982 by modifying an existing bedrock outcrop. The 6-km reach upstream from the manmade barrier was treated with antimycin in July 1982 to eradicate brown and Gila x rainbow trout. After the success of the reclamation was confirmed in October, 100 age-0 and older Gila trout were brought by helicopter from McKenna Creek in a tank suspended from a 46-m cable and released into selected pools in the upper 2 km of Little Creek on December 5, 1982. Limited reproduction was confirmed in 1983 for both S. gilae and speckled dace, Rhinichthys osculus, that survived the antimycin treatment in small numbers. Progressive increases in numbers and downstream distribution of both species have occurred in the treated reach since 1984. Although common prior to the reclamation, S. trutta, desert sucker (Catostomus clarki), and Sonora sucker (C. insignis) were not found in the treated reach of Little Creek in 1984-1986, but were still present downstream from the barrier.

A 1.9-km headwater reach of Big Dry Creek was treated with antimycin on June 27, 1984 to eradicate S. trutta and S. gairdneri hybrids. Potassium permanganate was metered into the creek from a 22.7-L container, that was located immediately above a 12-m waterfall, to detoxify the antimycin at the downstream boundary of the 1.9-km reach. Although all other trout were killed in 1984, it was necessary to retreat the same reach in June 1985 to eradicate age-0 S. gairdneri hybrids which survived the 1984 treatment. All visible trout killed by the antimycin in 1984 were picked up and measured to provide detailed data on the pre-treatment fish populations.

Because most trout in two study areas (286 m) of Big Dry Creek had been fin-clipped to permit population estimates prior to the treatment, it was possible to accurately estimate the recovery rates for marked fish of different age groups in both taxa (Turner and McHenry 1985). The vari-

ability in recovery rates between different species, age groups, and study sites documented the necessity of using different rates to estimate the numbers of fish killed during toxicant applications.

For the antimycin treatments in Little Creek and Big Dry Creek in 1984, a preliminary instream bioassay was used to determine the proper spacing between the 22.7-L antimycin-dispensing units and minimize the concentration of antimycin that was used the next day. These bioassays were performed by releasing antimycin from a single unit for 4 hours at a rate designed to give a constant concentration of 0.01 mg/L for the measured streamflow. The distance downstream to where all fish were dead within 24 hours was considered the maximum allowable distance between antimycin-dispensing units. The main reason for minimizing the concentration of antimycin was to reduce the mortality of aquatic invertebrates that would subsequently be available as food to the transplanted S. gilae.

In October 1985 an interagency team used pack mules to transplant 97 age-0 and older S. gilae from Spruce Creek into the headwaters of Big Dry Creek. The numbers of S. gilae transplanted from Iron, McKenna and Spruce Creeks have been kept low to minimize impacts on the indigenous populations. The removal for transplant to Little Creek of nearly 25% of the age-1 and older S. gilae from McKenna Creek in December of 1982 had no apparent effect on subsequent spawning and population density in June 1984. Although transplants of larger numbers of S. gilae would have allowed for more rapid population increases in the three most recent stream restorations, the relatively small size of the indigenous donor populations made this impractical. However, the replication of indigenous populations in restoration streams will increase the potential for using either greater numbers of fish or taking fertilized eggs from donor populations for transplants into larger restoration streams in the future.

#### Population numbers

The number of age-1 and older S. gilae in streams of the Gila National Forests has been estimated by sampling study sites in each stream. Although less than 5% of the inhabited reach has typically been sampled per year for larger streams (e.g. Main Diamond, McKnight creeks), population estimates have been made for up to 25% of the inhabited reach in McKenna Creek. Methods used for estimating population numbers at study sites have been described by Turner and McHenry (1985). Except for McKenna and Sheep Corral creeks, streams were sampled at least twice in 1983-1985. Because estimates of the number of age-0 S. gilae were often unreliable until the fall samples, only the number of age-1 and older S. gilae were estimated by expanding the population densities found at study sites to the entire inhabited reach for each stream.

#### Indigenous populations

The estimated number of age-1 and older S. gilae in the five indigenous populations was estimated for the summer of 1985 (Table 1). The estimated numbers were less than 1000 S. gilae for Iron, McKenna, and Spruce creeks, whereas both the numbers of fish and population density were considerably greater for Main Diamond and South Diamond creeks, adjacent drainages in the Aldo Leopold Wilderness Area. The estimated number of fish in Main Diamond



Creek was over twice as great as the combined estimates for the other four indigenous streams. Sampling in 1983-1985 indicated that the numbers of S. gilae in Main Diamond, Iron, and McKenna creeks were relatively stable, whereas the number of S. gilae in South Diamond and Spruce creeks was more variable because of annual variations in streamflow.

Table 1. Estimated number of age-1 and older Gila trout in indigenous populations in the Gila National Forest, New Mexico, summer 1985.

Stream	Length of inhabited reach (km)	No. of age-1 and older Gila trout summer 1985	Elevation range (m)	
			Upper	Lower
Main Diamond	7	12,000-15,000	2675	2320
South Diamond	4	2,000-4,000	2500	2365
Iron <sup>a</sup> (above natural barrier)	2	600-1,000	2810	2675
McKenna	1	350-500	2110	2015
Spruce	4	500-1,000	2500	2055
Total	18	15,450-21,500	2810	2015

<sup>a</sup>The reach upstream from the 210-m intermittent section that served as a natural barrier.

#### Restoration populations

The number of age-1 and older S. gilae in study sites on McKnight Creek in June of 1985 was less than normal (Turner and McHenry 1985) because of the effects of a major flood in late December of 1984 that caused extensive bank sloughing (Table 2). The number of age-0 S. gilae in June 1985 was 15-20% of the estimated numbers for the same study sites in November 1984. In contrast, the lack of any flooding during the winter of 1985-1986 resulted in excellent overwinter survival of the strong 1985 year class. This should result in the numbers of S. gilae in McKnight Creek being several times greater in the summer of 1986 than in 1985.

The S. gilae in Iron and Little creeks were still in the early stages of population expansion in 1985. Based on the numbers of trout recovered during the antimycin treatments, the S. gilae in Iron and Little creeks should eventually increase to 5-10 times the number of fish estimated in the summer of 1985 (Table 2). Likewise, the number in the 2-km headwater reach

of Big Dry Creek should either equal or exceed the estimated 3801 trout that were present at the time of the 1984 antimycin treatment (Turner and McHenry 1985). Both density and standing crop of trout were positively influenced by good pool habitat and apparently stable streamflow in this headwater reach of Big Dry Creek.

Table 2. Estimated number of age-1 and older Gila trout in restoration streams of the Gila National Forest, New Mexico, summer 1985.

Stream	Length of inhabited reach	No. of age-1 and older Gila trout	Elevation range (m)		Year of transplant (No. of fish)	Source stream for transplant
			Upper	Lower		
McKnight	13	2000-3500	2510		1970 (307)	Main
			2100		1972 (110)	Diamond
Sheep Corral	1	50-100	1740		1972 (89)	Main
			1660			Diamond
Iron <sup>a</sup>	3	150-300	2670		1981 (38)	Iron
			2570		1984 (105)	
					1985 (51)	
Little	6	500-750	1960		1982 (100)	McKenna
			1850			
Big Dry	2	- <sup>b</sup>	2555		1985 (97)	Spruce
			2400			
Total	25	2,700-4,650	2670	1660		

<sup>a</sup>The 3-km reach between the natural and manmade barriers that was treated with antimycin in 1981.

<sup>b</sup>The transplant into Big Dry Creek occurred in October and no Gila trout were present during the summer.

Although populations are still expanding, the 25 km of occupied habitat in the restoration streams already exceeds the 18 km of streams that are occupied by S. gilae from the indigenous populations (Tables 1 and 2). In addition, an antimycin treatment scheduled for a tributary of Mogollon Creek in October 1986 will permit a transplant in 1987 from South Diamond Creek, the only unreplicated indigenous population of S. gilae. When this transplant is completed, each of the five indigenous populations will have been replicated and the primary objective of the recovery plan accomplished. After the success of transplants from South Diamond and Spruce creeks are determined, the recovery team has recommended the downlisting of S. gilae from endangered to threatened. Preliminary work by the USFWS on the

downlisting package has already started and downlisting may occur by 1988.

#### Public Relations Efforts

Although the status of the recovery program for S. gilae has been reviewed regularly at scientific meetings, communications to nonprofessional groups and the general public have been limited until recently. However, a renewed emphasis on public relations that was recommended by the recovery team in 1985 has resulted in presentations on the recovery program to both professional and sportsmen groups in 1986 and numerous contributed articles to New Mexico newspapers by NMSU and government agencies represented on the recovery team. The U.S. Forest Service (USFS) recently prepared a 4-page fact sheet on the Gila trout recovery program that is available to the public at ranger stations and various agency offices. Popular articles have already appeared and are being prepared for various publications of New Mexico conservation organizations.

The New Mexico Department of Game and Fish (NMDGF) has prepared videotape releases on the recovery program that have been shown on New Mexico and Texas television stations. A professional quality videotape, "The Endangered Fishes of the Southwest", that was sponsored by the Arizona-New Mexico Chapter of the American Fisheries Society, includes a segment on Gila trout and has been shown at professional and public meetings. Poster displays prepared by the USFS and USFWS also include segments on S. gilae and other native trouts. A duplicate slide set on the Gila trout and restoration efforts is being maintained by NMDGF for use by agency personnel. The Gila Trout Recovery Team has also recommended the preparation of a 15 to 30-minute videotape on the Gila trout recovery program for release to public television stations and use at public meetings. Footage for this videotape was taped by NMDGF personnel on three field trips during 1986.

#### Evaluation of Sport Fishing Potential

A major subobjective of the Gila Trout Recovery Plan was to "assess Gila trout as a sport species" (U.S. Fish and Wildlife Service 1983). Because the continued recovery of S. gilae will require eradication of non-native trouts from selected restoration streams, an evaluation of the sport fishing potential of S. gilae was considered necessary by the NMDGF in order to make informed fisheries management decisions. Future public acceptance for the replacement of existing fisheries for non-native trout with a Gila trout fishery may depend, in part, on the relative desirability of S. gilae as a potential game species. A review of length distributions, growth rates, and standing crops of S. gilae provided some evidence of comparative sport fishing potential of the species (Turner and McHenry 1985).

Although the indigenous populations in Iron and Main Diamond grow more slowly, S. gilae in most headwater streams reach 18-22 cm by the end of their third growing season (Table 3). S. gilae during the early stages of population expansion in Little and McKnight creeks reached 165 and 179 mm, respectively, by the end of their second growing season. Although year-class strength causes some variation, elevation and spawning time strongly influence size of age-0 S. gilae. Mean total length of S. gilae after their

first growing season ranged from 49 mm in Iron Creek at an elevation of 2700 m to 84 mm in Little Creek at 1925 m.

Table 3. Back-calculated total lengths of Gila trout from streams of the Gila National Forest, New Mexico.

Stream (Year collected)	No. of fish	Back-calculated mean total length at annulus (mm)				
		1	2	3	4	5
South Diamond						
(1983)	25	69	124	182	223	256
(1975)	13	85	143	219	303	337
Spruce						
(1983)	18	77	135	180	250	
Sheep Corral						
(1983)	14	77	138	204	243	
McKnight						
(1983)	37	73	131	182	223	267
(1976)	18	102	179	235	290	
Little						
(1985) <sup>a</sup>	-	84	165			
(1984)	27	89	148 <sup>b</sup>	211 <sup>b</sup>		

<sup>a</sup>Actual mean total length at the end of the growing season of Gila trout hatched in Little Creek.

<sup>b</sup>Gila trout transplanted from McKenna Creek in December of 1982.

Growth of rainbow trout in small Arizona and New Mexico streams was comparable to growth of S. gilae (Tarzwell 1938; Turner and McHenry 1985). Mean back-calculated total lengths of brown trout collected from Little Creek, New Mexico in 1975-1977 were 110, 180, 213, and 243 mm at annuli 1-4, respectively (Mello 1977). Although earlier fry emergence allows greater mean lengths after the first 2 years of life, growth of S. trutta in Little Creek was comparable to growth of S. gilae at annulus 3 and 4 (Table 3). Although comparable data are not yet available on growth and length-frequency distributions of S. gilae and S. trutta from the same stream, it appears that growth and mean lengths of S. trutta will probably exceed those parameters for S. gilae (Sigler 1952; Bishop 1955; Avery and Hunt 1981). However, data from the Gila National Forest indicates that S. trutta are more susceptible than S. gilae to the negative effects of common winter floods that can severely reduce year-class strength and survival of older fish (Turner and McHenry 1985). Thus, the somewhat greater growth and mean lengths of S. trutta may be mainly a function of lower population densities. It is likely that S. gilae will produce more stable populations and a more dependable fishery than S. trutta in streams of the Gila National Forest.

that are subject to winter flooding.

Another measure of the relative desirability of S. gilae as a game species is their standing crops in the unexploited populations of the Gila National Forest. Standing crops of S. gilae were determined in 1984 for ten sites on six streams and compared to standing crops predicted by the Habitat Quality Index (HQI) of Binns and Eiserman (1979). Although the HQI Model II consistently underestimated the standing crop of S. gilae, HQI Model I was reasonably accurate with a mean error of 23.5% between predicted and estimated standing crops (McHenry 1986). Estimated standing crops of S. gilae ranged from 25.7 kg/hectare in the marginal habitat of McKenna Creek to 200.3 kg/hectare for a site on South Diamond Creek. Mean standing crops of S. gilae from six New Mexico streams either exceeded or equaled reported standing crops of other salmonids from streams of comparable size (Allen 1969; Binns and Eiserman 1979; Reiser and Bjornn 1979).

#### STAGE-4 ACTIONS

Once official downlisting to threatened status has occurred, recommendations will be made to open some wilderness streams with S. gilae to regulated fishing. Research on the sport fishing potential of S. gilae is continuing and recommendations for stream-specific fishing regulations will be made before the New Mexico Department of Game and Fish opens any streams to public fishing. Evaluations of angler satisfactions and the impacts of angling on S. gilae populations will guide subsequent decisions on appropriate management alternatives. Assuming satisfactory public acceptance of S. gilae as a game species, the restored populations of S. gilae in several headwater streams will be expanded downstream into larger, more productive waters. The next step in the recovery program will be the selection of appropriate actions that need to be taken before S. gilae can be removed from threatened status by the U.S. Fish and Wildlife Service.

#### CONCLUSIONS

The recovery program for S. gilae has nearly accomplished the primary objective of the recovery plan. The eventual success of the recovery program has been assured because of the coordinated, cooperative efforts of agencies represented on the recovery team. After S. gilae from the five indigenous populations have been successfully replicated, downlisting of the species from endangered to threatened status will occur. Although specific streams and appropriate fishing regulations are still to be selected, the decision to open some S. gilae streams to public fishing will probably occur within 2-3 years. The relative desirability of the Gila trout as a game species and public opinion will guide the rate and magnitude of subsequent restoration efforts. By completing planned actions, all five indigenous populations of S. gilae will have been transplanted into one or more restoration streams and the survival of the remaining genetic diversity of the species assured.

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## DETERMINATION OF RESTING ULTRAVIOLET AND VISIBLE LIGHT

### AVOIDANCE LEVELS FOR BROWN TROUT

William T. Helm and Terrence H. Lee  
Department of Fisheries and Wildlife  
Utah State University

Considerable effort is devoted to assessing fish habitat today. One component of many evaluation systems used for brown trout habitat is cover, and one function of cover is to reduce light intensity in the water below. From an academic standpoint it would be interesting to know to which portions of the light spectrum browns react. From a practical standpoint it may be necessary to explain differences in trout behavior from one location to another.

In 1979 Bachman et al. reported that 93% of the 24-hour activity occurred during the morning and evening crepuscular periods. Free-running experiments in constant darkness did not show such a pattern, suggesting the activity pattern is controlled by changing light intensity. They indicated that food availability was not involved in this activity pattern. Other investigators support this contention (Swift 1962, 1964; Chaston 1968).

The roles of ultraviolet (<400 nm) and visible (400-800 nm) light in influencing activity patterns of wild fish have not been established. There is ample literature demonstrating that trout have the necessary ocular structures and visual pigments to detect ultraviolet light (Munz and Beatty 1965; Tsin 1979; Jacquest and Beatty 1972). This suggests that fish may react in some fashion when exposed to such short wave radiation.

Significant amounts of ultraviolet light penetrate to the modest depths occupied by brown trout in small to medium streams. Some 20 to 60 percent of the surface intensity of ultraviolet of 360-365nm penetrates to one meter depth in various lakes (Wetzel 1975). Ultraviolet penetration into water varies, depending upon the amount of dissolved organic and inorganic materials, turbidity of the water, and specific wavelength of ultraviolet.

Laboratory tests were conducted to establish whether browns would avoid UV light, and if so to determine the avoidance intensity levels. Reactions of the trout to visible light were also measured. The source of UV was two 15 watt GE F15T8-BLB black-light fluorescent bulbs. A 300 watt bulb provided visible light. A temperature controlled, rectangular tank 213 cm x 61 cm x 56 cm was divided across the center with black plexiglass, with an opening on the bottom for fish passage between the two chambers.

Tests were conducted by increasing or decreasing one type of light while holding the other constant, until the fish changed compartments. The light intensity at the position vacated by the fish was recorded as the avoidance value. Each fish was run through a six-step sequence three times.



A total of 30 fish was tested. These avoidance values are classified as resting avoidance values.

The three separate runs were not significantly different ( $F$ ;  $P < 0.05$ ) for either visible or ultraviolet light, therefore the overall mean avoidance response intensity for each was calculated on the total three-run data. A computed correlation coefficient ( $r$ ) value of 0.018 for visible light and 0.146 for UV indicated there was little correlation between length of fish tested (12 to 30 cm) and fish response to light intensity.

The mean resting UV avoidance value was 3500 microwatts  $\text{cm}^{-2}$ , about 25% of incident UV in full sunlight in Logan, Utah. Mean resting VL avoidance value was 2800  $\mu$  watts  $\text{cm}^{-2}$  (646 foot-candles), about 6.5% of the visible light in full sunlight in Logan. Previous field measurements in a number of Utah streams by Gosse and Helm (1982) yielded a value of about 5%. The laboratory values were corrected for cosine error, while the field values were not. The field values would increase if corrected, bringing them even closer to the laboratory values. No field measurements of UV at fish locations were made during previous studies.

Measurements of natural UV and visible light were made each hour at seven locations on July 31, 1982 in the Blacksmith Fork River near Logan, Utah, in a reach oriented nearly east and west. The water in this stream is very clear, with an attenuation of only 20 percent of incident visible light at 2m depth. Weather was clear skies, bright sun, with intermittent winds. Data from four contrasting stations are shown here (Figure 1). Station one was an unshaded riffle area 0.5m deep; station two was 0.6m deep under an overhanging river birch with sparse branches one to two meters above the water surface; station three was 0.76m deep under an overhanging river birch with branches hanging close to the water surface; station six was 0.5m deep under dense brush overhanging the stream bank.

Both UV and visible light intensities increased rapidly in the morning and remained above avoidance levels all day in the unshaded riffle. The overhanging tree with branches one to two meters above the water reduced near-bottom UV and VL to near or below avoidance levels until afternoon. Late afternoon sun angle allowed light to slant in under the branches. At stations three and six, with overhanging branches close to the water, even low sun angles did not permit much light to reach the near-bottom locations typically occupied by trout. Stations two and three are locations where trout commonly feed, and station six is a resting area identified during previous studies (Helm et al. 1982).

Several inferences can be drawn from these data. First, both UV and VL exceed their respective avoidance levels at nearly the same time in the morning in unshaded areas, and remain high for about the same length of time. Under such conditions neither could be identified as more likely than the other to evoke an avoidance reaction among brown trout. Second, there is a direct relationship between the distance of overhanging vegetation above the water and the amount of light reaching near-bottom areas beneath. Third, there is an inverse relationship between the distance of overhanging

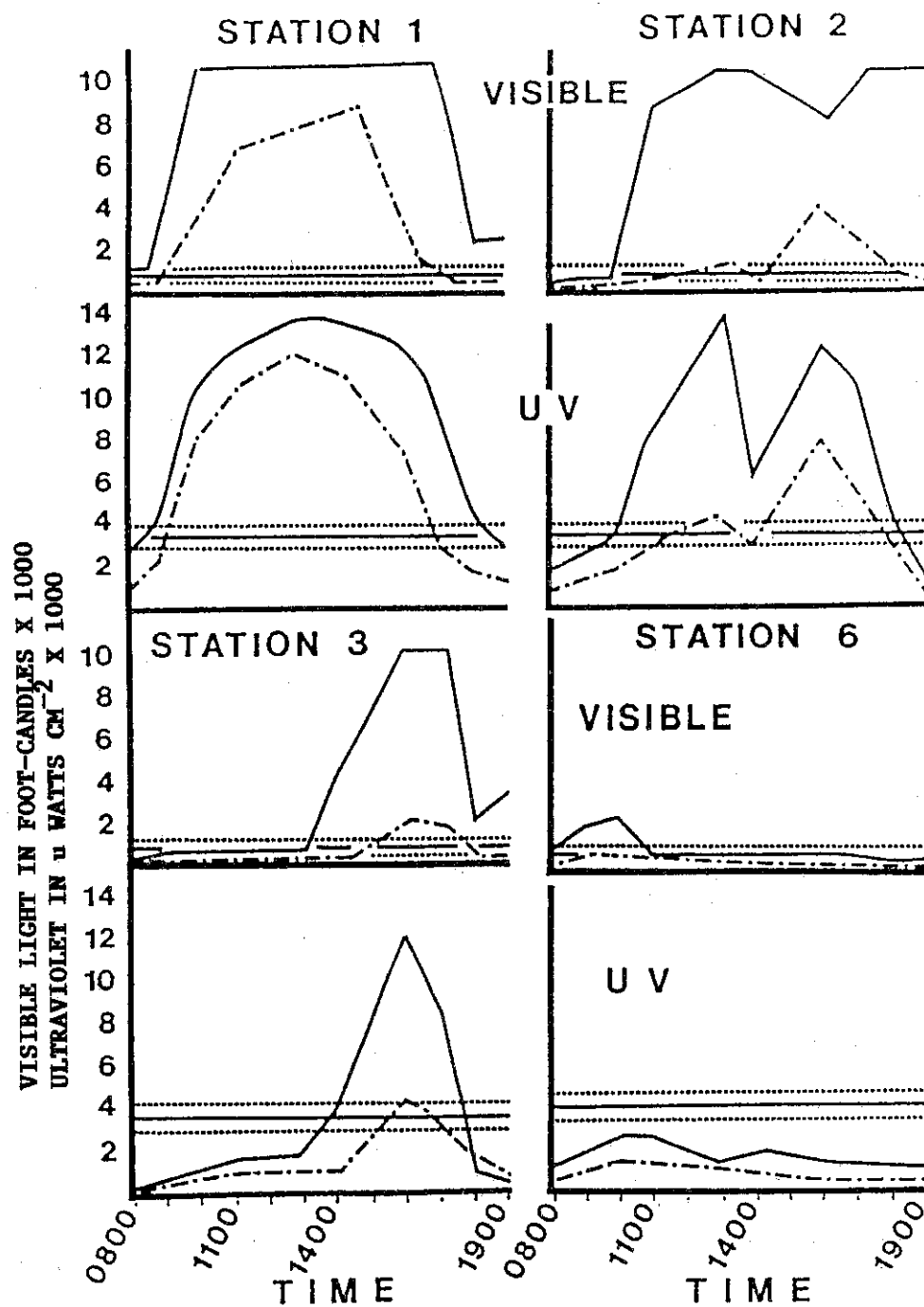


Figure 1. ULTRAVIOLET AND VISIBLE LIGHT SURFACE (SOLID LINE) AND NEAR BOTTOM INTENSITIES, BLACKSMITH FORK RIVER, UTAH, JULY 31, 1982.

vegetation above the water and the amount of time that light levels are below avoidance levels.

As cloud cover increases in density, UV decreases more rapidly than visible light (Figure 2). Under moderately heavy cloud cover UV falls below resting avoidance level, while visible light, at about 50 percent of full incident sunlight, is still well above resting avoidance level. This 50 percent value has been found to be the visible light feeding avoidance level in previous field studies. Thus while moderately heavy to heavy cloud cover would not reduce visible light to resting levels, it would provide light levels in the acceptable range for brown trout feeding.

Theoretical percent daylight residence time based on near-bottom UV and visible light mean avoidance values.

Station	<u>Resting</u>		<u>Feeding*</u>			
	<u>UV</u>		<u>Visible</u>		<u>Visible</u>	
	Hours	Percent	Hours	Percent	Hours	Percent
4	11	100	11	100	11	100
6	11	100	11	100	11	100
3	8	73	7	64	11	100
2	6	55	4	36	11	100
1	4	36	4	36	7	64
7	3	27	2	18	9	82
5	3	27	1	9	11	100

\*Visible light of 5,000 foot-candles or less (Gosse and Helm 1982).  
No value established for UV.

The field measurements can be used to determine theoretical residence time as determined by light levels, the amount of time during daylight that light levels are within acceptable ranges for resting or feeding (Table 1). Stations 4 and 6 are beneath shoreline vegetation, 2 and 3 are under the overhanging tree, 1 is in open riffle, and 5 and 7 in open pools. Only the locations under the low-hanging shoreline vegetation provided uninterrupted resting light levels all day. Visible light was more limiting than UV. The combination of shade, agitated water surface and depth reduced light levels sufficiently that five of the seven locations provided uninterrupted feeding

vegetation above the water and the amount of time that light levels are below avoidance levels.

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It appears that while brown trout detect and react to ultraviolet light, the levels of UV-A (324-390nm) measured here are no more, and possibly less limiting than are the levels of visible light.

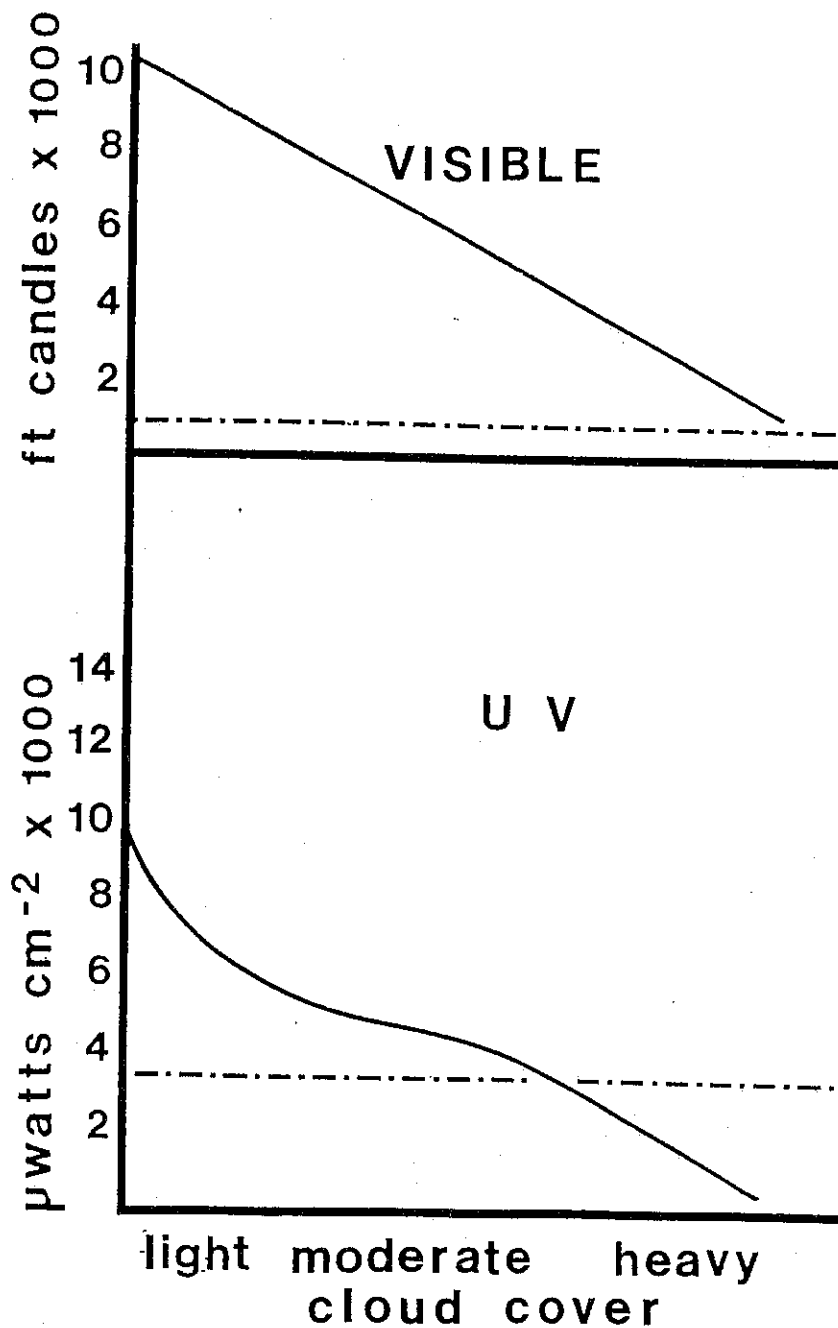


Figure 2. Effect of cloud cover on incident ultraviolet and visible light intensities in Logan, Utah. Dashed lines are lab UV and visible light mean avoidance intensities.

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DO NATURALLY SPAWNING HATCHERY STEELHEAD AFFECT  
THE GENETIC RESOURCES OF WILD STOCKS?  
PRELIMINARY FINDINGS FROM THE KALAMA RIVER, WASHINGTON

Steven A. Leider and Mark W. Chilcote  
Washington Department of Game  
Olympia, Washington

Preliminary results from summer-run steelhead genetic marking studies in the Kalama River indicate that the success of naturally spawning hatchery fish (Skamania stock) in producing adult offspring is 18% of that for wild fish. Differential mortality occurred within both the freshwater and marine phases.

This suggests smolt-to-adult survival for naturally produced offspring of hatchery spawners may be limited by the proportion of "hatchery-type genes" in the offspring population. For rivers where hatchery and wild steelhead are not reproductively isolated, this genetic impact will probably reduce the natural productivity and potential adult returns of subsequent wild generations. Using empirical Kalama River data, this is demonstrated in the form of a relationship between hatchery wild spawner ratios and natural production potential.

HATCHERY-REARED SALMONIDS:  
FORGOTTEN PREDATORS IN THE COLUMBIA BASIN?

D. D. Dauble, R. H. Gray, T. L. Page  
Battelle, Pacific Northwest Laboratory  
Richland, WA  
and W. B. Duke, Oregon Dept. Fish and Wildlife  
Enterprise, OR

The role of juvenile salmonids as predators in natural ecosystems is well documented, but poorly understood in terms of systems-wide management of native salmonid populations. We collected juvenile chinook salmon, released from upriver locations, in the Hanford Reach of the Columbia River, from 1973-1978 and in 1984-1985, to identify feeding habits. Methods of capture included gill net, fyke net, beach seine, electroshocker, and hook and line.

Juvenile salmon (87-337 mm FL) were opportunistic feeders, consuming a wide variety of terrestrial and aquatic insects (>10 orders). Pupal and adult Trichoptera and Diptera were primary components of the diet during all seasons. Age-0 fall chinook salmon were also a major food item following their emergence from redds below Priest Rapids Dam. Incidence of piscivory averaged 35% during the spring 1975-1978 (n=34), but only 5% in 1984 (n=258). A preliminary model, based on mouth gape of predators (smolts) and body depth of prey (fry), suggests that major hatchery releases of juvenile summer/spring chinook salmon could influence survival of wild 0-age fall chinook salmon that rear in the Hanford Reach. Results may be applied to management of hatchery releases in other river systems.



COMPARATIVE GROWTH AND DEVELOPMENT OF DIPLOID AND  
TRIPLOID COHO SALMON ONCORHYNCHUS KISUTCH

Orlay W. Johnson, Walton W. Dickhoff, and Fred M. Utter  
Northwest and Alaska Fisheries Center, NMFS  
Seattle, WA and School of Fisheries  
University of Washington, Seattle

This paper compares growth and gonadal development of triploid coho salmon in three treatment groups. The comparisons were made in fresh and seawater from the time of smoltification at 18 months to the onset of sexual maturity at 37 months. No differences were detected in the ability of triploids to smoltify and to successfully adapt to seawater under normal conditions. Likewise, no differences were observed in growth parameters (length, body weight, or condition factor).

Gonadal development was more severely retarded in female triploid fish than in males. The average gonado-somatic index (GSI) of triploid males at 37 months of age was 80.5% of diploids, and over-all male gonadal development suggests that some form of spermiation would occur at the time of maturation in the diploid controls. Triploid females showed an almost complete blockage of gonadal development and oocyte maturation. The average GSI of triploid females was 11.8% that of diploid females. Vitellogenin was undetectable in triploid females, but was present in diploid females; a correlated reduction in the hepato-somatic index was observed in triploid relative to diploid females. Estradiol levels in the plasma of the triploid fish were on the average significantly lower than in the diploid controls after the 30th month.

An Evaluation of Fish Passage at the Sunnyside Canal  
Fish Screening Facility

Duane A. Neitzel, C. Scott Abernethy, E. William Lusty  
and Leslie A. Prohammer  
Pacific Northwest Laboratory  
Richland, Washington

The Sunnyside Canal Fish Screening Facility is in the Sunnyside Canal, about 500 m downstream of the Sunnyside Dam on the Yakima River (river kilometer 167). The screening facility diverts fish that have entered the canal back into the Yakima River.

We branded and released about 4000 chinook salmon, Oncorhynchus tshawytscha and 2000 steelhead, Salmo gairdneri, smolts in front of or within the screening facility. We caught 507 of the steelhead and none were descaled or killed. We caught 3625 of the chinook salmon and less than 2% were descaled or killed. Our data indicate that fish were safely diverted from the Sunnyside Canal into the Yakima River.

The fish screening facility is part of a joint project by the Bonneville Power Administration and the Bureau of Reclamation to construct fish passage and protective facilities at existing irrigation and hydroelectric diversions in the Yakima River Basin. The project is part of the Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program.

The Application of a Dual-Beam Hydroacoustic System  
as a Fish Size Classifier on the Kenai River, Alaska

Samuel V. Johnston  
BioSonics, Inc.  
4520 Union Bay Pl. NE  
Seattle, WA 98105

David M. Gaudet  
Dr. Paul A. Skvorc  
Alaska Dept. Fish and Game  
Division of Commercial Fisheries, Research Section  
Box 3-2000  
Juneau, AK 99802

Recent developments in echosounding technology have made possible the in situ measurement of target strength for individual fish targets as they pass through an acoustic beam. Target strength is a measure of acoustic reflectivity which is related to fish size (R. H. Love, 1971). The measurement of target strength is accomplished using a dual-beam echosounding system (J. E. Ehrenberg, 1978). With this system, it is possible to separate fish on the basis of size and direction of movement. The system combines signal processing hardware and computer software to select acoustic returns from each individual fish target and group them together to allow mean target strength to be calculated from several echoes from the same fish.

The Kenai River in South-Central Alaska supports one of the largest king salmon (*Oncorhynchus tshawytscha*) sport fisheries in the state, as well as a large commercial sockeye salmon (*Oncorhynchus nerka*) fishery. Managing these two fisheries requires that accurate estimates of each run be made separately. During the summer of 1985, Alaska Department of Fish and Game funded and, with the assistance of BioSonics, Inc., carried out research on the Kenai R. to determine if fish targets could be classified as to size using the dual-beam acoustic system. Since the size distributions of the two primary fish species in the Kenai River are non-overlapping, this would allow target classification by fish species as well. Results indicate that the dual-beam acoustic system could separate fish targets into species groups based on size. In addition, target direction (upstream or downstream) was determined to allow removing downstream traveling debris from the data base.

RESPONSES OF JUVENILE STEELHEAD TROUT AND COHO SALMON  
TO THE ENRICHMENT OF THE KEOGH RIVER  
WITH INORGANIC FERTILIZER

C. J. Perrin(1) and P. A. Slaney(2)  
Limnotek Research Development Inc., Vancouver B.C. and  
Ministry of Environment, Fisheries Research and  
Development Section, Vancouver, B.C.

Research was initiated in 1981 in experimental stream sections to investigate the role of inorganic nutrients on salmonid production in coastal streams. In 1984 and 1985 the entire Keogh River, with the exception of an upstream control, was enriched with regulated additions of phosphorus and nitrogen. Concentrations of soluble reactive phosphate (SRP) and dissolved inorganic nitrogen (DIN) were increased ten and five times, respectively, to 10 ug.L<sup>-1</sup> SRP and 100 ug.L<sup>-1</sup> DIN during April to September. Periphyton accumulation rates increased substantially aside from a month during early summer.

Compared to the control, the mean size of underyearling coho salmon and steelhead trout doubled by autumn in 1984 and 1985 in the upper and middle reaches, but increased only marginally in a lower reach. Mean weight of yearling steelhead parr was marginally increased over the control in 1984 but approximately doubled in 1985. Effects on salmonid smolt production can be predicted but remain uncertain until enumerations are completed in 1986 and 1987.

NUTRIENT CONCENTRATION AS A LIMITATION TO  
STEELHEAD SMOLT PRODUCTION IN THE KEOGH RIVER

Pat A. Slaney, Chris J. Perrin, and Bruce R. Ward  
Ministry of Environment, Fisheries Branch, University of  
British Columbia, Vancouver, and Limnotek  
Research and Development Inc, Vancouver, B.C.

Finite habitat characteristics including preferred rearing space, shelter from freshets and predators, and food supply combine to provide an environment in streams that promotes intense competition, manifested in territorial behavior (Chapman 1962, McFadden 1969). Aside from overfishing mortality which is capable of undersaturating streams with eggs and fry, density dependent mortality in the fry to parr stage is considered to dominate regulation of populations, thus setting "carrying capacity" of streams for salmonid smolts (e.g. McFadden 1969). Investigations of stocked underyearlings have indicated a finite capacity for production of parr and smolts (Bjornn 1978, Trip and McCart 1983, Hume and Parkinson 1986). A similar pattern has been found for wild smolts at Carnation Creek (coho; Holtby and Hartman 1982) and Keogh River (steelhead; Ward and Slaney, 1986) in British Columbia.

Factors limiting the production of salmonid smolts per unit area can be separated into two types. Some limitations temporarily reduce smolt production below capacity, including freshets in winter (Hume and Parkinson 1986; Ward and Slaney, data on file), droughts (Smoker 1953), or poor egg incubation conditions (McFadden 1969). The second type are those that set average capacity. These include cool water temperatures (Holtby and Hartman 1982, Egglisshaw and Shackley 1985), instream cover or winter shelter (Ward and Slaney 1979 and 1981, House and Boehne 1985), and possibly predation (e.g. merganers; Elson 1962).

Another important factor of the latter type is food supply. During stream surveys McFadden and Cooper (1962) found that streams carrying higher concentrations of dissolved solids support a greater standing crop of salmonids than "infertile" streams. This and similar observations infer that nutrient supply may be of some importance in regulating growth of salmonids and hence the availability of food.

Indeed, more recent studies have shown that trophic production in streams can be manipulated either through supply of inorganic nutrients or particulate organic matter (POM). In coastal streams, for example, Stockner and Shortreed (1978) and Perrin *et al.* (1986) have shown that additions of phosphorus and nitrogen can increase autotrophic production in excess of an order of magnitude from the untreated condition. This was due to elimination of phosphorus deficiency (Perrin *et al.* 1986). During pilot studies in the Keogh River in 1981, Slaney and Perrin (in prep.) measured a 77% greater increase in mean weights of juvenile coho relative to a control due to nitrogen and phosphorus additions within the first 2 months of treatment. In the same pilot studies, additions of grain as labile POM (after

Mundie et al. 1983) increased mean weights of coho fry (*Oncorhynchus kisutch*) by ca. 50% relative to the control but only after 5 months of treatment.

To determine whether gains in juvenile salmonid growth could improve overwinter survival and smolt production, a whole-river enrichment experiment was started in 1984 on the Keogh River. Inorganic fertilizer was selected as the enrichment material because of results from the pilot study. This paper reports on preliminary findings of change in trophic production and smolt yield of steelhead trout (*Salmo gairdneri*) since fertilizer additions were initiated.

#### STUDY SITE

The Keogh River is a third-order system that flows for 32 km from a 129 km<sup>2</sup> watershed located near Port Hardy, northern Vancouver Island (Fig. 1). It is utilized extensively by steelhead trout, coho salmon, cutthroat trout, and pink salmon. During the fertilization period of May through September, average discharge is 1.2 to 2.5 m<sup>3</sup>·s<sup>-1</sup>. Mean water temperatures are 9 C (annual) and 12 to 13 C (May to September; range 5 to 19 C). Riparian vegetation is typical of Pacific rain forest, dominated by sitka spruce, western hemlock, cedar, red alder, and salal. Logging has been active in the Keogh drainage for the past 30 years and has resulted in wide variation in extent of overstream forest canopy.

Background nutrient concentrations are typically low with dissolved inorganic nitrogen (DIN) and soluble reactive phosphorus (SRP) concentrations near or less than detectable limits. Phosphorus in particular has been found to be extremely deficient (Perrin et al. 1986).

#### METHODS AND MATERIALS

Twenty-nine km of the Keogh River were treated with additions of inorganic fertilizer (Fig. 1). To maintain a control for measurements of trophic responses to fertilization, a 3 km reach at the Keogh River headwaters remained untreated. Fertilizer trials were conducted using a coated slow release material during spring to summer of 1983, but release rates were unpredictable.

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For target concentrations of 10 ug·L<sup>-1</sup> SRP and 100 ug·L<sup>-1</sup> DIN (NO<sub>3</sub><sup>-</sup> + NO<sub>2</sub><sup>-</sup> + NH<sub>3</sub> + NH<sub>4</sub><sup>+</sup> - N) at complete mixing, a hydrologic flux model was used to calculate approximate loading rates. Calculations were based on the use of a dry mix of 11-55-0 (ammonium phosphate) and 34-0-0 (ammonium nitrate) to achieve the N/P supply ratio of 15:1 by atoms. Fish feeders (Sweeney Feeders Inc.) custom fitted with stainless steel and plastic parts were used to dispense fertilizer at 6 locations in

1984 (Fig. 1). For both 1984 and 1985 during the period of April 15 through September 30, approx 13 tonnes of fertilizer were added to the river. Concentrations of  $\text{NO}_3^- + \text{NO}_2^- - \text{N}$ ,  $\text{NH}_4^+ + \text{NH}_3 - \text{N}$  and SRP were determined from bi-weekly samples collected in the control at W104 and in the treatment reach at W103, HWY and Trap 1 (Fig. 1) and analyzed by methods outlined in MOE (1976) and APHA (1980).

Periphyton biomass was sampled from three replicate styrofoam substrata (Perrin and Johnston 1985) located at W104, W103 and HWY in 1985 and also at West Trib in 1984. Biomass was expressed on an accrual basis from samples collected for chlorophyll *a* analysis every four to seven days in up to four separate time series: series 1 - before treatment in early April; series 2 - in late April or early May; series 3 - in July; and series 4, in September. The first five days of incubation were considered an inoculation phase. On each sampling date, one sample was collected from each replicate substratum by removing a circular core and analyzed using the spectrophotometric technique outlined in MOE (1976). At the end of each incubation series additional cores were preserved in Lugols solution for taxonomic examination (Northcote *et al.* 1975).

Stream invertebrates were sampled during treatment in 1984 and 1985 with the objective to describe availability of fish food organisms and compare food availability to growth of steelhead fry. Six replicate drift samples were collected in monthly intervals at the control (W104), W103, HWY, and West Trib sites (Fig. 1) in 1984, and at control (W104) and HWY sites in 1985. A 200  $\mu$  mesh net collected the sample behind a Cushing (1964) sampler with a 25  $\text{cm}^2$  mouth aperture. All samplers were in place for 3-4 hours beginning about 2 hours before sunset. Sample counts were converted to numbers per 100  $\text{m}^3$  sampled using depth and velocity measurements. Samples were preserved, sorted, invertebrates identified to the family level, and wet weights measured to the nearest mg.

Juvenile steelhead populations were sampled in July 1980 to determine spatial variability and in mid-July and the end of September in 1984 and 1985. Four reaches were sampled; upstream of W104 (control), near W103, near HWY, and near pumphouse (Fig. 1). To determine population estimates in 1980 a multiple step DeLury estimate (Seber and LeCren 1967) was conducted in each reach within 200 to 300 m sections stratified into discrete habitat units 10 to 30 m in length. In 1984 a Petersen mark and recapture estimate was carried out in four 50 m sections in each reach (Ricker 1968) except at W103 where fish were only sampled for lengths, weight and age. Sections were selected that represented the habitat composition of the river which had been measured previously. Each unit or subsection was sealed with stop nets, and fish were collected with a type VIIIA electrofisher (Smith Root, Wash.). In pools, repeated seining were conducted after successive electrofishing shallow areas and



debris. Fork lengths and weights were measured to the nearest mm and 0.1 respectively. Fry were subsampled (50-100) randomly, whereas all parr were sampled. Scales for age determination were mounted on gummed labels, pressed onto plastic, photo-micrographed, and then interpreted by two readers. These sites were resampled in 1985, but population estimation was reduced to a single step DeLury (Seber and LeCren 1967).

Smolts were enumerated at Trap 1, (Smith and Slaney 1980) (Fig. 1). All migrating juvenile steelhead trout were counted from April 1 to June 15. Smolts were separated from parr using a 130 mm criteria, a length that coincided both with a length frequency separation and silver coloration. Fork lengths and weights were subsampled daily and weekly, respectively, in proportion to numbers migrating. Scales were subsampled by length strata according to Ricker (1975), then processed and aged as described above. Capture efficiency was determined by releasing marked coho smolts; numbers of migrants were adjusted upwards by approx 10%.

## RESULTS AND DISCUSSION

Periphyton accumulation followed a consistent pattern in each year of treatment in which the effects of fertilization exaggerated natural seasonal patterns (Table 1). For example, very low accumulation rates in early April were followed by a 3.5 times rate increase in the control in May. Fertilizer additions increased net accumulation rates by more than an order of magnitude to result in biomass levels that could be considered "nuisance levels" (Horner et al. 1983). Following May, fertilizer addition significantly increased periphyton accumulations, but only to levels that were 20-50% of those attained in early spring. In contrast, maximum biomass in the control remained 5-10 times lower than in fertilized reaches. Throughout the growing season, diatoms dominated the community, although chlorophytes gained increasing importance from July through September.

Although temporal differences in invertebrate biomass and density were highly significant ( $p < 0.05$ ), treatment effects were not detectable in both years. Highest biomass values of almost 600 mg per 100 m<sup>3</sup> were typical in late May but this declined to 45 mg per 100 m<sup>3</sup> by late July. Highest densities of nearly 300 organisms per 100 m<sup>3</sup> occurred about one month after peak biomass. Other than this June peak, however, densities remained constant and similar at the control and treatment sites at about 75-100 organisms per 100 m<sup>3</sup>. Dipterans accounted for 50-75% of all organisms and mayflies comprised 15-25% in both the control and treatment sites.

Table 1. Periphyton chlorophyll a accumulation during 20-day incubations in 1984 control and HWY sites of the Keogh River during fertilization. Asterisks indicate significant differences  $p < 0.05$ .

	Pretreat- ment		May		July		Sept	
	Cont.	HWY	Cont.	HWY	Cont.	HWY	Cont.	HWY
Maximum biomass (mg chl <u>a</u> -m <sup>-2</sup> )	0.8	1.8	6.0	94.0*	3.5	20.0*	3.8	40.0*
Net accumulation rate (mg chl <u>a</u> -m <sup>-2</sup> .d <sup>-1</sup> )	0.1	0.1	0.35	4.5*	0.13	0.80*	0.12	1.50*

Although our results suggest that fertilization did not increase the availability of invertebrate drift, it is important to recognize confounding factors. Any increase in invertebrate production may, for example, have been masked by an increase in cropping rates by fish. However, ration size in stomachs of fry at HWY and the control did not differ significantly at each sampling period. These results may also have been affected by unknowingly selecting a sampling time that did not match a period of active feeding at each site. Indeed, the marked increase in fry weights due to treatment (Fig. 2) does suggest that our insect sampling techniques were insensitive for measuring change in availability of food organisms.

Prior to enrichment, steelhead fry in the upper river were consistently larger than those in the lower river. Fry in this section emerge earlier than fry of the lower river (i.e. as a result of earlier adult spawning and higher water temperatures) and, therefore, the upper reach has a longer rearing period. Fertilization did not affect between site differences in mean weights, but because weights in the control actually declined between 1980 and 1984, the increases shown in Fig. 2 are up to 2.5 times pretreatment weights.

Gains in fry weights during the 1984 growing season were sustained into 1985 to yield significantly larger 1+ parr by the fall of 1985 ( $p < .05$ , Fig. 3). Parr in treated reaches were 1.6 to 2.1 times larger than the upstream control (Fig. 3) yet mean size was similar in the W103 and the control during midsummer of pre-treatment years (data on file).

Preliminary estimates of fry and parr density suggest that site differences were not significant, except for parr in 1984. During three years prior to enrichment of the river the average steelhead parr density was 0.06/m<sup>2</sup>. During enrichment in 1984 mean parr density was 0.09/m<sup>2</sup> and 0.04/m<sup>2</sup> in the treated and

control reaches, respectively. Fry densities were similar: 0.83 and 1.21 in the mid- and lower Keogh, and 0.90 in the control. Parr and fry densities in 1985 were similar in control and treated sites (fry, 0.6 vs 0.4 to 1.0/m<sup>2</sup>; parr, 0.1/m<sup>2</sup>), although the technique utilized for population estimation was less accurate in 1985. Preliminary results indicate a 1.5 to 2-fold increase in standing crop of juvenile steelhead, primarily as a result of increased growth in the fry and parr stages. This is consistent with a pilot scale enrichment conducted in the upper Keogh River in 1981 (Slaney and Perrin 1986).

Age composition of steelhead parr during summer and fall in 1985 was dominated by age 1+ throughout the treatment and control reaches. However, age 2+ and 3+ parr accounted for only 6.5% (range 3.2 to 12%) in the enriched reaches, and 15.6% in the control. In contrast, during three years prior to enrichment, age 2+ plus 3+ fish comprised 35.0% and 22.0% of the steelhead parr in the treated and control reaches, respectively.

Smolt yield from the Keogh River has varied greater than five-fold from 1977 to 1983, or from 2100 to 11,500 smolts (Ward et al. 1986). The lowest output was associated with an extreme freshet during fall in 1975. However, this variability is reduced substantially when smolt output is examined by egg or fry brood years. Prior to enrichment, smolt yield averaged 0.026 smolts/m<sup>2</sup> (range 0.021 to 0.030; 1976 to 1981 broods), but increased to 0.032/m<sup>2</sup> (1982 brood), and is estimated at 0.032/m<sup>2</sup> for the 1983 brood. This is equivalent to a 25% increase over pre-treatment years, although the experiment remains incomplete until 1988.

Prior to enrichment the composition of smolts migrating through the counting fence was dominated by age 3's (57%, Fig. 4). Commencing in 1984 there was a shift to age 2 smolts, and by 1985 they comprised 70% of the output of 8,500 smolts (Fig. 4). Age 4 smolts were almost eliminated by 1985. This age class shift closely matches shifts in parr age composition. Hence, stream enrichment has reduced resident time required for smolt migration.

Examination of returns of adult wild steelhead to the Keogh River demonstrated that smolt survival is a function of smolt size (Ward et al. 1986). After enrichment the mean size of age 3 smolts has shifted significantly ( $p < 0.05$ ) from a mean of 179 mm (1977 to 1983) to 187 mm (1984 to 1985). Age 2 smolt length increased from an average of 153 mm before fertilization to 163 mm in 1984 and 168 mm in 1985 ( $p < .05$ ), or approaching the equivalent of age 3 smolts (Fig. 5). Thus, shifts in age structure of smolts were associated with increased size at age, and marine survival should not change significantly.

These results are consistent with results from sampling various other streams. For example, Egglshaw (1972) found the rate of cellulose decomposition and the growth of juvenile brown

trout in England were positively co-related with nutrient concentration. Streams with higher conductivity, as an indicator of "fertility", were also associated with higher standing crops of resident trout in Pennsylvania (Cooper and Scherer 1967). Sampling during summer, upstream and downstream of the input of treated sewage, at a Michigan stream demonstrated increased growth, and a slightly higher density of brown trout (Ellis and Gowing 1957).

The gains in trout growth at the Keogh River resulted from stimulation of the food chain at its lowest trophic level. Increased size of fry and parr were carried through the winter, thus sharply reducing the dominant age at smolting without significantly reducing mean smolt size. Accordingly, preliminary results indicate smolt yield is increasing in proportion to the reduction of age 3 and 4 smolts, in agreement with Symons (1979). Changes in food supply have been difficult to detect, but experimental manipulations of the food chain demonstrate the importance of this limiting factor to smolt production in a nutrient deficient stream.

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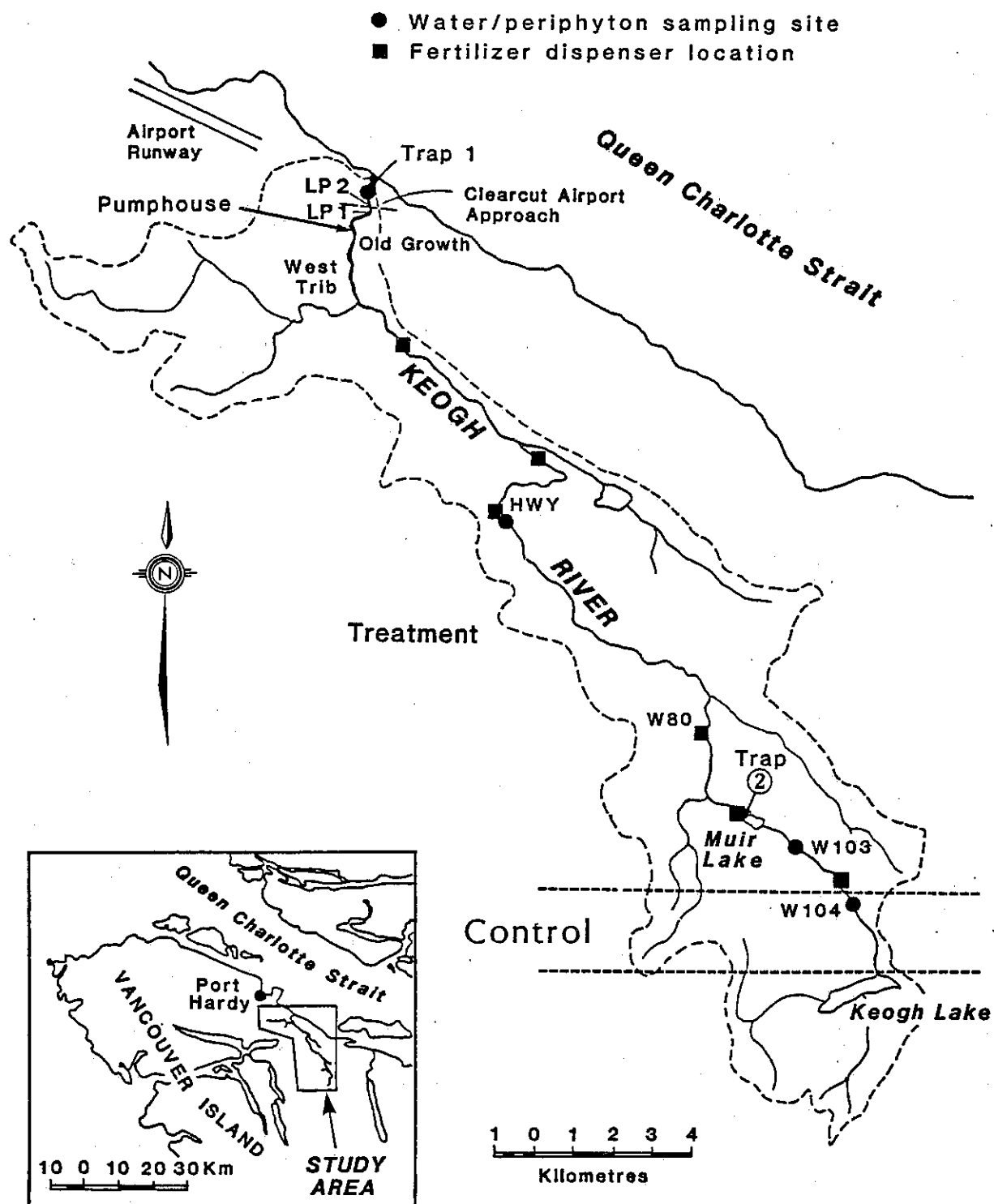


FIGURE 1. Location of the Keogh River study site and layout of sampling and fertilizer injection sites.



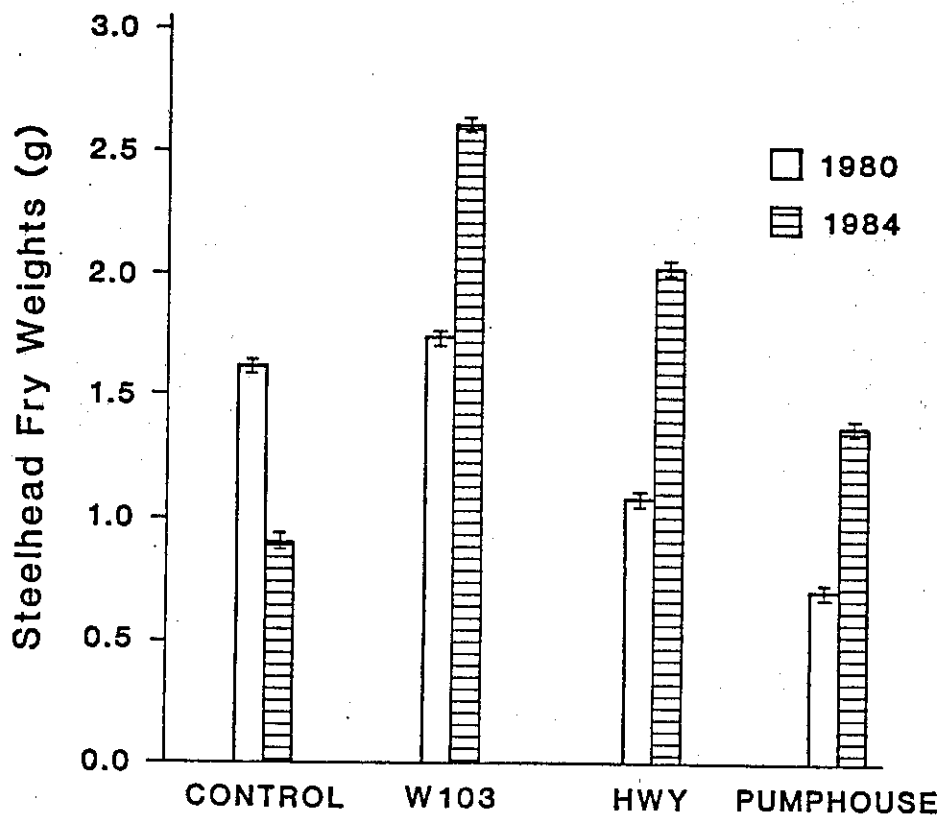


Figure 2. Steelhead fry weights in July before and during whole-river fertilization. Error bars represent 95% confidence intervals.

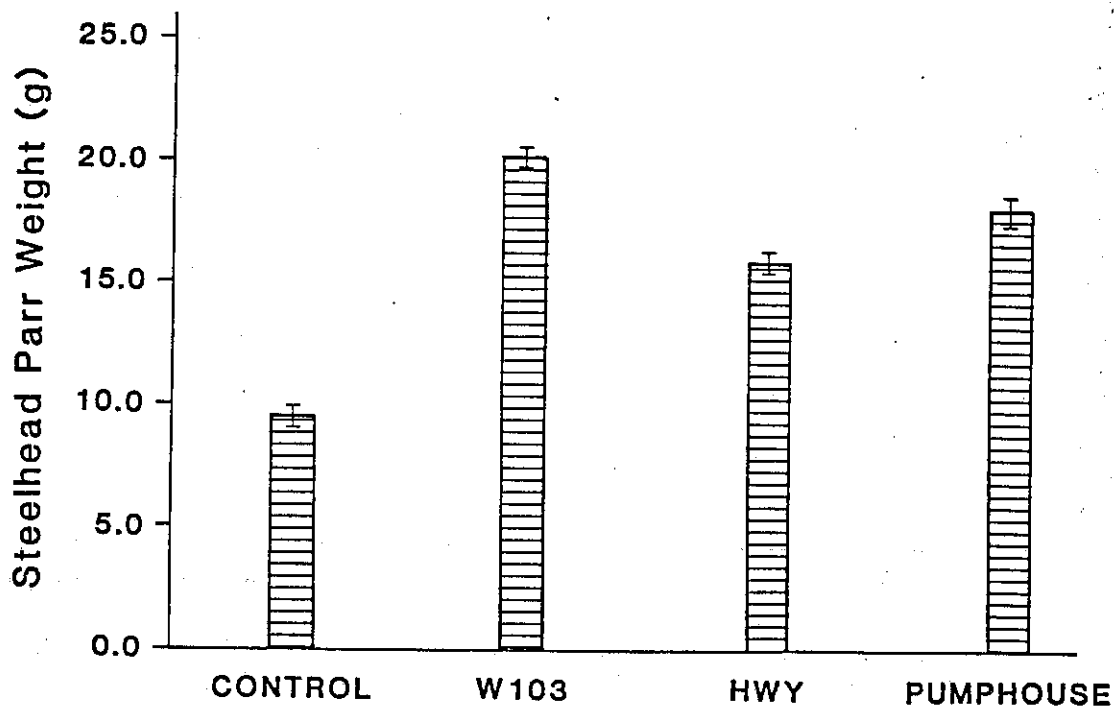


Figure 3. Steelhead age 1+ parr weights in the second season of whole-river fertilization. Error bars represent 95% confidence intervals.

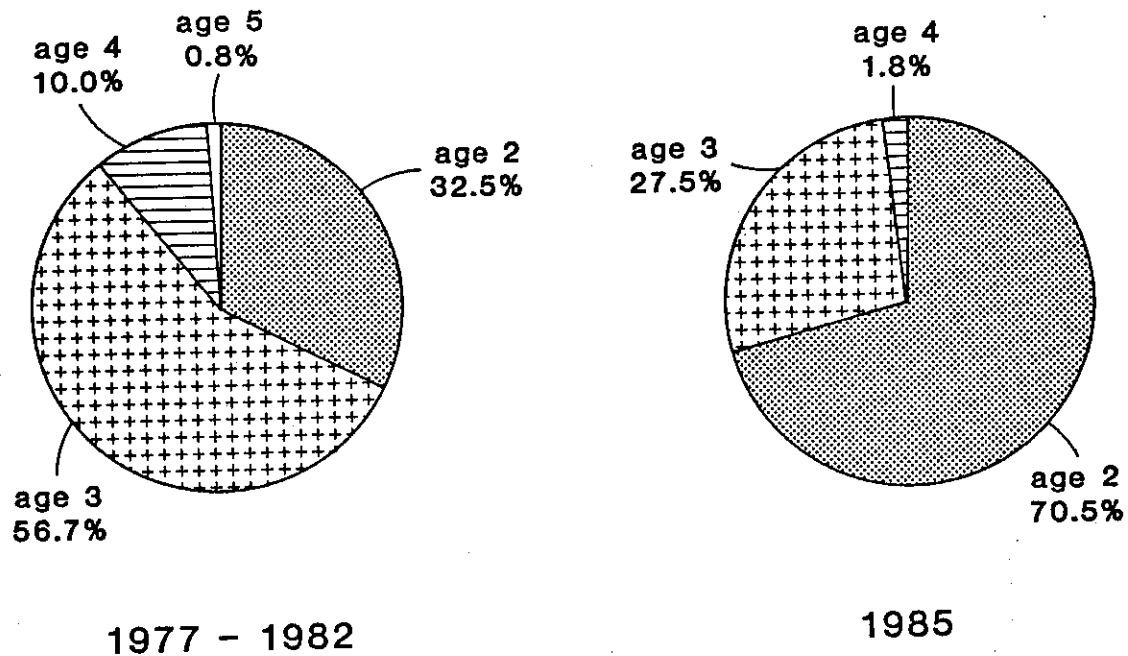


Figure 4. Steelhead smolt age composition in the Keogh River before and after whole-river fertilization.

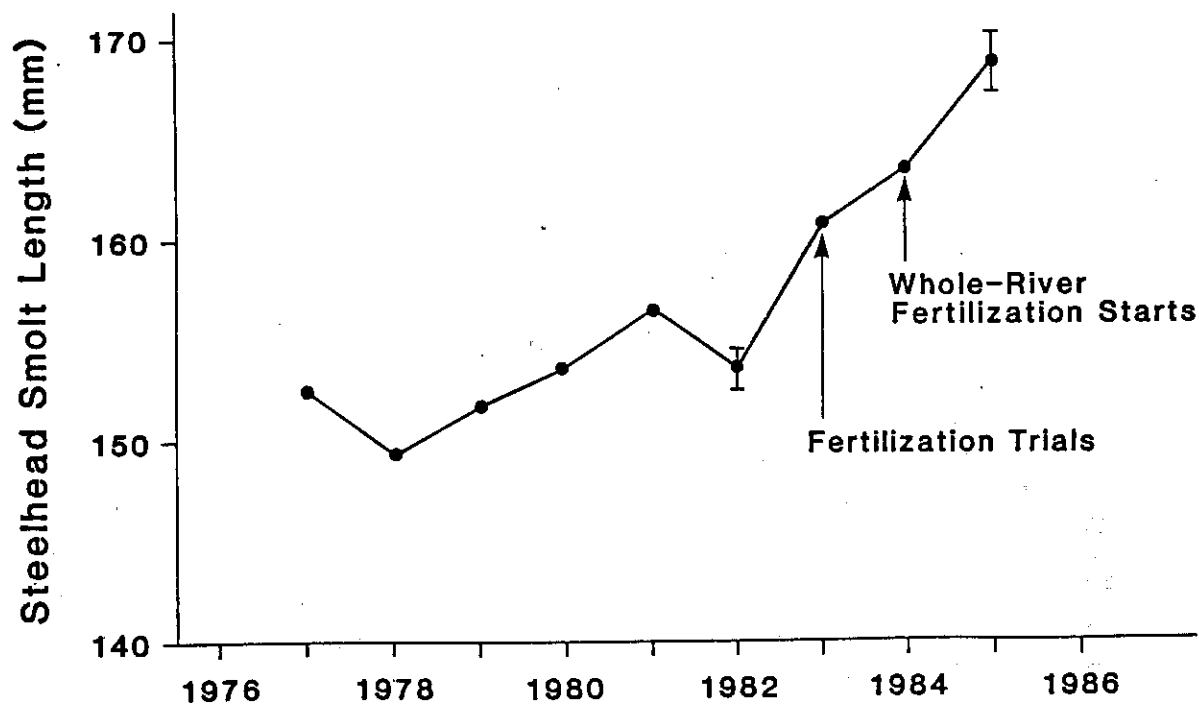


Figure 5. Sizes of 2-year old steelhead smolts in the Keogh River before and after whole-river fertilization.

TIME OF DEATH ESTIMATION IN BLACKTAIL DEER  
BY TEMPERATURE AND AQUEOUS HUMOR GLUCOSE

James O. Pex, M.S.  
Kenn D. Meneely, B.S.

Criminalists, Oregon State Police

Fred C. Andrews, PhD

Professor of Mathematics, University of Oregon

INTRODUCTION

The need to determine the time of death (TOD) in deer within the first several hours is a significant problem. A game officer may contact a hunter late at night or during the early morning hours possessing a deer carcass. Intuition and some circumstantial evidence may suggest the deer was obtained after the legal shooting hours. Direct physical evidence from body temperature and eye fluid glucose can aid in the prosecution of poachers, or can exonerate persons trapped by unfortunate or prejudicial circumstances.

Several scientists (3,7,12) have studied glycolysis in the peripheral blood and in vitreous humor (eye fluid) of humans. During the 1950s and 60s several comparisons were made between antemortem and postmortem specimens. More recently, Coe (2) demonstrated the postmortem changes in vitreous glucose occurs quite rapidly, but were of limited value in diagnosing deaths due to hypoglycemia.

In 1979, Schoning and Strafus (9) tested vitreous humor glucose in sixty mongrel dogs and found that the glucose was affected by time but not by the outside environmental temperature between 4°C and 37°C. Determination of TOD by body temperature is also of value and has a high correlation to the eye fluid glucose. Kistner and members of the Oregon State Police Game Division (1) obtained sequential body temperatures from thirty freshly killed deer. Graphical illustrations of temperature versus time, revealed the body weight (muscle mass in the rump) had a direct effect on the rate of cooling. Larger deer cooled slightly slower than smaller deer.

The purpose of this study is to combine body temperature and eye fluid glucose data to provide a time of death in deer carcasses with 95% confidence. The total number of deer studied was two hundred two, (fifteen in a controlled study and one hundred eighty seven in a field study).

## MATERIALS AND METHODS

For purposes incident to a range management impact study, fifteen deer were killed. The animals were obtained in three range management areas near Alsea, Oregon. The animals were shot in the neck, field dressed and weighed. Physical measurements were obtained and an examination for disease was made by a wildlife veterinarian. All deer were free from significant physiological problems which might influence the body temperature of eye fluid glucose. The outside temperature varied from 3.2°C to 17°C.

The field study was conducted at the McDonald Forest Check Station - a unique opportunity where hunters must check in and out of a twenty square mile special hunting area. It is an either sex hunt for blacktailed deer. Successful hunters were required to "punch" a special tag which was provided to each hunter for recording the TOD to the nearest 15 minutes. Each deer collected is weighed, examined for disease and a record of age and sex is obtained. The method of transportation, area of wound, rump temperature and eye fluids were also collected. The deer varied in weight from 36 pounds to 150 pounds. Methods of transportation varied considerably from open bed pickups, pickups with canopies, vans and automobile trunks. Outside temperatures varied from 6°C to 20°C. Animals which were skinned, totally dismembered, or suffered injury to the eyes or the eye sockets were not sampled.

Approximately 0.5ml of Aqueous Humor was removed from an eye with a needle and syringe. The clear, colorless fluid is placed in an evacuated tube containing Sodium Fluoride as a preservative. In the control study, samples were obtained at one, three, and six hours after death. Also at those intervals, an incision was made into the rump. A thermometer was inserted until contact was made with the Femur, before the temperature was obtained.

Aqueous Humor specimens were centrifuged and the clear supernatant removed. An occult blood test was performed as an aid to rule out physical damage to the eyes. 50ul of fluid, control and standards were added to one milliliter of 6% o-toluidine in appropriately labeled 13x75mm test tubes. The mixture was incubated at 100°C for ten minutes, cooled and read in a spectrophotometer at 630nm. All tests were performed in duplicate. Low optical density measurements prevented an accurate reading below 5mg%.

## STATISTICAL METHODS

The hours since death variable,  $Y$ , is estimated from measurements of glucose (variable  $x_1$ ) and body temperature (variable  $x_2$ ) by a standard linear regression model in these two variables. The data used to effect the estimation of the regression coefficients were the 26 observations in the control study previously defined. The fitted least squares regression equation for the mean time since death is  $Y = 17.1 - .0704x_1 - .333x_2$  and the estimated standard deviation about the regression is  $s = .7853$  on 23 degrees of freedom. The coefficient of determination is  $R^2 = .879$ .

The problem at hand is to use these data and computations to predict the value of the variable Y (hours since death) by utilizing measurements on  $X_1$  (glucose) and  $X_2$  (body temperature). Standard regression analysis theory (11) yields the 95% prediction intervals as given in tables one and two. For example, if a deer carcass has  $X_1 = 59$  (glucose level) and  $X_2 = 37.5$  (body temperature in  $^{\circ}\text{C}$ ) then from the table corresponding to  $X_2 = 37.5$ , we read opposite  $X_1 = 59$ , that the lower prediction limit (LPRED) = -1.53, the upper prediction limit (UPRED) = 2.17, and the estimated mean is .318. The interpretation is that deer carcasses with  $X_1 = 59$ ,  $X_2 = 37.5$  average about .318 hours since death but that the time of death is predicted to be between 0 and 2.17 hours. The confidence of this prediction is 95%.

A separate table was prepared for each  $0.5^{\circ}\text{C}$  increment. The range of temperatures for the computations runs from  $26.5^{\circ}\text{C}$  ( $80^{\circ}\text{F}$ ) to  $40^{\circ}\text{C}$  ( $104^{\circ}\text{F}$ ). The data presented in the table is the result of a mathematical computation which, in some instances, produces variable combinations that may be considered to be physiologically unacceptable. For example, one would not expect to see a body temperature of  $26.5^{\circ}\text{C}$  and an aqueous humor glucose of 60mg%.

#### DISCUSSION

This study confirms the work of Hamilton-Patterson and Johnson (7). Glucose will diminish in concentration with time until glycolysis is complete. They reported the process took 3.5 to 7 hours. Our results are similar.

Coe, (3) indicated the decline of postmortem vitreous glucose in humans was erratic and precipitous. In blacktailed deer, the decline is fairly linear and predictable (Table 3).

The 31 deer under 50 pounds examined in the field study were treated as a separate group. The muscle mass in the rump provided less insulation for the deep muscle temperature, which declined at a more rapid rate, consequently, utilization of the combined glucose and temperature creates an extended time bias when compared to the actual time reported by the hunter. The values for the first three hours are accurate, however, the 3 to 7 hour range is falsely extended. By utilizing only the glucose, and omitting the temperature entirely (Table 4 and 5), all 31 deer were within the prediction interval. It must be noted that the  $R^2 = .828$ . The upper and lower prediction intervals will be slightly larger when only utilizing glucose. Schoning and Strafus (9) stated that after 3 hours glucose values appeared to be unrelated to time or temperature in dogs. It is apparent here that the decline in glucose in deer is independent of temperature, within the limitation of this study, and remains relative to time for a longer period.

The body temperature decline is apparently related to muscle mass. The temperature decline of the adult deer in the control study fit within the time versus temperature parameters previously established by Carlson and Kistner (1).

Headshot deer in the field study were examined independently also. As indicated earlier, those deer which had actual damage to the eye socket and/or eyes were not sampled. Of the twenty-seven deer in this category, three deer were found to be outside the prediction interval, however, they had complimentary body temperature and glucose values. The time of death reported by the hunters in all three cases was excessively short and outside the frequency of times reported for other deer with similar values. Variability in glucose values due to hydrostatic shock from the bullet in these deer was not realized.

The sum of headshot deer (27), deer under 50 pounds (31), and the 50-150 pound deer (129) equals 187 deer. Ten (5.3%) were found to be outside the parameters of the prediction interval in the first eight hours. In all ten cases, the time reported by the hunter was less than that given by the prediction interval.

The following is an actual case:

Case 1. At 9:00AM, a hunter transported a 120 pound four-point buck to the McDonald Forest Check Station. The deer was field dressed and in excellent physical condition. The 3 1/2 year old buck was transported in the back of a pickup approximately 10 miles. The outside temperature was 13°C.

At the check station, the hunter reported the TOD as 7:15AM and the body temperature was 82°F. Subsequent eye fluid examination revealed the glucose to be 8mg%. The mean prediction interval was calculated to be 7.1 hours, however, the range is 5.1 to 9.1 hours. Legal shooting time was approximately 6:30AM. The probable TOD was 2:00AM, but could have been as late as 4:00AM.

Some shooting was reported in the management area during the night, but no one was apprehended.

The following case demonstrates an alternative applicability:

Case 2. A game officer stopped a hunter at 2:00AM. Spotlight activity and shooting had been reported in the area. The hunter was transporting a 120 pound buck deer in a van. The animal was field dressed and had not been skinned. The thirty minute sequential body temperatures are 100°F and 98°F. Subsequent glucose determination reveals aqueous humor glucoses of 37mg% and 32mg%.

The mean prediction interval was 1.71 hours, however the range was from 0 to 3.49 hours. The deer was probably killed at about 12:15AM, but could have been killed as early as 10:30PM. The drop in body temperature and glucose for the 30-minute interval is consistent with the control study.

#### ACKNOWLEDGMENTS

The authors wish to thank Superintendent Williams, Major Dingeman, and Lt. Vaughan of the Oregon State Police for their support in this project. We also wish to thank Ted Kistner, DVM, for his technical assistance.

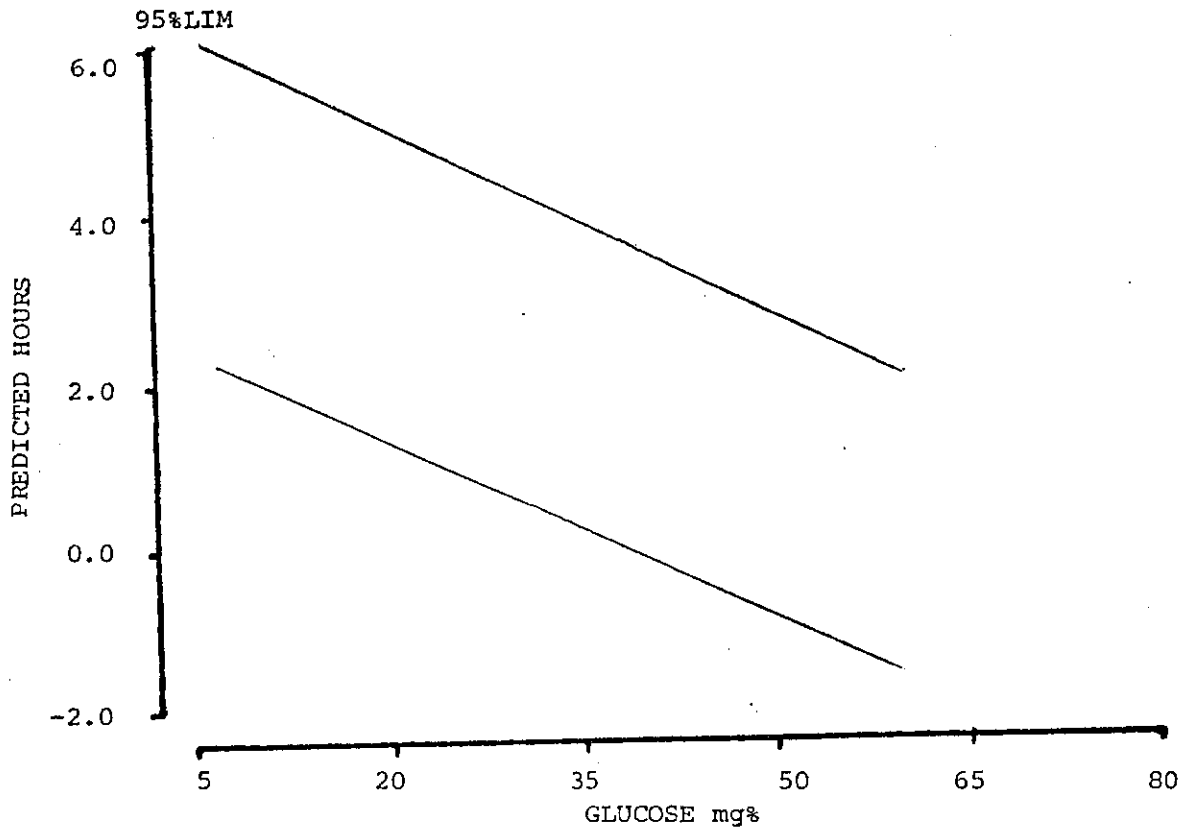
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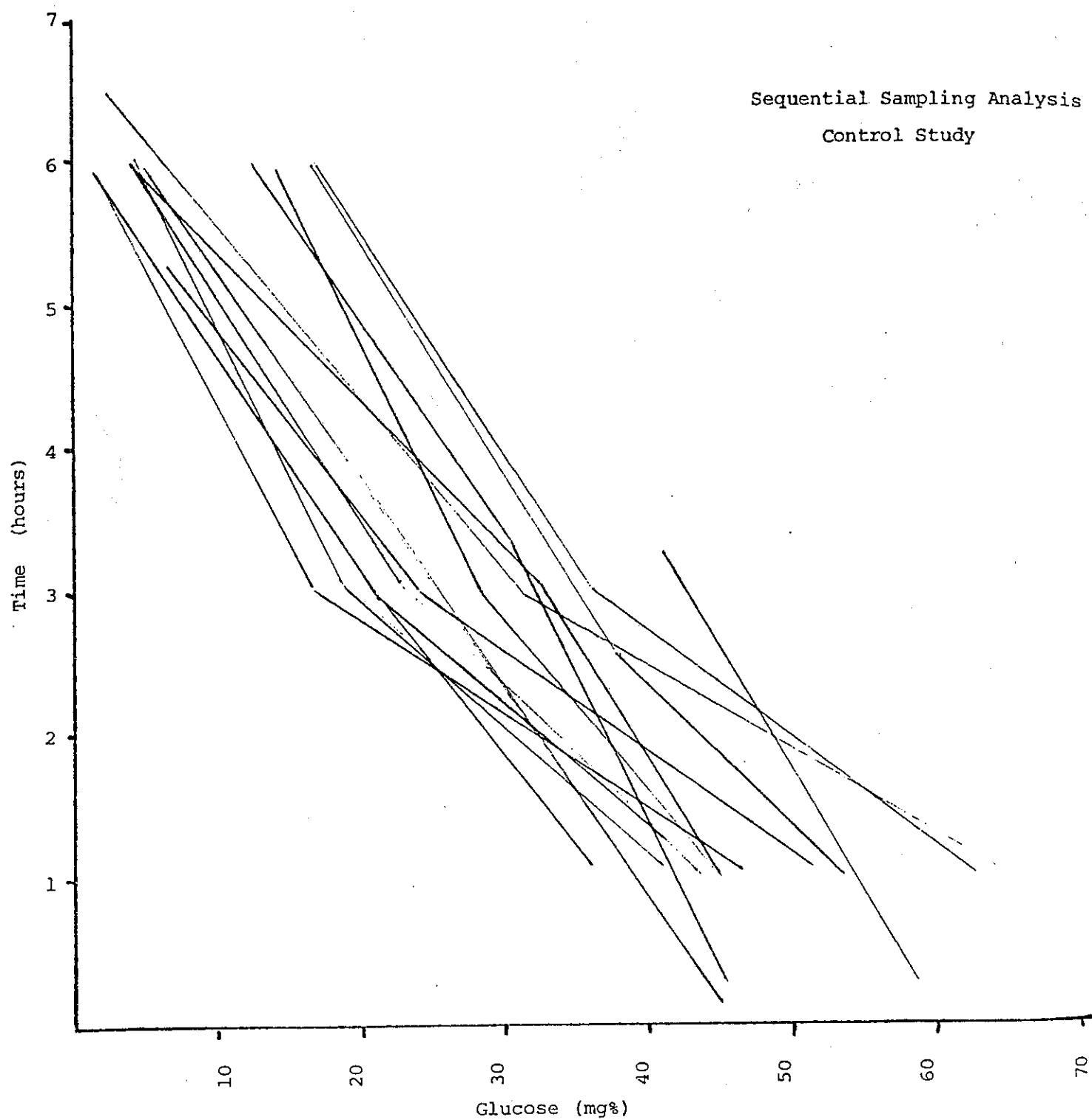
<u>GLUCOSE</u> <u>MG%</u>	<u>Y-PRED</u> <u>(MEAN)</u>	<u>LPRED</u> <u>(LOWER)</u>	<u>UPRED</u> <u>(UPPER)</u>
5	4.15700	2.18081	6.13319
6	4.08590	2.12265	6.04915
7	4.01480	2.06416	5.96544
8	3.94370	2.00535	5.88205
9	3.87260	1.94620	5.79900
10	3.80150	1.88672	5.71628
11	3.73040	1.82689	5.63391
12	3.65930	1.76670	5.55190
13	3.58820	1.70617	5.47023
14	3.51710	1.64526	5.38894
15	3.44600	1.58399	5.30801
16	3.37490	1.52234	5.22746
17	3.30380	1.46031	5.14729
18	3.23270	1.39790	5.06750
19	3.16160	1.33509	4.98811
20	3.09050	1.27189	4.90911
21	3.01940	1.20828	4.83052
22	2.94830	1.14426	4.75234
23	2.87720	1.07983	4.67457
24	2.80610	1.01498	4.59722
25	2.73500	0.94972	4.52028
26	2.66390	0.88402	4.44378
27	2.59280	0.81790	4.36770
28	2.52170	0.75134	4.29206
29	2.45060	0.68434	4.21686
30	2.37950	0.61691	4.14209
31	2.30840	0.54903	4.06777
32	2.23730	0.48071	3.99389
33	2.16620	0.41194	3.92046
34	2.09510	0.34273	3.84747
35	2.02400	0.27306	3.77494
36	1.95290	0.20294	3.70286
37	1.88180	0.13237	3.63123
38	1.81070	0.06134	3.56006
39	1.73960	-0.01014	3.48934
40	1.66850	-0.08207	3.41907
41	1.59740	-0.15445	3.34925
42	1.52630	-0.22728	3.27988
43	1.45520	-0.30056	3.21096
44	1.38410	-0.37429	3.14249
45	1.31300	-0.44847	3.07447
46	1.24190	-0.52308	3.00688
47	1.17080	-0.59814	2.93974
48	1.09970	-0.67364	2.87304
49	1.02860	-0.74957	2.80677
50	0.95750	-0.82594	2.74094
51	0.88640	-0.90272	2.67552
52	0.81530	-0.97994	2.61054
53	0.74420	-1.05757	2.54597
54	0.67310	-1.13562	2.48182
55	0.60200	-1.21407	2.41807
56	0.53090	-1.29293	2.35473
57	0.45980	-1.37219	2.29179
58	0.38870	-1.45185	2.22925
59	0.31760	-1.53189	2.16709
60	0.24650	-1.61232	2.10532



TABLE 2



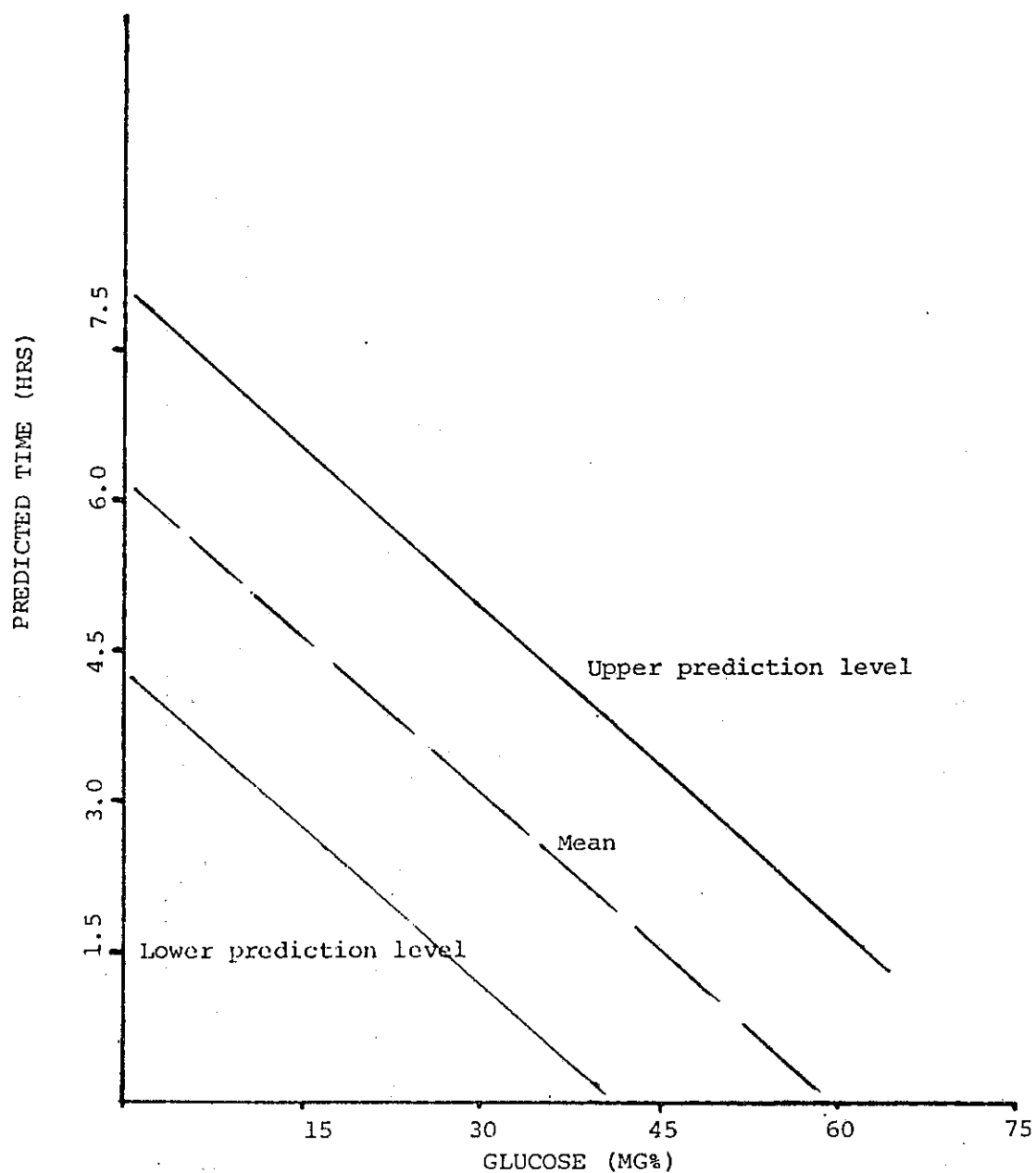
The above is a graphical illustration of the upper and lower prediction limits for Table 1.



PREDICTION INTERVAL FOR GLUCOSE ONLY

<u>GLUCOSE</u> <u>MG%</u>	<u>Y-PRED</u> <u>(MEAN)</u>	<u>L-PRED</u> <u>(LOWER)</u>	<u>U-PRED</u> <u>(UPPER)</u>
5	5.59500	3.63082	7.55918
6	5.49400	3.53514	7.45286
7	5.39300	3.43928	7.34672
8	5.29200	3.34324	7.24076
9	5.19100	3.24702	7.13498
10	5.09000	3.15062	7.02938
11	4.98900	3.05404	6.92396
12	4.88800	2.95727	6.81873
13	4.78700	2.86031	6.71369
14	4.68600	2.76317	6.60883
15	4.58500	2.66583	6.50417
16	4.48400	2.56831	6.39969
17	4.38300	2.47060	6.29540
18	4.28200	2.37269	6.19131
19	4.18100	2.27459	6.08741
20	4.08000	2.17630	5.98370
21	3.97900	2.07782	5.88018
22	3.87800	1.97913	5.77687
23	3.77700	1.88026	5.67374
24	3.67600	1.78118	5.57082
25	3.57500	1.68191	5.46809
26	3.47400	1.58244	5.36556
27	3.37300	1.48278	5.26322
28	3.27200	1.38291	5.16109
29	3.17100	1.28284	5.05916
30	3.07000	1.18258	4.95742
31	2.96900	1.08212	4.85588
32	2.86800	0.98145	4.75455
33	2.76700	0.88059	4.65341
34	2.66600	0.77953	4.55247
35	2.56500	0.67826	4.45174
36	2.46400	0.57680	4.35120
37	2.36300	0.47514	4.25086
38	2.26200	0.37328	4.15072
39	2.16100	0.27121	4.05079
40	2.06000	0.16896	3.95104
41	1.95900	0.06650	3.85150
42	1.85800	-0.03616	3.75216
43	1.75700	-0.13901	3.65301
44	1.65600	-0.24206	3.55406
45	1.55500	-0.34531	3.45531
46	1.45400	-0.44875	3.35675
47	1.35300	-0.55239	3.25839
48	1.25200	-0.65622	3.16022
49	1.15100	-0.76024	3.06224
50	1.05000	-0.86446	2.96446
51	0.94900	-0.96887	2.86687
52	0.84800	-1.07347	2.76947
53	0.74700	-1.17825	2.67225
54	0.64600	-1.28323	2.57523
55	0.54500	-1.38839	2.47839
56	0.44400	-1.49374	2.38174
57	0.34300	-1.59927	2.28527
58	0.24200	-1.70498	2.18898
59	0.14100	-1.81088	2.09288
60	0.04000	-1.9165	1.99696

TABLE 5



The above is a graphical illustration of the upper and lower prediction limits for the aqueous glucose in Table 4.

PHENOTYPING PHOSPHOGLUCOSE ISOMERASE  
IN WEST COAST CERVIDS FOR  
SPECIES IDENTIFICATION AND INDIVIDUALIZATION

James O. Pex, M.S.  
Criminalist, Oregon State Police

James R. Wolfe, M.S.  
Criminalist, Alaska Department of Public Safety

INTRODUCTION

The individualization of deer blood or meat is of primary importance to the criminalist attempting to determine if a game violation involves more than one deer, or trying to compare a bloodstain or portion of meat to a given deer kill.

Previous serologic techniques for the identification of Cervid tissues have centered about using immunochemical methods for identification of the family level and then applying electrophoresis to identify the species (1, 2). Individualization within a big game species is not a common forensic technique (3).

A survey of the literature revealed limited information on enzyme polymorphisms on blacktail and mule deer. Enzyme screening of other cervids have found variation present at low levels, with the greatest average heterozygosity present in whitetail deer (4).

The methods employed in these previous studies were starch gel electrophoresis, which requires an overnight run (5) and is sometimes difficult to interpret because of background staining. The use of cellulose acetate as a support medium for electrophoresis of human bloodstains has been well documented (6). This medium allows for a small sample size and permanent preservation of the stained results. The PGI isozymes of up to 20 samples can be separated in 30-40 minutes using this technique.

This study describes the polymorphism of glucose 6-phosphate isomerase (PGI:EC 5.3.1.9) in Columbia blacktail deer (Odocoileus hemionus columbianus) and mule deer (Odocoileus hemionus hemionus), and the relative mobilities of PGI from Sitka blacktail deer (Odocoileus hemionus sitkensis), whitetail deer (Odocoileus virginianus), Roosevelt elk (Cervus elaphus roosevelti), Rocky mountain elk (Cervus elaphus nelsoni), moose (Alces alces), reindeer (Rangifer tarandus) and barren ground caribou (Rangifer tarandus granti) as determined by cellulose acetate electrophoresis. Proteins from muscle, whole blood, serum and bloodstains on paper and cloth were examined.

## MATERIALS AND METHODS

Bloodstains from Columbia blacktail deer, mule deer, whitetail deer, and elk were randomly collected from carcasses by game officers of the Oregon State Police. Whole blood and muscle were also submitted to the laboratory when possible. These specimens were obtained incident to contact with successful hunters in the field or upon removal of road-killed animals. Meat, blood and serum samples from Sitka blacktail deer, moose, elk, reindeer and caribou were collected by Alaska Department of Fish and Game biologists from chemically immobilized animals or by Alaska Division of Fish and Wildlife Protection Officers contacting hunters in the field. Bovine blood samples were collected from local slaughter houses. Samples from both sexes were collected. All specimens were frozen at -20C. The specimen age varied from one week to one year.

Meat samples were homogenized in the membrane buffer or water, for a final dilution of 1:50. The bloodstains were also dissolved in the membrane buffer or water. The dilution was dependent on the size and concentration of the stain, 1:1 to 1:3 being the average. Those meat and blood extracts were centrifuged (12,000 x g) for three minutes before electrophoresis. The use of sulfhydryl reagents does not alter isoenzyme patterns or improve the results on old stains.

Samples were electrophoresed on either Beckman Microzone or Sartorius Sartophor equipment using Sartorius 12200BB 70/145 membranes. The buffers and reaction mixtures were those described by Grunbaum (6) and Wolfe (7): A tris (Hydroxymethyl) amino methane-borate stock tank buffer (109.03g tris, 30.92g boric acid and 7.44g EDTA were dissolved to one liter distilled H<sub>2</sub>O) was adjusted to pH 8.7. A 1:20 dilution in distilled water was used for the membrane buffer. A 1:7 dilution of stock was used for the working tank buffer. Specimens were usually electrophoresed at 400 volts for 40 minutes. Double row 20 sample applications were run at 300v for 30 minutes. The minimum sample size was 0.5 ul. The reaction mixture consisted of 13 mg fructose-6 phosphate, 3 mg NADP, 12.5 units glucose-6 phosphate dehydrogenase, 3 mg MTT, 3 mg PMS in 5 ml 0.06m tris, pH 8.0 buffer. This was added to 0.25g Noble agar liquified in 10 ml buffer.

## RESULTS AND DISCUSSIONS

PGI exhibits a definite polymorphism in only two of the eight cervid species/subspecies examined (Table 1). This polymorphism in Columbia blacktail and mule deer appears to be a biallelic polymorphism at the PGI-1 locus, with three phenotypes present in both subspecies (Fig. 1). Both homozygous phenotypes appear as a three banded pattern, with the most cathodal band of each phenotype being the most intense. The heterozygous phenotype appears as a six banded pattern with the intermediate bands being the most intense. Such an isozyme pattern would be expected from a dimeric enzyme coded for by two loci, one fixed for a single allele and one polymorphic with two alleles. A similar pattern

was found in Scandinavian moose by Ryman et al. (8), in which those moose exhibited variation at the anodal locus PGI-2; however, no moose homozygous for the rare allele were reported in Ryman's study.

Multiple secondary anodal banding was observed in many samples in the present study, however, it did not appear to have a genetic basis. Over 80% of the reindeer in our study exhibited additional anodal bands, and no pattern consistent with an anodal rare allele homozygote was found. Multiple secondary anodal banding in a deer PGI type 1-1 could be confused with a type 2-1 if the criteria that the inner bands must be the most intense were not applied. Although the moose, caribou, reindeer, whitetail deer, elk, and Sitka blacktail deer samples examined in this study were monomorphic, the relative mobilities of PGI can still be of use for species identification (Fig. 1 & Fig. 2). Elk and beef can be readily differentiated from the rest of the cervids, and Sitka blacktail deer (monomorphic for PGI type 2-2) can be distinguished from Alaska moose and caribou. These relative mobilities are identical to what Baccus et al (9) reported in their study, except they observed no variation in mule deer PGI. This discrepancy was probably due to their small sample size (N=2 for mule deer).

Our reporting of whitetail deer PGI as being monomorphic, although based on small sample size, is supported by the large number of whitetail deer examined by Baccus (N=753). Although no confirmatory family studies were performed to prove the PGI variation is actually genetic, the observed frequencies closely match the Hardy-Weinberg expectations ( $P > .90$ ). The banding patterns are also similar to what Vanderberg and Stone (10) observed in Rhesus monkeys, in which the three phenotypes were determined by two autosomal codominant loci PGI-1 and PGI-2.

It is interesting that the most common PGI phenotype in Columbia blacktail deer is type 2-2 where the most common phenotype for mule deer is type 1-1 (Table 2). Since both subspecies of deer can interbreed, it is fortunate that the rarer phenotypes of each subspecies were also found in areas of Oregon where the complimentary species is not found. In the high Cascade Mountain areas where blacktail and mule deer are known to interbreed, samples from bucks only were utilized. The subspecies was determined by the antler fork pattern.

Identification of the PGI patterns in game enforcement is useful for quickly differentiating between certain closely related members of the deer family for species identification. It also provides a useful "blood type" for mule deer and Columbia blacktail deer in situations involving multiple deer carcasses.

FIGURE LEDGENDS

FIG. 1 Cellulose acetate electrophoretogram of blood samples from moose, whitetail (WT) deer, Columbia blacktail (BT) deer, mule (M) deer, elk and beef (bovine) stained for PGI. Deer PGI phenotypes are listed along the right side. All deer samples were dried blood extracts. The 10 samples were applied at the arrow.

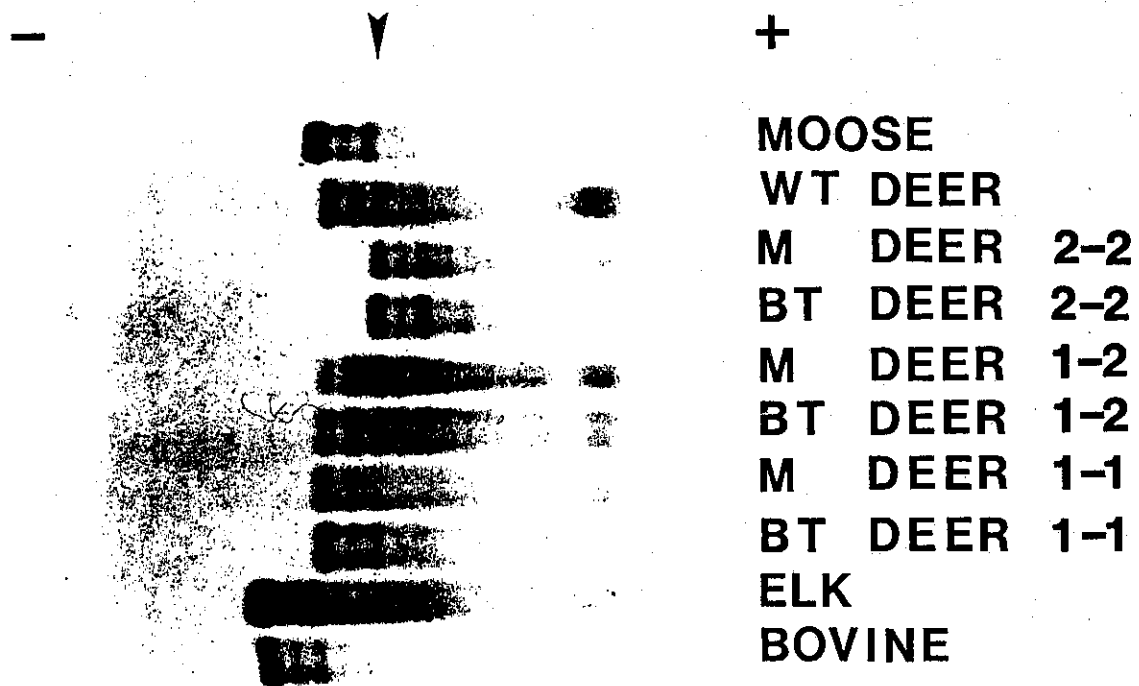




FIG. 2 Cellulose acetate electrophoretogram of meat samples from mule deer (M), caribou, moose, elk and blacktail (BT) deer. Some deer samples were frozen for up to three years.

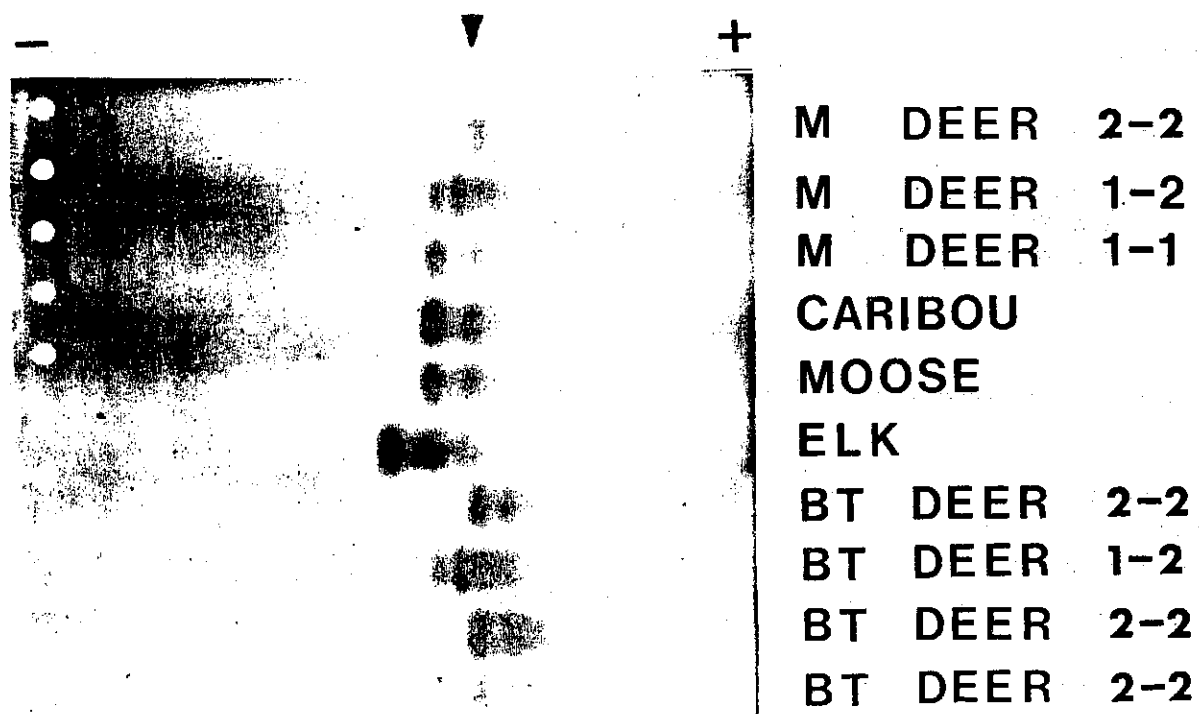


TABLE 1 - Listing of PGI Screening Results for 8 Members of the Cervidae.

SPECIES	LOCALE	NUMBER	ALLELE FREQ'S PGI-1
Mule Deer	Oregon	65	0.70, 0.30
Columbia Blacktail Deer	Oregon	111	0.18, 0.82
Sitka Blacktail Deer	Alaska	21	monomorphic
Whitetail Deer	Oregon	2	monomorphic
Elk	Oregon	45	monomorphic
Elk	Alaska	2	monomorphic
Moose	Alaska	100	monomorphic
Caribou	Alaska	75	monomorphic
Reindeer	Alaska	46	monomorphic

TABLE 2 - Phenotype and Gene Frequencies for PGI in Columbia Blacktail Deer and Mule Deer. Expected Frequencies Calculated Assuming Hardy-Wienberg Equilibrium.

Population Sample	<u>Phenotype</u>			<u>Total</u>	<u>Gene Frequency</u>	
	1	2-1	2		PGI <sup>1</sup>	PGI <sup>2</sup>
Blacktail Deer						
Number Observed	3	31	77	111		
Incidence Observed	0.027	0.279	0.693		0.178	0.822
Incidence Expected	0.032	0.292	0.676			
Mule Deer						
Number Observed	31	29	5	65		
Incidence Observed	0.477	0.446	0.077		0.700	0.300
Incidence Expected	0.490	0.420	0.090			

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The Ecology and Management  
of Interior Stocks of Cutthroat Trout

Edited by  
John S. Griffith  
Department of Biological Sciences, Idaho State University  
Pocatello, Idaho 83209

This is a collection of nine papers on the above subject. It is a Special Publication of the Western Division American Fisheries Society and is available at a price of \$10.00 from J. S. Griffith, Department of Biological Sciences, Idaho State University, Pocatello, Idaho 83209. Make checks payable to Western Division American Fisheries Society.

**WESTERN ASSOCIATION OF FISH AND WILDLIFE AGENCIES**  
**RESOLUTION**

Federal Ocean Sport Fishing License

WHEREAS, the federal administration proposes to establish a federal sport fishing license for ocean and tideland waters; and

WHEREAS, the management of fisheries in state waters has been vested in the state governments; and

WHEREAS, the majority of species supporting recreational fisheries off the west coast occur in state waters; and

WHEREAS, west coast states have been, and are actively managing these fishery resources; and

WHEREAS, the fisheries resources are best managed on a state basis because of widely varying habitats, species and fishing opportunities; and

WHEREAS, these state efforts are currently supported principally by revenues derived from sport fishing licenses issued by the individual states; and

WHEREAS, a federal sport fishing license would place another special user fee on sport anglers; and

WHEREAS, the federal sport fishing license proposed could not be expected to result in enhanced recreational fishing resources or improved fishing opportunities; and

WHEREAS, the burden of administering and enforcing sales of the federal sport fishing license through the collection of fees would fall principally on the individual states who may be unable to assume this burden on a cost-effective basis; and

WHEREAS, a federal sport fishing license could reduce the state's opportunity to increase fees when needed to maintain essential management programs;

NOW, THEREFORE, BE IT RESOLVED, that the Western Association of Fish and Wildlife Agencies opposes any proposed federal sport fishing license, and

BE IT FURTHER RESOLVED, that a copy of this resolution be sent to each member the Congressional Delegation from the western states, the President, the Secretary of the Department of Commerce, the Director of the National Marine Fisheries Service, and appropriate Congressional committees.

Adopted in Convention  
Portland, Oregon  
July 23, 1986

**WESTERN ASSOCIATION OF FISH AND WILDLIFE AGENCIES**  
**RESOLUTION**

Landowner/Sportsmen Relations Conference

WHEREAS, public access to private lands represents an issue of continuing importance, and

WHEREAS, landowner/sportsmen relations is one key element in maintaining access, and

WHEREAS, several states have developed programs to address both access and improved relationships between landowners and sportsmen,

THEREFORE, BE IT RESOLVED, the Western Association of Fish and Wildlife Agencies endorse plans for a national conference of state agency representatives to share ideas and programs to further such efforts.

Adopted in Convention  
Portland, Oregon  
July 23, 1986.

# WESTERN ASSOCIATION OF FISH AND WILDLIFE AGENCIES

## RESOLUTION

### Emergency Winter Feeding

WHEREAS, Public Law 87-152; 75 STAT. 389 authorizes the use of Commodity Credit Corporation owned surplus grain for emergency feeding of resident wildlife; and

WHEREAS, it is of critical importance during emergency winter feeding operations to feed animals as soon as possible; and,

WHEREAS, it is often most practical to resell the surplus grain and use it as a "credit" against pellets that are processed and ready for immediate feeding; and

WHEREAS, it is unclear whether or not resale of grain for use as a credit is specifically allowed by P.L. 87-152;

NOW, THEREFORE, BE IT RESOLVED, that the Western Association of Fish and Wildlife Agencies urges Congress to amend P.L. 87-152 to clearly allow the resale of surplus grain to be used as a credit against existing supplies of pellets; and

BE IT FURTHER RESOLVED, that copies of this resolution be transmitted to the President of the U.S. Senate and the Speaker of the U.S. House of Representatives for distribution to the appropriate committees of both bodies of the Congress of the United States.

Adopted in Convention  
Portland, Oregon  
July 23, 1986

# WESTERN ASSOCIATION OF FISH AND WILDLIFE AGENCIES

## RESOLUTION

### Computerized Fish and Wildlife Information Systems

WHEREAS, wildlife, fisheries, and water quality biologists as well as other resource managers or administrators have a broad spectrum of informational needs; and

WHEREAS, fish and wildlife enforcement officers also depend on similar information and cooperation between associate agencies in various states; and

WHEREAS, technology exists to develop a computerized fish and wildlife informational system within the western states; and

WHEREAS, only a small number of states have successfully established such systems on a national or regional scale; and

WHEREAS, such automated information systems would augment existing knowledge and communication within resource, scientific or management structure; and

WHEREAS, such automated systems would greatly assist administrative and field enforcement personnel in the identification, apprehension and prosecution of violators and in the analysis, evaluation and prevention of wildlife crimes; and

WHEREAS, unification and coordination of similar efforts would be in the best interest of fish and wildlife resources and the success of an automated program;

NOW, THEREFORE, BE IT RESOLVED that the Western Association of Fish and Wildlife Agencies encourages and supports the establishment of an integrated Multi-State Fish and Wildlife Information Project; and

BE IT FURTHER RESOLVED that the project should provide technical assistance, fundamental or practical research data, training information and coordination to states and agencies interested in developing and using computerized Fish and Wildlife Information Systems.

Adopted in Convention  
Portland, Oregon  
July 23, 1986



# **WESTERN ASSOCIATION OF FISH AND WILDLIFE AGENCIES**

## **RESOLUTION**

### **Economic Values of Fish and Wildlife Recreation**

WHEREAS, the travel cost and contingent value methods provide commensurate valuation of wildlife/fisheries and marketed commodities; and

WHEREAS, travel cost and contingent values have been published in the Federal Register (Principles and Standards, 1979; Principles and Guidelines, 1983; CERCLA 301, U.S. Dept. of Interior, 1985); and

WHEREAS, the travel cost and contingent value methods are used by the U.S. Army Corps of Engineers, the Bureau of Reclamation, U.S. Fish and Wildlife Service, Soil Conservation Service, National Marine Fisheries Service and the Environmental Protection Agency; and

WHEREAS, the U.S. Forest Service is not using these valuation procedures, which is resulting in conceptually and empirically unsound values of wildlife/fisheries in RPA and Forest Planning;

NOW, THEREFORE, BE IT RESOLVED, that the Western Association of Fish and Wildlife Agencies urges the U.S. Forest Service to use travel cost and contingent value derived values, without downward adjustment, and to implement valuation studies using these two methods for the 1990 Resources Planning Act Program.

Adopted in Convention  
Portland, Oregon  
July 23, 1986

# **WESTERN ASSOCIATION OF FISH AND WILDLIFE AGENCIES**

## **RESOLUTION**

### **Fish and Wildlife Economic Surveys**

WHEREAS, decisions on standards for valuation of fish and wildlife are made at the Washington, D.C. policy level; and

WHEREAS, comparability of wildlife/fisheries values across states is needed for adoption of state values in national resource policy analysis by Federal agencies;

NOW, THEREFORE, BE IT RESOLVED, that the Western Association of Fish and Wildlife Agencies urges states to consult with one another in designing wildlife/fisheries valuation surveys and attempt to collect as a minimum information on variables on the attached list when doing economic survey research.

Attachment

Adopted in Convention  
Portland, Oregon  
July 23, 1986

DATA REQUIREMENTS  
(Example for Fishing)

1. Sportsman's zip code of residence.
2. Primary Purpose of trip, e.g. fishing or not fishing.
3. Primary destination, e.g. what river.
4. Round trip miles.
5. Round trip travel time.
6. Number of fish caught.
7. Number of anglers in the party.
8. Number of days fished.
9. Hours fished.
10. Expenditures

	En route	Destination	At Home
--	----------	-------------	---------

- |                                    |  |  |  |
|------------------------------------|--|--|--|
| a. Transportation                  |  |  |  |
| b. Lodging                         |  |  |  |
| c. Food purchased in stores        |  |  |  |
| d. Supplies & misc. (tackle, ice ) |  |  |  |
| e. Food bought in rest.            |  |  |  |
| f. Rental fees                     |  |  |  |
| g. Boat gas                        |  |  |  |
| h. Guide fees                      |  |  |  |
11. Income
  12. Years fished
  13. Education

# WESTERN ASSOCIATION OF FISH AND WILDLIFE AGENCIES

## RESOLUTION

In Support of "A Bill to Limit the Liability of Fishing Vessel Owners That Comply With Improved Safety Requirements"

WHEREAS, the Nation's fishing industry is experiencing serious problems in obtaining reasonable rates for Protection and Indemnity (P&I) and hull insurance for fishing vessels; and

WHEREAS, fishing is a dangerous occupation, as evidenced by United States Coast Guard data showing that the death rate for fishermen is seven times the national average for all industry groups and that during 1981-1984 an average of 84 lives were lost each year; and

WHEREAS, the cost of obtaining adequate P&I and hull insurance is reaching new heights, whereby fishing vessel owners have to pay large premiums for P&I and hull insurance to operate, or the vessel remains tied up in port or risks operating without insurance largely because of their inability to pay for the P&I insurance; and

WHEREAS, the Honorable Walter B. Jones, Chairman of the Committee on Merchant Marine and Fisheries in the U.S. House of Representatives, has introduced H.R. 4007 with the title of this resolution that includes the following reforms:

- (1) A fishing vessel meeting certain safety standards and providing adequate compensation for an injured seaman would be given a limit to the owner's liability for temporary disabilities (those of less than one year's duration);
- (2) The U.S. Coast Guard would be authorized to compile risk assessments to help insurers differentiate between and set premium rates for the various segments of the industry;
- (3) The Magnuson Fishery Conservation and Management Act (P.L. 94-265), which established the United States' 200-mile Fisheries Conservation Zone (FCZ), would be amended with safety as one of the required national standards that must be considered when developing and implementing a fishery management plan for fishing in the FCZ;
- (4) In order to reduce the risks in what is an inherently dangerous occupation, the U.S. Coast Guard would be authorized to set minimum safety standards on newly-constructed vessels (those with keels laid after January 1, 1987) and for existing vessels if the owner so desires; and

WHEREAS, the Western Association of Fish and Wildlife Agencies, representing both commercial and recreational fishermen, is concerned about the problems caused by such high premium rates for insurance and supports the effort of the National Council of Fishing Vessel Safety and Insurance, and the U.S. National Marine Fisheries Service;

NOW, THEREFORE, BE IT RESOLVED that the Western Association of Fish and Wildlife Agencies urges the Congress of the United States to support the efforts of Congressman Walter B. Jones to obtain relief for these pressing problems through enactment of H.R. 4407 or other appropriate national legislation; and

BE IT FURTHER RESOLVED that this resolution be transmitted to the Honorable Walter B. Jones of the U.S. House of Representatives, and to the President of the Senate and Speaker of the House of Representatives for distribution to the appropriate committees of both bodies of Congress of the United States; and

BE IT FURTHER RESOLVED that the Western Association of Fish and Wildlife Agencies urges the International Association of Fish and Wildlife Agencies to adopt this Resolution.

Adopted in Convention  
Portland, Oregon  
July 23, 1986

Abernethy, Scott (Wash.)  
 Adams, Bud (Ore)  
 Albright, Rick (Wash)  
 Almand, Dave (Wash DC)  
 Allen, Gene (Mont)  
 Anderson, John (Ore)  
 Anderson, Kathy (Ore)  
 Anderson, Randy (Wash)  
 Anderson, Rick (Colo)  
 Andrews, Stephen (Ore)  
 Aney, Warren (Ore)  
 Armantrout, Neil (Ore)  
 Baker, Fred (Ariz)  
 Baldes, Richard (Ore)  
 Barci, Dennis (Washj)  
 Barnes, Jerry (Calif)  
 Barnhart, Roger (Calif)  
 Barth, Don (Ore)  
 Bartschi, Don (Mont)  
 Barrett, Dan (Ore)  
 Barrows, Pete (Ore)  
 Bauer, Jerry (Ore)  
 Beamesderfer, Ray (Ore)  
 Beck, John (Ore)  
 Becker, Dale (Wash)  
 Becker, Robert (Ore)  
 Beiningen, Kirk (Ore)  
 Berryman, Jack (Wash DC)  
 Bickler, Mike (Ore)  
 Bisson, Peter (Wash)  
 Black, Hugh (Ore)  
 Blum, Joe (Ore)  
 Bond, Carl (Ore)  
 Bourne, Ken (Ore)  
 Bowers, Wayne (Ore)  
 Boyce, Ray (Ore)  
 Braun, Keith (Ore)  
 Bright, Larry (Ore)  
 Bristow, Bud (Ariz)  
 Brosnan, Dan (Ore)  
 Brouha, Paul (Virg)  
 Brown, Kay (Ore)  
 Brown, Kenneth (Wyom)  
 Brown, Scott (NM)  
 Buchanan, Dave (Ore)  
 Bunnell, Dwight (Ut)  
 Burck, Wayne (Ore)  
 Burns, David (Id)  
 Campbell, C. J. (Ore)  
 Capizzi, Jane (Ore)  
 Carey, Chris (Ore)

Carleson, Richard (Ore)  
 Carter, Chris (Ore)  
 Carufel, Louis (Ak)  
 Charles, Cheryl (Colo)  
 Chase, Don (Wash)  
 Christensen, Dale (Ore)  
 Christensen, Fred (Id)  
 Christianson, Chris (Ore)  
 Clady, Michael (Ore)  
 Clancy, Chris (Colo)  
 Claire, Errol (Ore)  
 Cleveland, Terry (Wyom)  
 Clinkscapes, Debra (Ore)  
 Coenen, Neal (Ore)  
 Conley, Jerry (Id)  
 Concannon, Greg (Ore)  
 Coffey, D. L. (Wyom)  
 Coffin, Patrick (Nev)  
 Cole, Richard (NM)  
 Coon, John (Ore)  
 Corsi, Chip (Id)  
 Corsi, Diane (Id)  
 Craven, Bruce (Ore)  
 Craven, Richard (Ore)  
 Crawford, Bruce (Wash)  
 Crawford, Terry (Nev)  
 Cribbs, Harold (Calif)  
 Crouse, Mike (Ore)  
 D'Aoust, Brian (Wash)  
 Dauble, Denni (Wash)  
 Daugherty, Mike (Ore)  
 Dean, Rober (Colo)  
 DeLFatti, Jerry (Ore)  
 Denney, Ralph (Ore)  
 Dimmick, Larry (Ore)  
 Doe, J. (Ore)  
 Dombeck, Michael (Calif)  
 Donaldson, Jack (Ore)  
 Downing, John (Mass)  
 Driscoll, Dee (Ore)  
 Duff, Don (Ut)  
 Durbin, Ken (Ore)  
 Dwyer, William P. (Mont)  
 Eastman, Danny (Ore)  
 Edwards, Curtis (Ore)  
 Eicher, George (Ore)  
 Elliott, John (Ore)  
 Elser, Al (Mont)  
 Ely, Craig (Ore)  
 Eng, Larry (Calif)  
 Evans, Dale (Ore)

Evans, Teela (Ore)  
 Evenhuis, Bernard (Wash)  
 Ewing, Dick (Ore)  
 Faast, Anthony (Ore)  
 Facciani, Steve (Wyom)  
 Fickeisen, Duane (Ore)  
 Fisher, Steve (Mont)  
 Ford, Tim (Calif)  
 Foster, Lynn (Ore)  
 Flynn, James (Mont)  
 Frank, Rebecca (Colo)  
 Frissell, Chri (Ore)  
 Fujishin, Lanny (Ore)  
 Fredd, Lou (Ore)  
 Garton, Ron (Ore)  
 Gerstung, Eric (Calif)  
 Gislason, Jeff (Ore)  
 Gladson, Jim (Ore)  
 Gleason, Ellen (Calif)  
 Geer, William (Utah)  
 Gilstrom, Jon (Wash)  
 Graham, Pat (Montana)  
 Greenley, Joe (Ore)  
 Gresswell, Bob (Wyo)  
 Griggs, Jim (Ore)  
 Gross, Mike (Wash)  
 Guth, Norman (Idaho)  
 Guthrie, Dan (Ore)  
 Haas, Jim (Ore)  
 Hagey, Dale (Ore)  
 Hahn, Peter (Wash)  
 Hall, James (Ore)  
 Hallauer, Fred (Ore)  
 Hamilton, Cliff (Ore)  
 Hansen, Richard (Idaho)  
 Hardin, Tim (Ore)  
 Harper, Joe (Ore)  
 Harju, Harry (Wyo)  
 Harriet, Jean (Wyo)  
 Hasselman, Ron (Ore)  
 Hastie, Bill (Ore)  
 Hatch, Keith (Ore)  
 Hatch, Michael (New Mexico)  
 Haugen, Gordon (Ore)  
 Hays, Steve (Wash)  
 Heineman, Gail (Alaska)  
 Heintz, Jim (Ore)  
 Helm, Bill (Utah)  
 Hemming, Nancy (Alaska)  
 Herb, Gene (Ore)  
 Hetzel, Glen (Idaho)  
 High, Will (Ore)  
 Hirose, Joanne (Ore)  
 Hogander, Geoff (Idaho)

Holubetz, Terry (Idaho)  
 Horner, Ned (Idaho)  
 Howse, John (Alaska)  
 Hubbell, Paul (Calif)  
 Huff, Clair (Utah)  
 Humphreys, Dick (Ore)  
 Hunt, Wayne (Ore)  
 Huntington, Charles (Ore)  
 Hvam, Judith (Ore)  
 Hyder, Roy (Ore)  
 Ingram, Paul (Ore)  
 Ingram, Rod (Ore)  
 Isakson, John (Wash)  
 Jauhola, Chris (Utah)  
 Jensen, Clair (Utah)  
 Jensen, Tom (Ore)  
 Jensen, Robert (Montana)  
 Jernberg, Pat (Ore)  
 Johnson, Jim (Ore)  
 Johnson, Kathy (Ore)  
 Johnson, Ray (Ore)  
 Jonasson, Brian (Ore)  
 Johnson, Orlay (Wash)  
 Jones, Carol (Colorado)  
 Karro, Terry (Wash)  
 Keeley, Patrick (Ore)  
 Kelly, Jack (New Mexico)  
 Kent, Eric (Montana)  
 Ketter, Holly (Ore)  
 Kidd, Del (Ariz)  
 Kiefer, Marc (Calif)  
 Klett, Ellis (New Mexico)  
 Klumph, Rick (Ore)  
 Knispel, Warren (Ore)  
 Knight, Denise (Utah)  
 Korn, Larry (Ore)  
 Krei, Mike (Wash)  
 Kruckenberg, Larry (Wyo)  
 Kruger, Rich (Ore)  
 Kubicek, Paul (Calif)  
 Kuhn, Bob (Ore)  
 Kunkle, Clair (Ore)  
 Kuntzelman, Don (New Mexico)  
 Labiske, Edward (Ore)  
 Landon, George (Ore)  
 Lantz, Dick (Ore)  
 Lane, Bob (Ore)  
 Larson, Richard (Wash)  
 Laurs, Michael (Calif)  
 Lawer, Melanie (Ore)  
 Lee, Keith (Nev)  
 Lentsch, Leo (Utah)  
 Leitch, Andy (Nev)  
 Lindsay, Bob (Ore)

Little, Jerry (Utah)  
 Long, Randy (Calif)  
 Lorz, Harry (Ore)  
 Maben, Bob (Ore)  
 MacHugh, Nancy (Ore)  
 Macleod, Jerry (Ore)  
 Majnarich, John (Ore)  
 Mamoyac, Steve (Ore)  
 Martin, Don (Idaho)  
 Martin, James (Ore)  
 Martinka, Robert (Montana)  
 Massey, Jay (Ore)  
 Mathers, John (Br. Col.)  
 Matthaei, William (Wash)  
 McGrath, Mary (Ore)  
 Mendel, Glen (Wash)  
 Millazzo, Sam (Nev)  
 Mills, Archie (Wash)  
 Molini, Willie (Nev)  
 Montagne, Rollie (Ore)  
 Monty, Montgomery (Ore)  
 Montgomery, Linn (Ariz)  
 Moon, Carol (Ore)  
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 Moore, Virgil (Idaho)  
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 Nelson, Dudley (Ore)  
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 Norrie, Ken (Idaho)  
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 Oakley, Art (Ore)  
 Oakland, Dan (Montana)  
 Olsen, Arnie (Montana)

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 Olson, Harold (New Mex)  
 Parker, Daren (Ore)  
 Parnell, Jack (Calif)  
 Parsons, Mit (Colorado)  
 Patterson, Robert (New Mex)  
 Persons, Bill (Ariz)  
 Pesek, Joe (Ore)  
 Petera, Pete (Wyo)  
 Peters, John (Colo)  
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 Pratt, Karen (Ore)  
 Prichard, Don (Colo)  
 Provan, Tim (Utah)  
 Purdy, Mary (Ore)  
 Quinn, Katherine (Utah)  
 Radonski, Gil (DC)  
 Randolph, Chris (Wash)  
 Raymond, Howard (Wash)  
 Reeher, Jim (Ore)  
 Reese, Art (Wyo)  
 Reger, Scott (Ariz)  
 Reid, Alice (Calif)  
 Reinecker, Tom (Idaho)  
 Reinhart, Johanna (Ontario)  
 Richardson, Norm (Wash)  
 Rieman, Bruce (Ore)  
 Rinne, John (Ariz)  
 Robart, Greg (Ore)  
 Ronne, Jerry (Ore)  
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 Ross, Mike (Ore)  
 Rousseau, Rollie (Ore)  
 Ruch, Jim (Colo)  
 Rutherford, Ken (Ore)  
 Saiki, Mike (Calif)  
 Sakuda, Henry (Hawaii)  
 Samura, Gail (Ore)  
 Schaeffer, Leslie (Ore)  
 Schamber, Tim (Ore)  
 Scherzinger, Dick (Ore)  
 Schmidt, Bruce (Utah)  
 Schneider, Phil (Ore)



Schroeder, Kirk (Ore)  
 Schuck, Mark (Wash)  
 Schultz, Tim (Colo)  
 Scott, Don (Wyo)  
 Shaffer, Jean (Nev)  
 Shaffer, Glenn (Nev)  
 Shake, Bill (Ore)  
 Shaw, Karen (Ore)  
 Shay, Ron (Ore)  
 Sheldon, Ray (Ore)  
 Siedelman, Don (Alaska)  
 Six, Larry (Ore)  
 Skoog, Ron (Michigan)  
 Smith, Hugh (Ore)  
 Smith, Jack (Wash)  
 Smith, Quentin (Ore)  
 Smith, Steve (New Mex)  
 Spear, Mike (New Mex)  
 Spinks, John (Colo)  
 Solazzi, Mario (Ore)  
 Soper, Curt (Calif)  
 Stanley, Chas (Ore)  
 Stainbrook, Chris (Ore)  
 Stapley, Homer (Utah)  
 Stedronsky, Wayne (Ore)  
 Stone, Mike (Wyo)  
 Stonebraker, Keith (Idaho)  
 Stringham, Paul (Utah)  
 Swartz, Don (Ore)  
 Sullivan, Carl (DC)  
 Taft, Edward (Mass)  
 Taylor, Doug (Ore)  
 Thiebes, John (Ore)  
 Thomas, Allan (Idaho)  
 Thomas, Jack (Ore)  
 Thompson, Fred (Wash)  
 Torvik, Sharon (Ore)  
 Thurow, Russ (Idaho)  
 Tol, Dennis (Nev)  
 Trainer, Chuck (Ore)  
 Trotter, Pat (Wash)  
 Turner, Bob (Colo)  
 Turner, Paul (New Mex)  
 Upham, Lee (Colo)  
 Unterwegner, Tim (Ore)  
 Vanicek, David (Colo)  
 Vogel, Tom (Ore)  
 Wagner, Harry (Ore)  
 Wallace, Peggy (Ore)  
 Wallenstrom, Rolf (Ore)  
 Walton, Jim (Wash)  
 Ward, Glen (Ore)  
 Warren, Del (Ore)  
 Wayland, Jack (Wash)

Weber, Walt (Ore)  
 Weland, Mike (Ore)  
 Wells, Jerry (Montana)  
 Westgate, John (Ore)  
 Wetherbee, Joe (Ore)  
 White, Bob (Montana)  
 Whitlach, Dick (Ore)  
 Williams, John (Ore)  
 Williams, Ron (Ore)  
 Willis, Chuck (Ore)  
 Willis, Sarah (Wash)  
 Wilson, Bill (Alaska)  
 Wolbert, Sharon (Ore)  
 Wolfe, Sandra (Calif)  
 Woodworth, John (Idaho)  
 Young, Frank (Ore)  
 Young, Jim (New Mex)  
 Zakel, Jeff (Ore)  
 Ziller, Jeff (Ore)  
 Zirges, Mac (Ore)