WF4313/6313-Fisheries Management

Module 1-Fisheries Management Overview & History

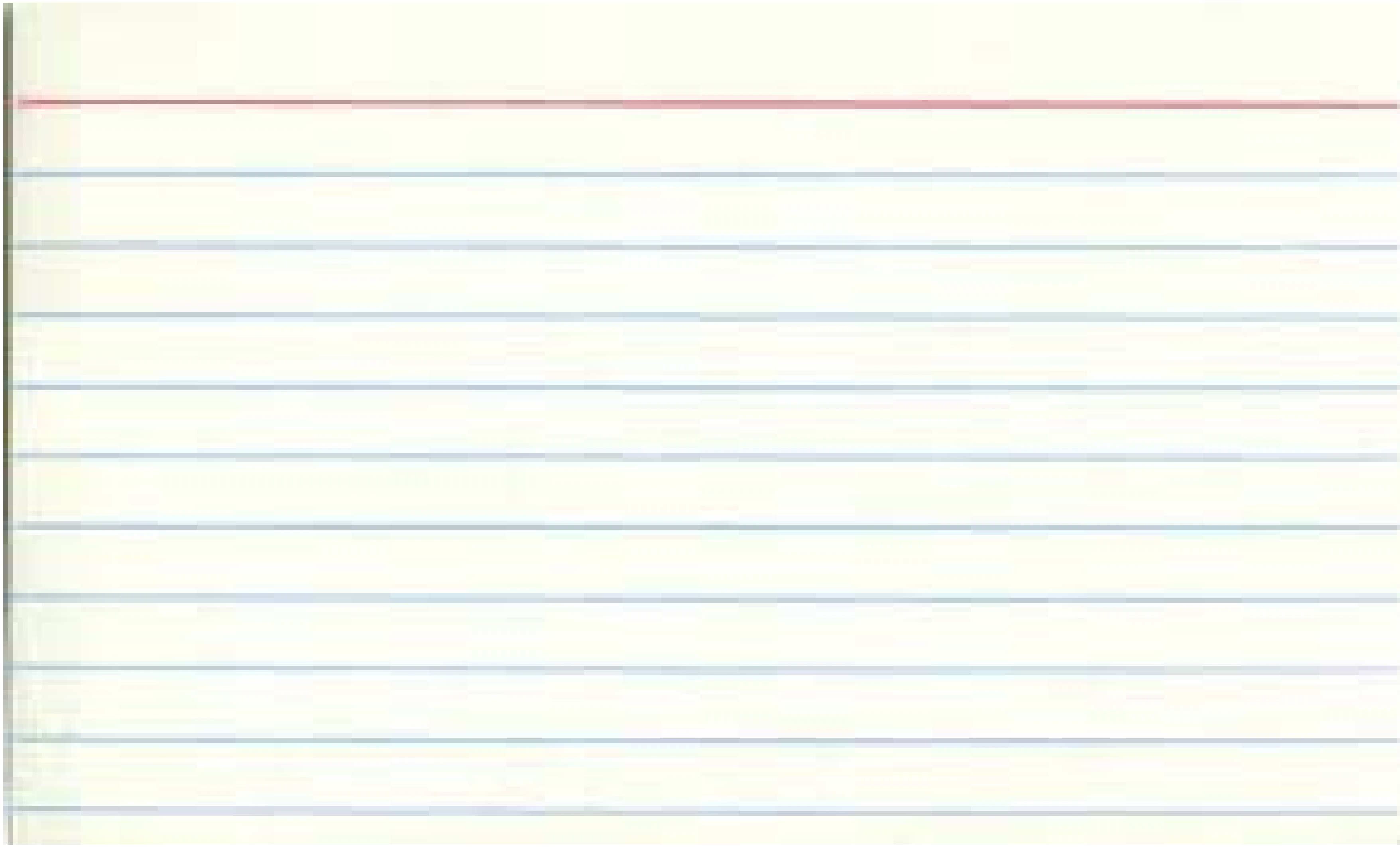
What is fisheries management?

What is Fisheries Management

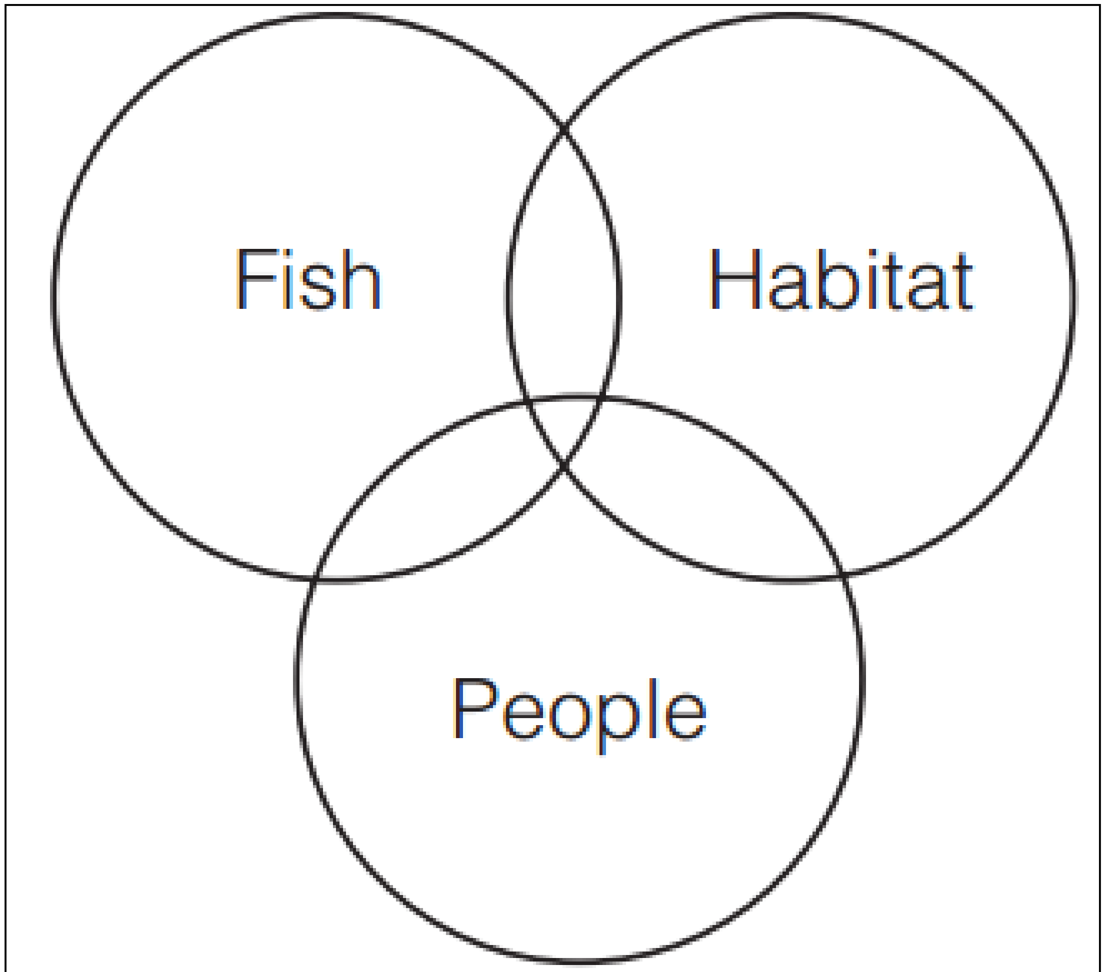
"The integrated process of information gathering, analysis, planning, consultation, decision-making, allocation of resources and formulation and implementation, with enforcement as necessary, of regulations or rules which govern fisheries activities in order to ensure the continued productivity of the resources and the accomplishment of other fisheries objectives."

http://www.fao.org/docrep/005/y3427e/y3427e03.htm

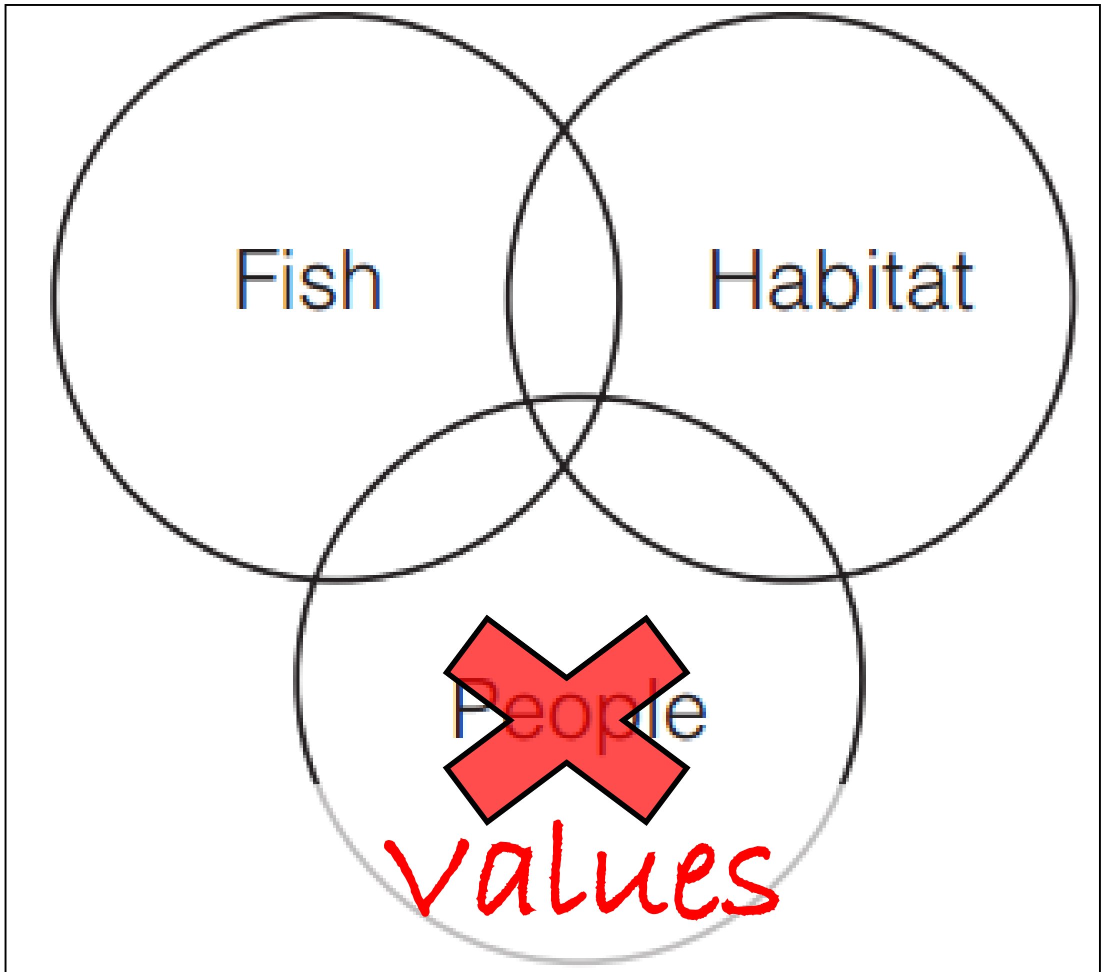
What is a Fishery?



The classic model



The classic model



Thinking *inside* the box

Fish	Value	Habitat

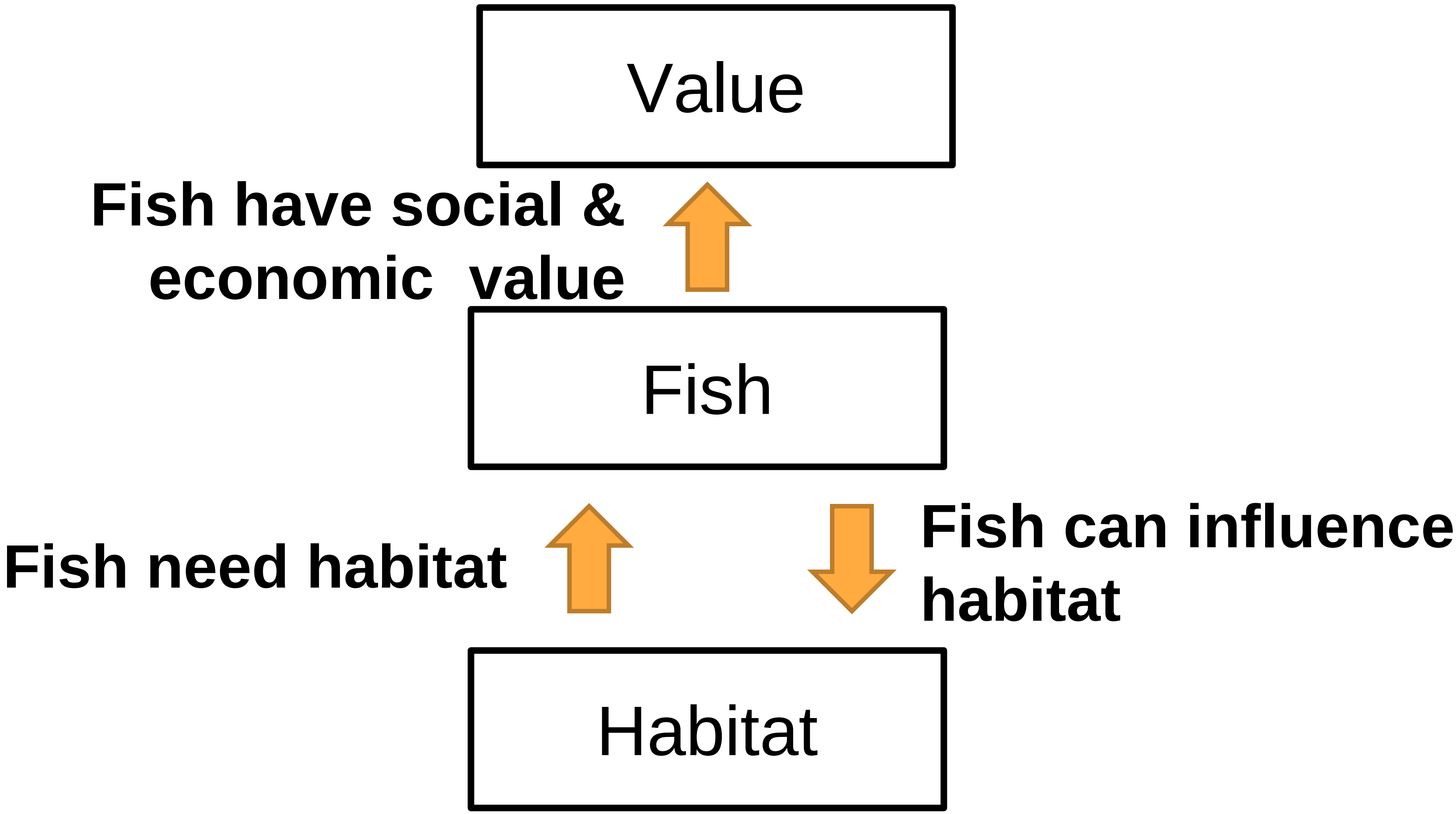
These are quantifiable

100 fish

100 tons of harvest

25 acres of habitat

The boxes are related



Fisheries values

The seafood industry—harvesters, seafood processors and dealers, seafood wholesalers and retailers—generated $129 billion in sales impacts, $37 billion in income impacts and supported 1.2 million jobs in 2011

http://www.st.nmfs.noaa.gov/economics/publications/feus/fisheries_economics_2011

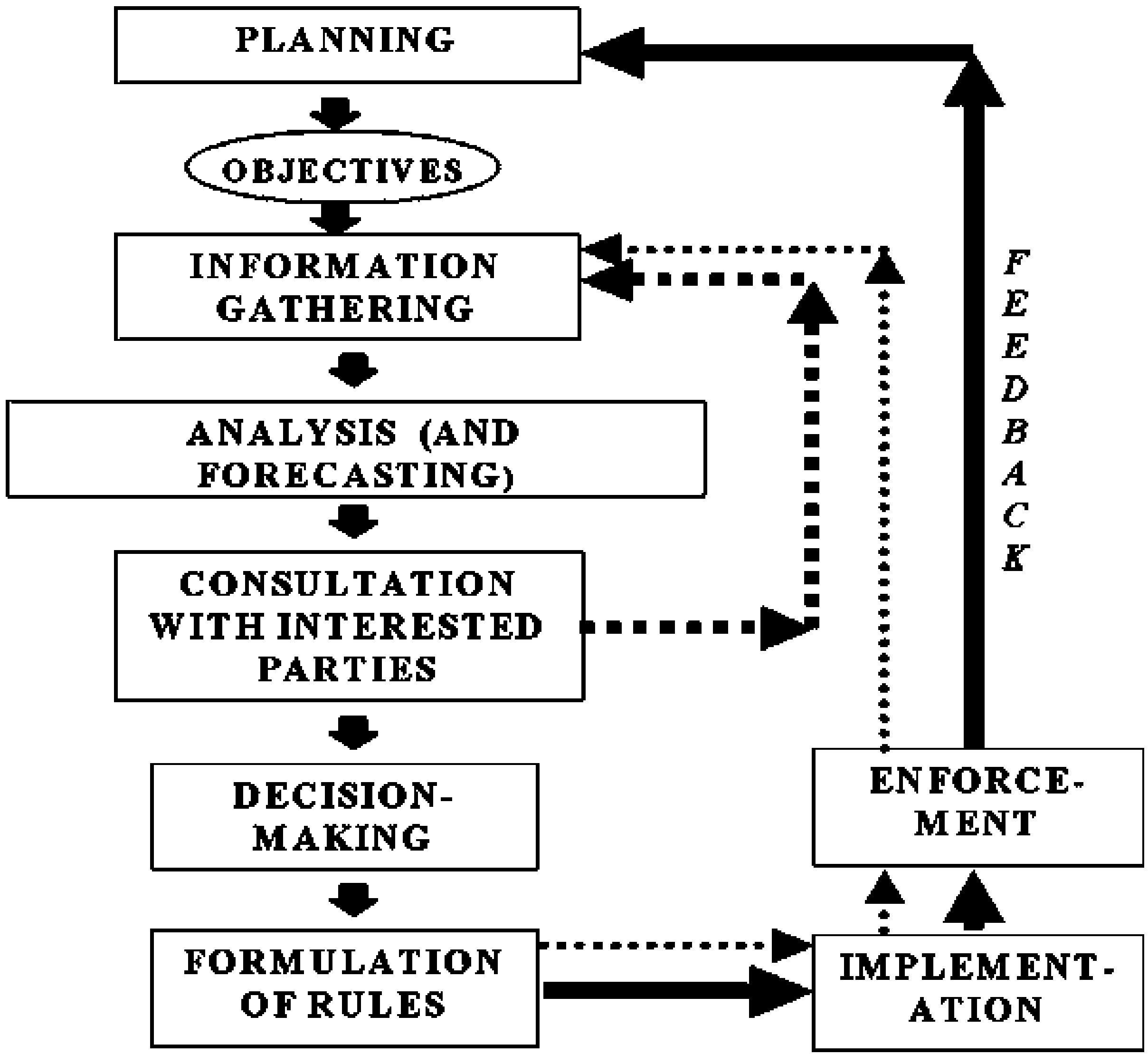
Fishery Benefits

- Commodity output — the weight or number of fish produced
  - animals harvested by capture (fishing for wild animals) or
  - culture (produced as captive animals)
- Commonly called the capture fisheries and the culture fisheries

Fisheries Management Goal

To produce sustainable biological, social, and economic benefits from renewable aquatic resources

Fisheries Management Conceptually

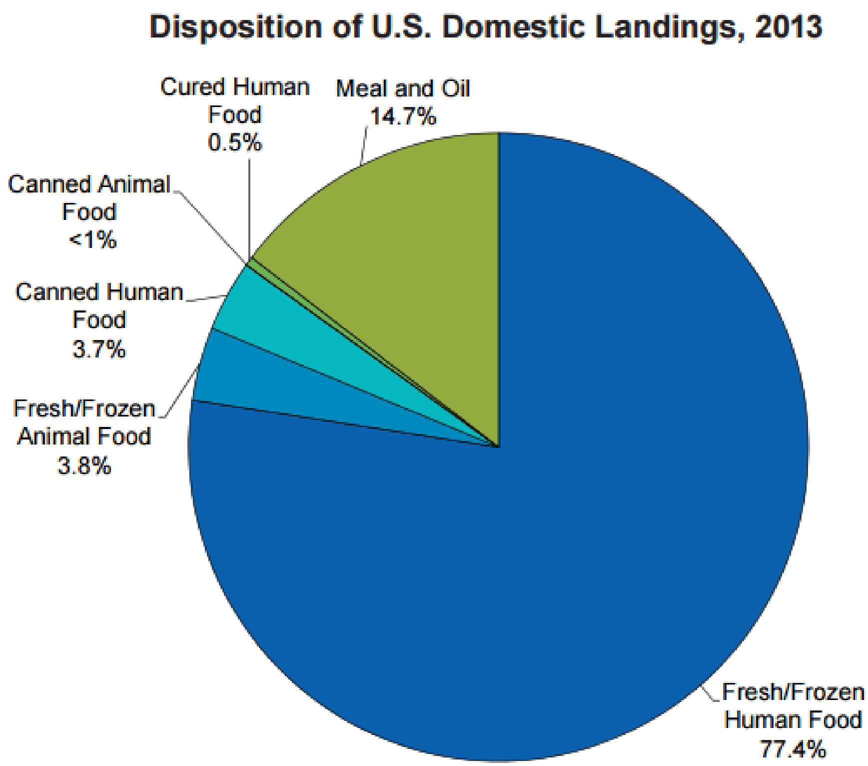


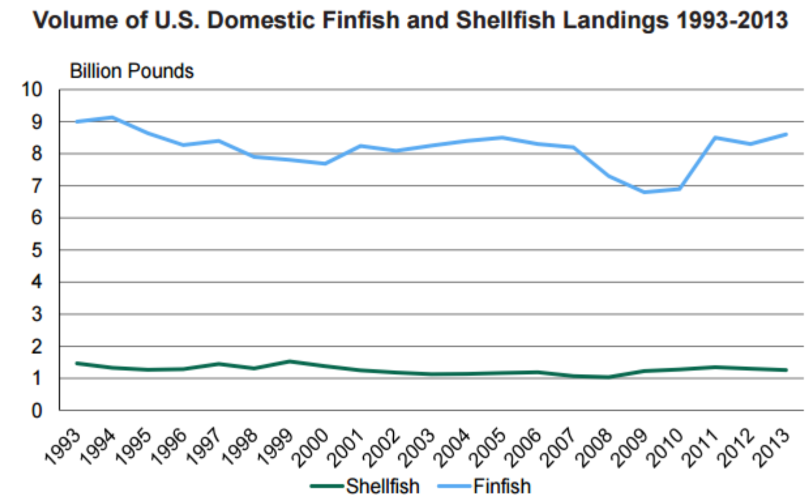
Why is fisheries management important?

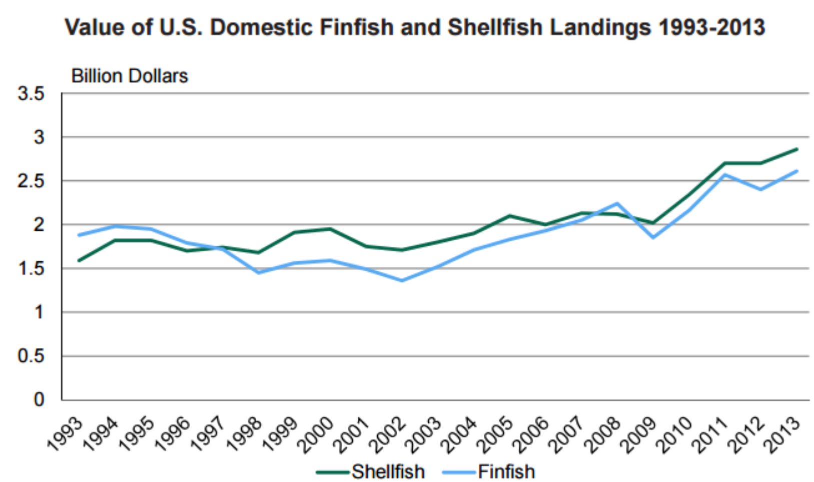
Why is all this important?

Why is all this important?

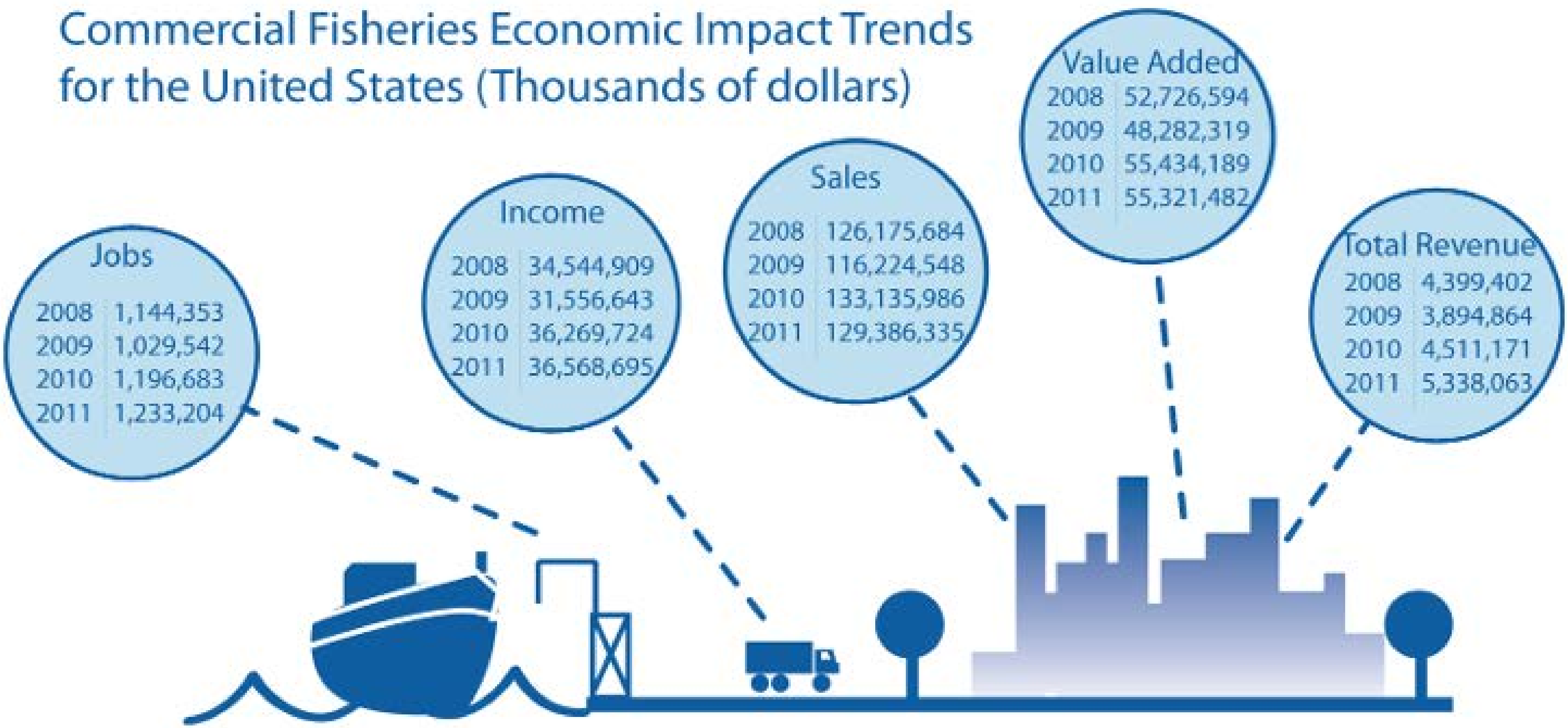
Economics





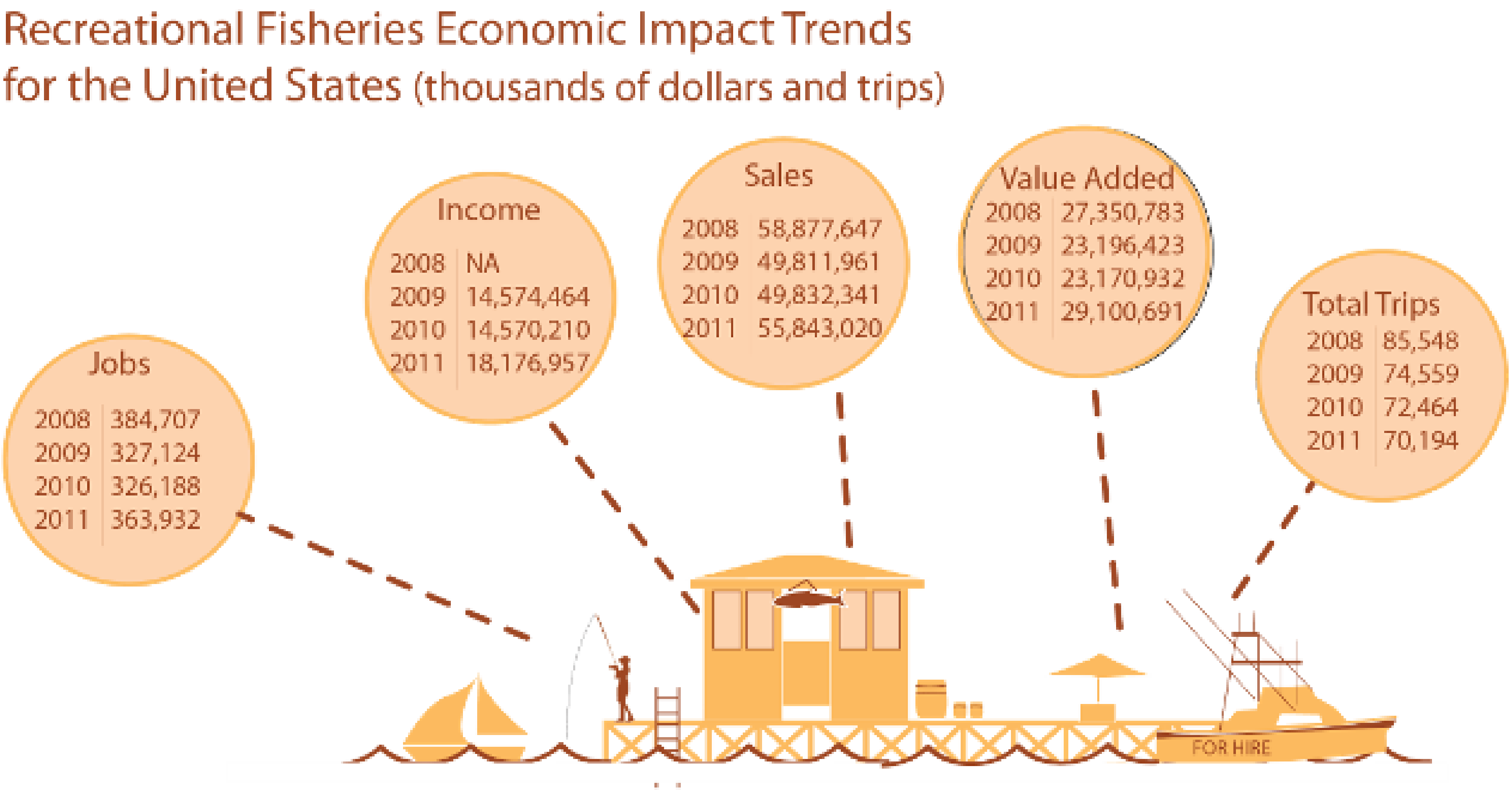


Why is all this important?



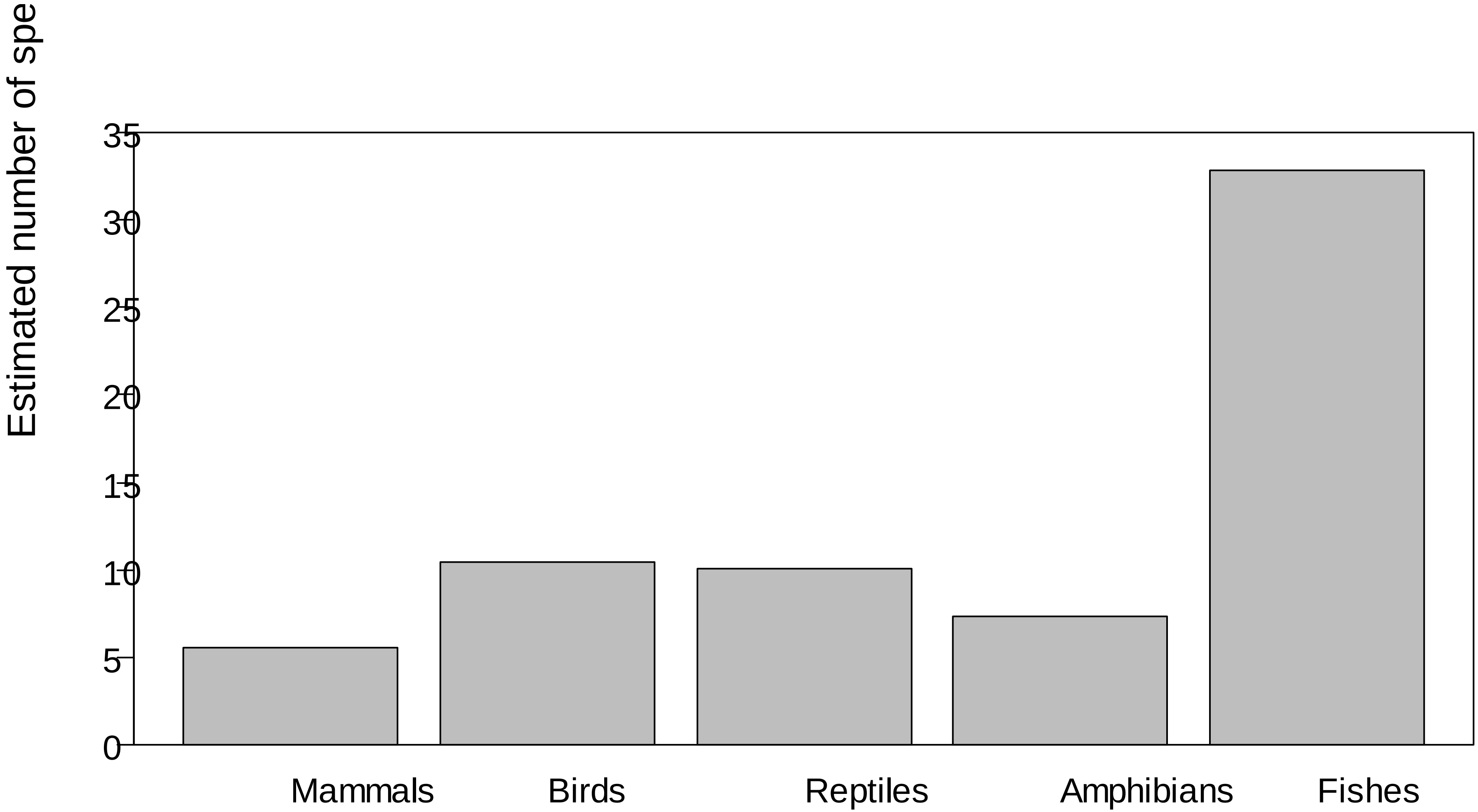
http://www.st.nmfs.noaa.gov/economics/publications/feus/fisheries_economics_2011

Why is all this important?



http://www.st.nmfs.noaa.gov/economics/publications/feus/fisheries_economics_2011

There are lots of fish…



And there are new fish being found…

- Terapontidae (grunters)
  16 new
  Eleotridae (
  3 new
  Atherinidae (hardy heads)
  1 new

ScienceDaily®

Your source for the latest research news

Twenty new freshwater fish species uncovered in Australia

Remote, iconic Kimberley unveiled as biodiversity hub

Date: January 6, 2016

Source: University of Melbourne

Summary: Researchers have discovered a record 20 new fish species while conducting fieldwork in the remote Kimberley, unveiling it as Australia's most biodiverse region for freshwater fish.

FULL STORY

Researchers have discovered 20 new species of freshwater fish during field work in the remote Kimberley region of Western Australia.

Credit: The University of Melbourne

It is the single greatest addition to the country's freshwater fish inventory since records began and boosts the total number of known species in Australia by almost ten per cent.

The research team included Associate Professor Tim Dempster, Professor Stephen Swearer, James Shelley, Matthew Le Feuvre (University of Melbourne), Dr Martin Gomon (Museum Victoria) and Dr Michael Hammer (NT Museum).

Team leader Dr Tim Dempster, from the University of Melbourne's School of BioSciences, says the discovery highlights the hidden wealth of biodiversity within the Kimberley.

"The freshwater ecosystems of the Kimberley are among the poorest known and least researched areas of Australia," Dr Dempster said.

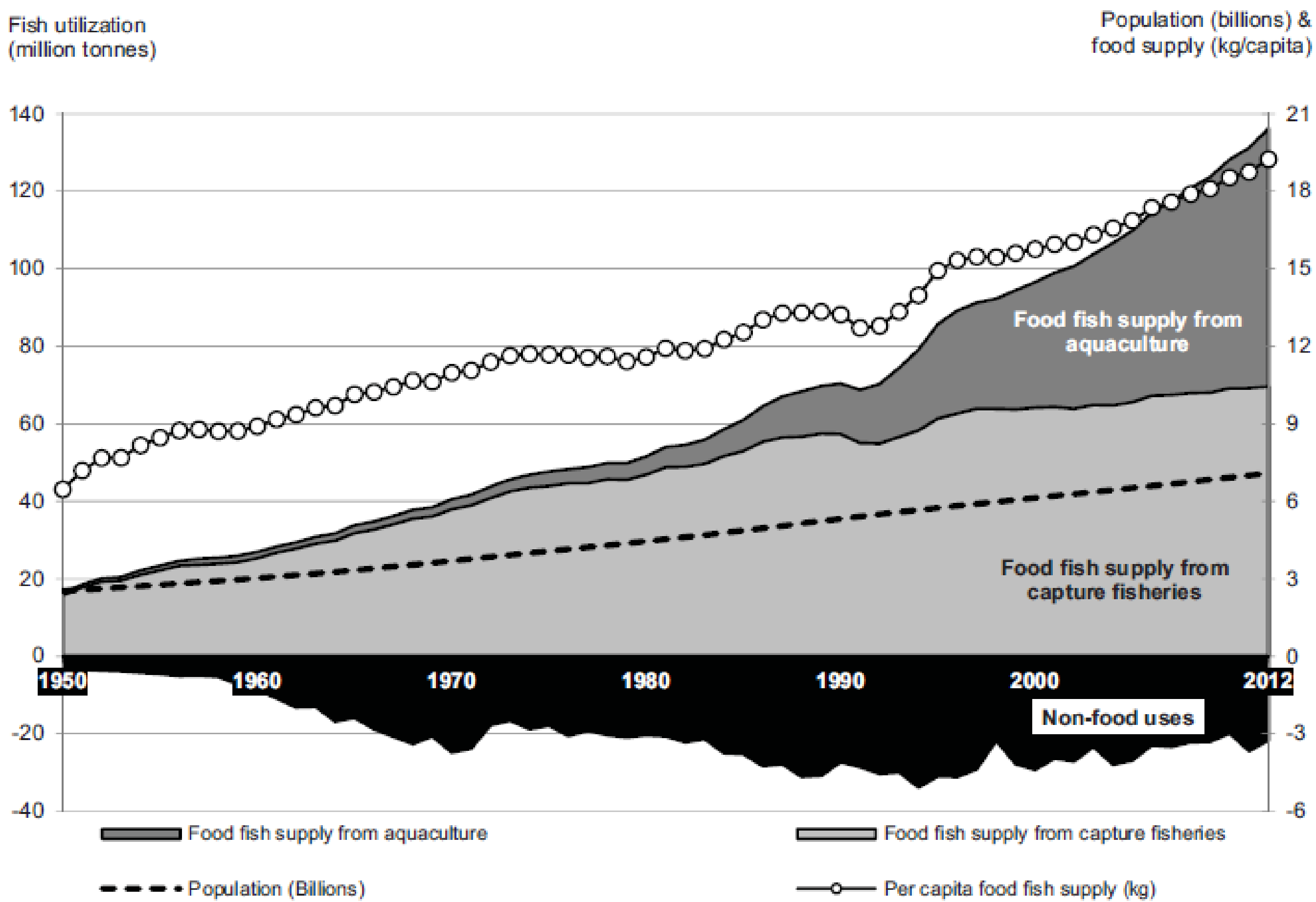
"If we can double the number of known fish species unique to the Kimberley in just three years, it can only mean the entire biodiversity of life in Kimberley rivers is underestimated.

"Certainly, it is a treasure trove for freshwater fish -- and the amazing thing is that we weren't even looking for it."

There are lots of fisheries associated with those fish

Figure 1

World fish utilization and supply/Utilisation et disponibilités mondiales de poisson/ Utilización y suministro mundiales de pescado



Fish are worth money…

Tsukiji market in Tokyo-*Sprawling wholesale fish market with an array of seafood & viewing areas for a popular tuna auction.*

Fish are worth money…

Kiyoshi Kimura, president of restaurant chain Sushi-Zanmai, poses with a 200-kilogram bluefin tuna he bought for $117,000 in Tokyo on Tuesday.—Reuters (*5 January 2016*)

Fish are worth money…

Bluefin tuna sells for £500,000 at Japan auction amid overfishing concerns

Huge fish sells for 74m yen as conservationists call for moratorium to help stabilise plunging Pacific stocks

Bluefin tuna auctioned for £517,000 at Tokyo market

A bluefin tuna has fetched 74.2m yen (£517,000) at the first auction of the year at Tsukiji market in Tokyo, amid warnings that decades of overfishing by Japan and other countries is taking the species to the brink of extinction.

74200000 Japanese Yen equals

636964.7060 US Dollar

74200000	Japanese Yen
636964.7060	US Dollar

Disclaimer

The Guardian (*5 January 2017*)

https://www.theguardian.com/world/2017/jan/05/bluefin-tuna-sells-for-500000-at-japan-auction-amid-overfishing-concerns

*World capture fisheries production in 2006 was about 92 million tons, with an estimated first sale value of $91.2 billion, comprising about 82 million tons from mar-
ine waters and 10 million tons from inland fisheries.-FAO*

http://www.un.org/depts/los/convention_agreements/reviewconf/FishStocks_EN_A.pdf

Fish are worth big money here in Mississippi …

- Dockside value of caviar: $350K ($60 per pound)
- Retail value of caviar: $1.6 mil. ($228 per pound)

Fishing is worth money in Mississippi…

- Recreational fishing
- 773 Million USD
  - –772.6 Freshwater
  - –46.3 Marine
- 12.8k Jobs

Henderson, J.E., S.C. Grado, I.A. Munn, W. D. Jones 2010. Economic Impacts of Wildlife- and Fisheries Associated Recreation on the Mississippi Economy: An Input-Output Analysis. Forest and Wildlife Research Center, Research Bulletin FO429, Mississippi State University. 21 pp.

Why is all this important?

Subsistence

People like to fish…

FRESH CHUM

Norwegian police to investigate 'fish mafia'

August 15, 2017

Police in Norway are set to open investigations into what authorities suspect to be illegal releases of pike fish at several locations in the country. …

Steelhead Chest

August 14, 2017

Handwrought sculptural steelhead chest. Pretty awesome.

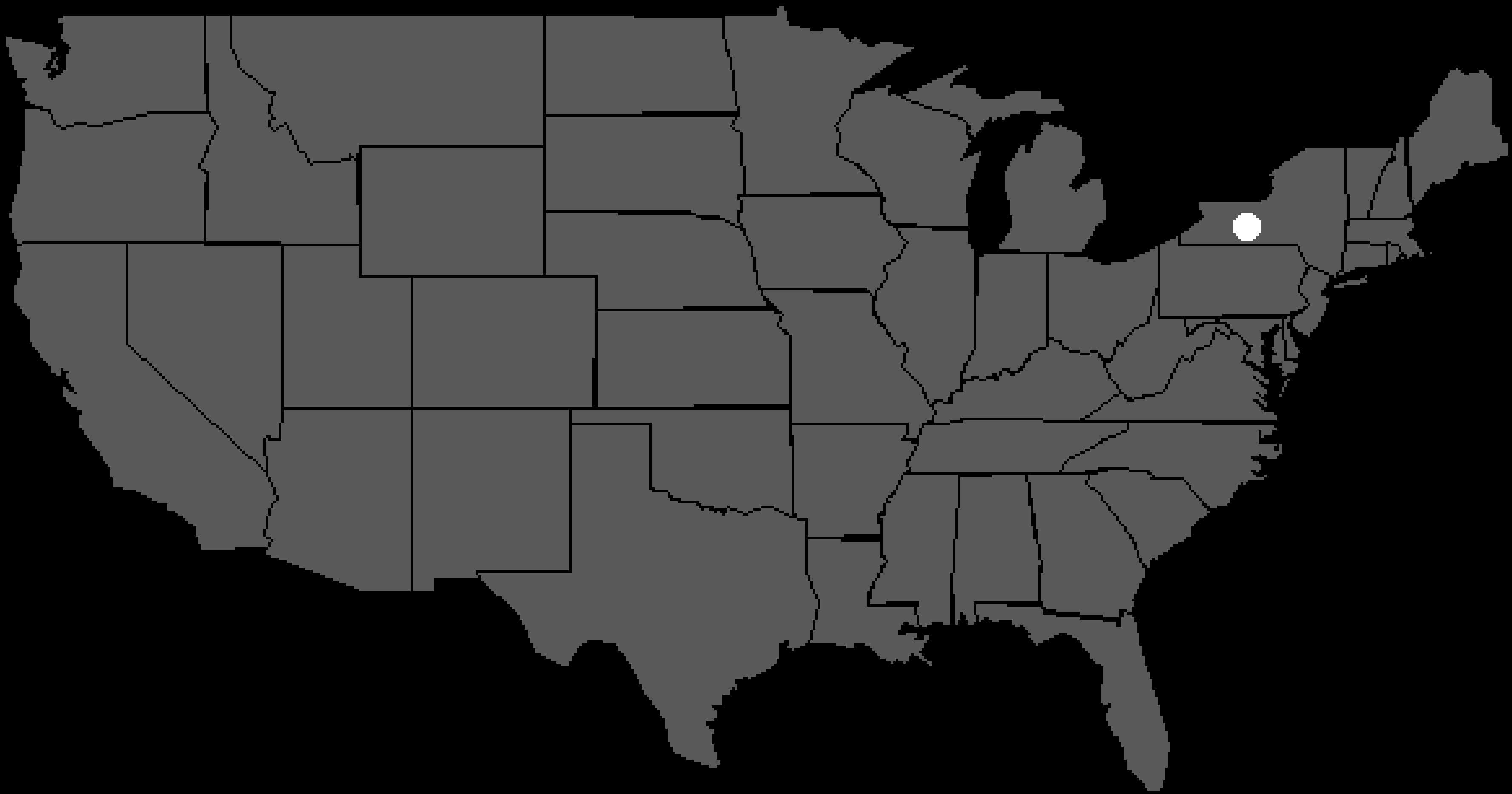
This Obscure Fishing Book is One of the Most Reprinted English Books Ever

'The Compleat Angler' is much more than an instruction manual on fishing. It's a Walden-like meditation on nature and friendship

The sport of angling ("angle" is an old work for "hook") was a popular 1600s pastime that had a number of guides written about it. (Wikimedia Commons)

An introduction to the Fisheries Manager: what can I expect?

You can expect…



To move around!

Interdisciplinary

"For fishery science is interdisciplinary. Rigid educational backgrounds for fishery biologists are impractical, and the continually increasing mass of scientific data makes it more and more likely that the solution of future problems will come from teams of specialists— teams that might include experts like the biometrician and the water chemist, whose cooperation is commonplace in fishery agencies today. "

Everhart et al 1975

Interdisciplinary & teams

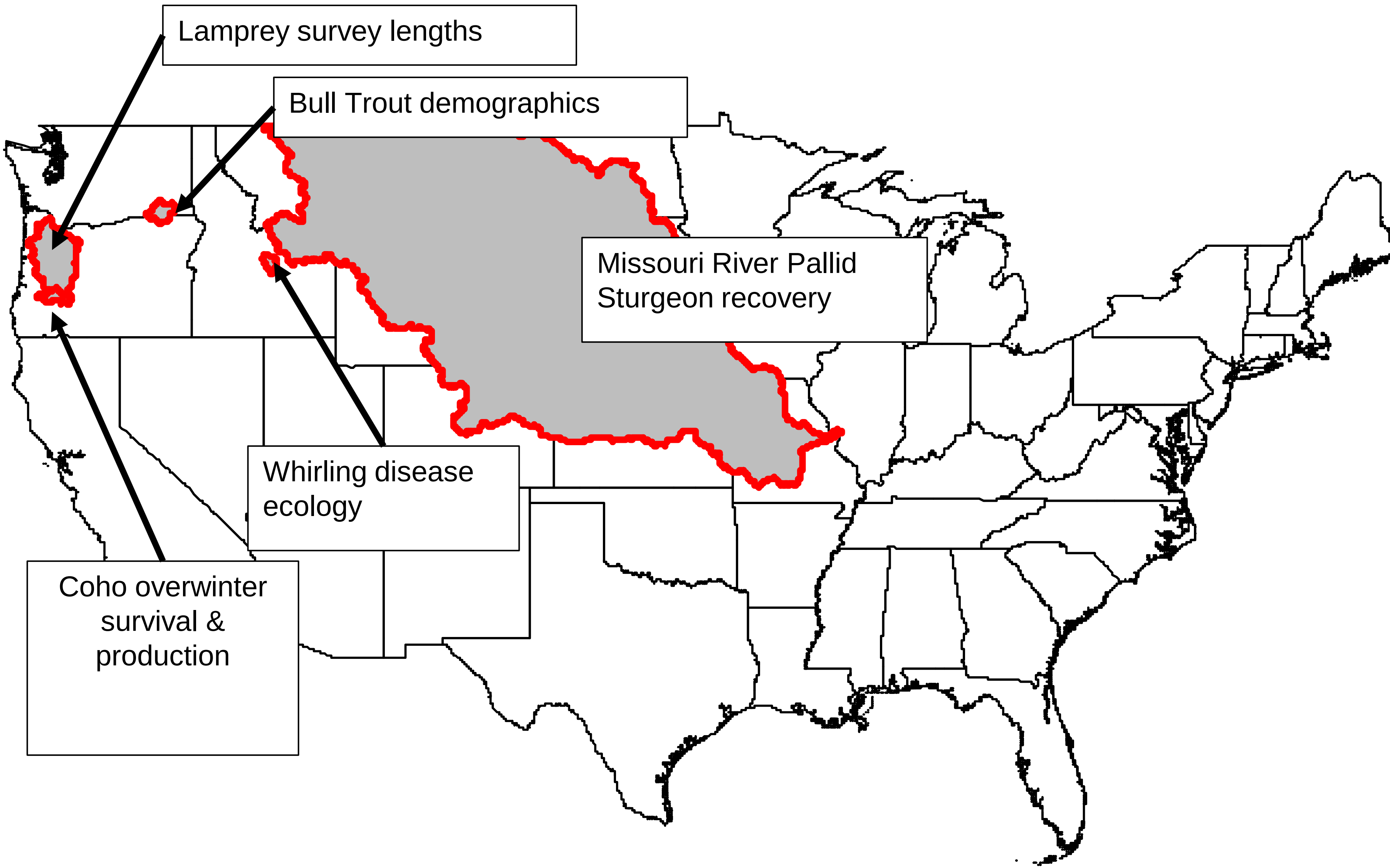
- Work with others:
  - Within agency
  - Among agencies
  - Stakeholders: lake associations, fishing clubs
  - Disciplines: fisheries, wildlife, water quality
- Do more with less
  - Distance teams

Work with interesting folks

- Federal agencies: Army Corps of Engineers, Forest Service, Bureau of Reclamation,
- State agencies: MDWFP
- Conservation entities: Nature conservancy, Trout Unlimited, American Rivers
- Private companies: Cramer & associates, Battelle, Timber companies

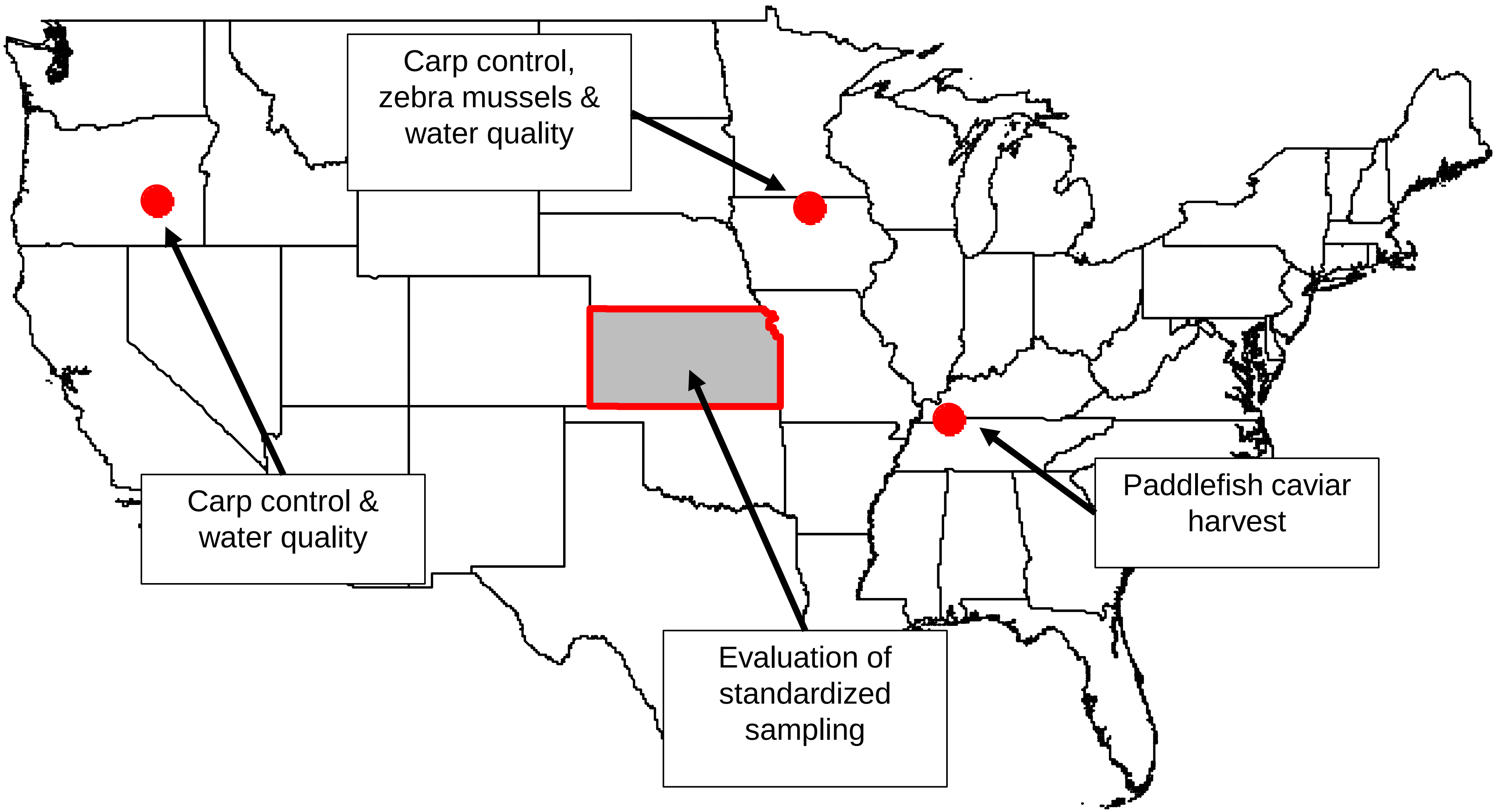
Work for and with interesting folks!

Work on streams



Recent river fun

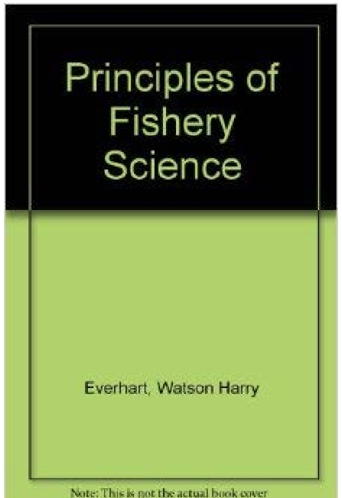
Work on lakes and reservoirs

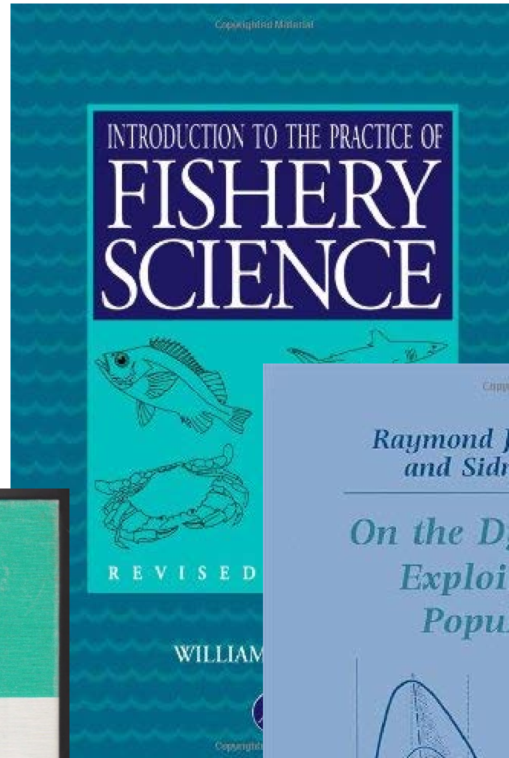


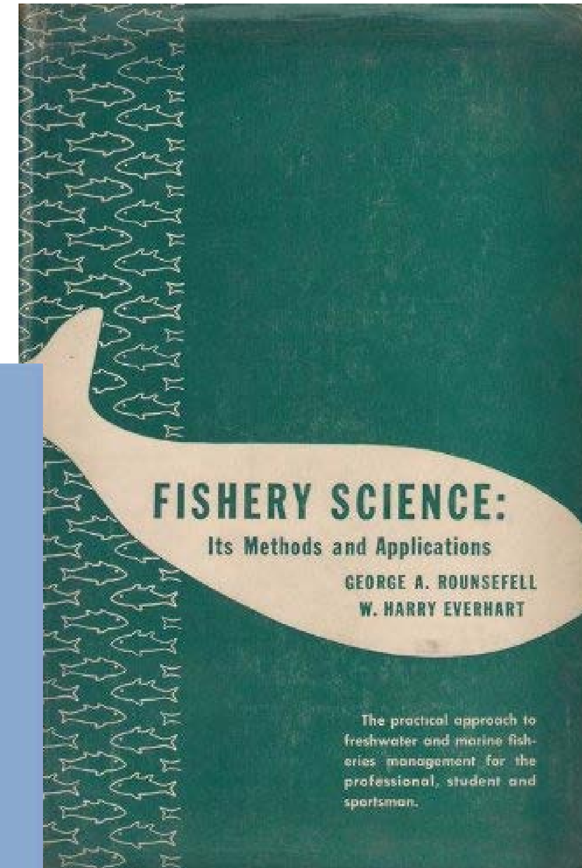
Use things like this…?

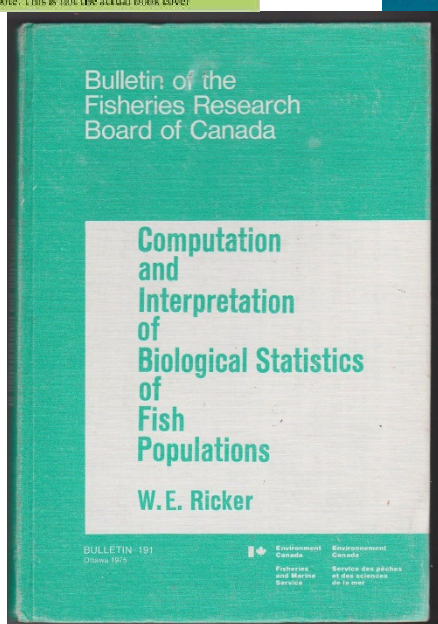
$$\frac{dB}{dt} = -Z \cdot B$$

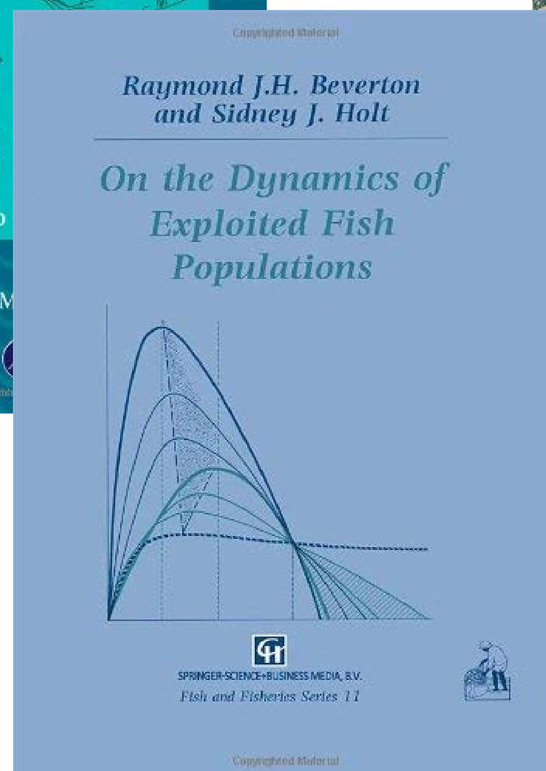
Fisheries textbooks…











Fisheries textbooks…

R 1. number of recruits to the catchable stock
2. number of recaptures of marked or tagged fish
3. multiple correlation coefficient

S rate of survival ($= -\log_e Z$) [*s*]

S′ apparent survival rate ($= -\log_e Z'$)

U instantaneous rate of "other loss" (includes emigration and, for tagged fish, the shedding of tags)

V 1. utilized stock, virtual population
2. variance

W_∞ the mean asymptotic weight which corresponds to L_∞

Y yield, catch by weight

Z instantaneous rate of (total) mortality [*i*]

Z′ instantaneous rate of disappearance (total losses) from a stock ($= F + M + U = Z + U$)

— (over a symbol) a mean value

Σ summation symbol

1.4. Numerical Representation of Mortality

1.4.1. Total mortality rate. The mortality in a population, from all causes, can be expressed numerically in two different ways.

(a) Simplest and most realistic perhaps is the *annual expectation of death* of an individual fish, or *actual mortality rate*, expressed as a fraction or percentage. This is the fraction of the fish present at the start of a year which actually die during the year.

(b) If the number of deaths in a small interval of time is at all times proportional to the number of fish present at that time, the fraction which remains at time *t*, of the fish in a population at the start of a year ($t = 0$), is:

$$\frac{N_t}{N_0} = e^{-Zt} \tag{1.1}$$

The parameter Z is called the *instantaneous mortality rate*. If the unit of time is 1 year, then at the end of the year (when $t = 1$):

$$\frac{N_1}{N_0} = e^{-Z} \tag{1.2}$$

But $N_1/N_0 = S = 1 - A$; hence $1 - A = e^{-Z}$, or $Z = -\log_e(1 - A)$; hence the instantaneous mortality rate is equal to the natural logarithm (with sign changed) of the complement of the annual expectation of death.

The instantaneous rate Z also represents the number of fish (including new recruits) which would die during the year if recruitment were to exactly balance mortality from day to day, expressed as a fraction or multiple of the steady density of stock.

8

1.5.3. Single age-groups. Consider a single age-group of fish in the recruited (fully vulnerable) part of a stock. Its abundance during a year decreases from N to NS, according to equation (1.2); for example, from the point A to the point B_1 in Fig. 1.1. The *average* abundance during the year is the area of the figure under AB_1, divided by the length of the base (which is unity). In our symbols, this is:

$$\overline{N} = \int_{t=0}^{t=1} Ne^{-Z}dt = N\left(\frac{e^{-Z}}{-Z} - \frac{1}{-Z}\right) = \frac{N(1-e^{-Z})}{Z} = \frac{NA}{Z} \tag{1.15}$$

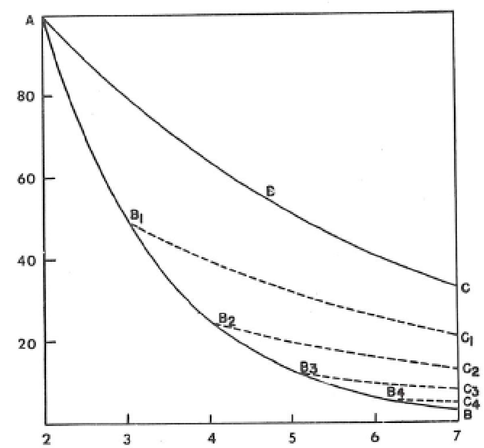


Fig. 1.1. Exponential decrease in a stock from an initial abundance of 100 at age 2, when the annual mortality rate is 0.2 (AC) and when it is 0.5 (AB). The broken lines indicate population structure during a period of transition from the smaller to the larger mortality. (Redrawn from fig. 8 of Baranov 1918, by S. D. Gerking.)

The total deaths, which equal NA by definition, are therefore Z times the average population. Since the mortality is at each instant divided between natural causes and fishing in the ratio of F to M, then natural deaths are $M/(F + M) = M/Z$ times NA, or (from 1.15) M times the average population; that is:

$$\frac{M}{F+M} \times NA = \frac{MNA}{Z} = M\overline{N} \tag{1.16}$$

12

Fisheries textbooks…

using the term 'natural mortality' in this paper (see §7.1). The rate of natural mortality at any time t, which we shall denote by $_M(dN/dt)$, depends on the number of fish present at that time, and in the simplest case we may write

$$_M\left(\frac{dN}{dt}\right) = -MN \quad \ldots \quad \ldots \quad \ldots \qquad (3.1)$$

This is the form used by several authors, including Baranov (1918), Graham (1935), Schaefer (1943) and Ricker (1944), and although suitable as a first approximation it is necessary to remember that there are few published data that can support it in detail. It may usually be taken to imply that natural death is due to a large number of causes acting randomly, and that the probability of a particular fish dying between any time t and time $t + \Delta t$, is constant. More precisely, we may expect the natural mortality coefficient to vary with age of fish, the theoretical consequences of which are discussed in §7.2.1, and also to be dependent on population density (§7.3). For the simple population model, however, we shall assume that the natural mortality rate can be represented by (3.1) above, the coefficient M being constant and effective from age t_ρ onwards.

A problem which may conveniently be mentioned in connection with natural mortality concerns the *life-span*. If the natural mortality rate remains constant the maximum life-span will, hypothetically, be of infinite duration, though in practice, if we consider any one finite brood of fish, there will come a time when the last survivor dies. Previous authors who have dealt theoretically with the life-span (e.g. Baranov and Ricker) have in fact assumed it to be unlimited, but this can give rise to serious discrepancies if combined, as in the treatment of these authors, with certain assumptions concerning the behaviour of other factors, such as growth, with increasing age (see §17.8). For constructing a population model we suggest that a better procedure may be to terminate the life abruptly at a certain high age which we shall denote by t_λ, so that all surviving fish die at this age. The value of t_λ, in any particular case, will be largely arbitrary; in practice it will be chosen to correspond with the greatest age for which adequate data are available, since data will inevitably become progressively less for fish of increasing age. A further discussion is given in §7.2.2.

3.3 Fishing Mortality

The correct mathematical formulation of fishing mortality and its dependence on the characteristics of both the population and the fishing activity is clearly of great importance in developing a theoretical model of a fishery. A detailed discussion of this problem is given in §8.3.1; here it will be sufficient to state certain general principles and relationships.

A preliminary definition of terms is required at this stage. We use the term *fishing power* to denote the catching power of an individual vessel, and this is measured as the ratio of the quantity caught by that vessel per unit fishing time to that by a vessel selected as a standard reference, fishing at the same time and place and using a standard gear, i.e. both vessels being taken as fishing on the same density of fish (see §12). In this way each vessel of a fleet can be allocated a *power factor* (P.F.), and the fishing time of each vessel can be reduced to standard units of effort by multiplying by its power factor. The *fishing effort* of a fleet we then define in the units 'total standard hrs. fishing/year', and *fishing intensity* as the fishing effort per unit area in the units 'total standard hrs. fishing/year/square nautical mile'. The terms 'fishing effort' and 'fishing intensity' are often used synonymously in fishery research, but we are here distinguishing them in accordance with the use of the words 'effort' and 'intensity' in physical sciences, and the terms are not interchangeable. It should be noted also that 'fishing time' cannot be used in place of 'effort' unless the fishing powers of the vessels (and their gear) concerned remain constant. Thus while 'catch per unit effort' can be used in many instances as a reliable index of density, 'catch per day's absence or catch per 100 hrs. fishing' cannot unless the above criterion is satisfied.

For the simple population models we regard it as a necessary characteristic of demersal fishing activity that there is a random element in the relative movement of fish and gear.

The weight of the individual at any age t between $t_{\rho'}$ and t_λ is given, from (3.9), by

$$w_t = W_\infty \sum_{n=0}^{3} \Omega_n e^{-nK(t-t_0)}$$

so that the total weight of the year-class at this age is

$$N_t w_t = R' W_\infty e^{-(F+M)(t-t_{\rho'})} \sum_{n=0}^{3} \Omega_n e^{-nK(t-t_0)}$$

Now the rate at which fish are being caught is the same as the rate of decrease due to fishing (3.2), except that the sign is positive. Denoting the yield in weight by Y_W, the rate of yield in weight from the year class is therefore

$$\frac{dY_W}{dt} = F \, . \, N_t w_t$$

and substituting for N_t and w_t gives

$$\frac{dY_W}{dt} = FR' W_\infty e^{-(F+M)(t-t_{\rho'})} \sum_{n=0}^{3} \Omega_n e^{-nK(t-t_0)}$$

Grouping terms containing t gives

$$\frac{dY_W}{dt} = FR' W_\infty e^{(F+M)t_{\rho'}} \sum_{n=0}^{3} \Omega_n e^{nKt_0 - (F+M+nK)t}$$

and the yield obtained from the year-class throughout its *fishable life-span*, i.e. between ages $t_{\rho'}$ and t_λ, is obtained by integrating with respect to t between these limits, that is

$$Y_W = FR' W_\infty e^{(F+M)t_{\rho'}} \sum_{n=0}^{3} \Omega_n e^{nKt_0} \int_{t_{\rho'}}^{t_\lambda} e^{-(F+M+nK)t} \, dt$$

Finally, substituting for R' from (4.2) and integrating gives*

$$Y_W = FRW_\infty e^{-M\rho} \sum_{n=0}^{3} \frac{\Omega_n e^{-nK(t_{\rho'}-t_0)}}{F+M+nK} \left(1 - e^{-(F+M+nK)\lambda}\right) \quad \ldots \qquad (4.4)$$

where

$$\lambda = t_\lambda - t_{\rho'} = \text{the fishable life-span}$$

Now the total annual yield from the population is the sum of the yields from each of its constituent year-classes during one year of life. Since we are supposing that the population is in a steady state (and, in particular, is receiving the same number of recruits each year), the total annual yield from it is the same as the yield throughout the fishable life-span of any one of the constituent year-classes and hence is also given by (4.4). This fact has been realised by several of the authors previously mentioned, and also by W. F. Thompson (1937), but it is convenient to give in §4.2 a proof for the particular model we are postulating, since to do so demonstrates the use of summation methods which are indispensable for the analysis of certain problems to be considered later in Part II.

*This is the yield equation described by Graham (1952) and of which a brief derivation has been given by Beverton (1953).

Fisheries textbooks…

crop of any given time. The standing crop in weight at any given time is the product of the average individual weight times the number of individuals present at that time. This concept may be expressed in a general way by:

$$Y = \int_T F(t)W(t)N(t)dt$$

where $F(t)$ is a time function of force of fishing mortality, $W(t)$ is a time function for weight, and $N(t)$ is a time function for number of fish in the population. The product of these functions on an instant-by-instant basis is summed over time period T. Two specific applications of this concept will be considered next; the first formulation is exemplified by Ricker, the second by Beverton and Holt. The major difference between the two procedures is the function used to express growth.

Ricker's method breaks the time period into intervals and life stages so that the rates of growth and mortality may be considered constant within the time interval without any appreciable error being introduced. The stock change and yield for each interval and age group are summed over intervals to provide an estimate of total yield. Growth is assumed to be expressed by:

$$W(t) = W(o)e^{gt}$$

and numbers of fish alive by:

$$N(t) = N(o)e^{-Zt}$$

Initial biomass is $W(o)N(o)$. Biomass for the next unit interval (assuming constant growth and mortality rates) is then the initial biomass times the growth function times the mortality function:

$$\text{Biomass} = N(o)W(o)e^{g}e^{-Z}$$

Given the initial biomass for any interval, the factor by which this changes is e^{g-Z} which may be easily evaluated from a table of exponential functions. The force of total mortality is partitioned into the fishing and natural components, and by an iterative procedure, the force of fishing giving maximum yield may be determined. Effects on catch-per-unit effort and average size of fish may also be estimated by such tabular procedures.

To compute yield by this method it is necessary to have frequent measurement of size by age as well as knowledge of natural mortality. The

yield is given on a per recruit or per assumed initial weight of stock basis, as is true of the dynamic pool models in general. Population estimates for each year class would provide an actual basis for numbers present.

The following abbreviated example will demonstrate the above procedure for determining yield. Largemouth bass from a small lake were sampled at periodic intervals with fishing and natural mortality determined from tagging studies, creel census, and population estimates. Information obtained is presented in Table 8-1. The same kind of calculation would be made for all ages in the population; we have presented only two ages to show computations. Different values for F may be substituted to determine the one giving the largest yield.

The yield model of Beverton and Holt starts from the familiar expression for yield:

$$Y = \int_T F(t)W(t)N(t)dt$$

with von Bertalanffy's growth equation for $W(t)$. The expression for $N(t)$ is common to all models in fishery literature, but is broken down into time periods corresponding to age at recruitment and age at capture. If recruitment, R, to the area of a fishery occurs at age t_r, then:

$$N(t) = \text{R}e^{-M(t - t_r)}$$

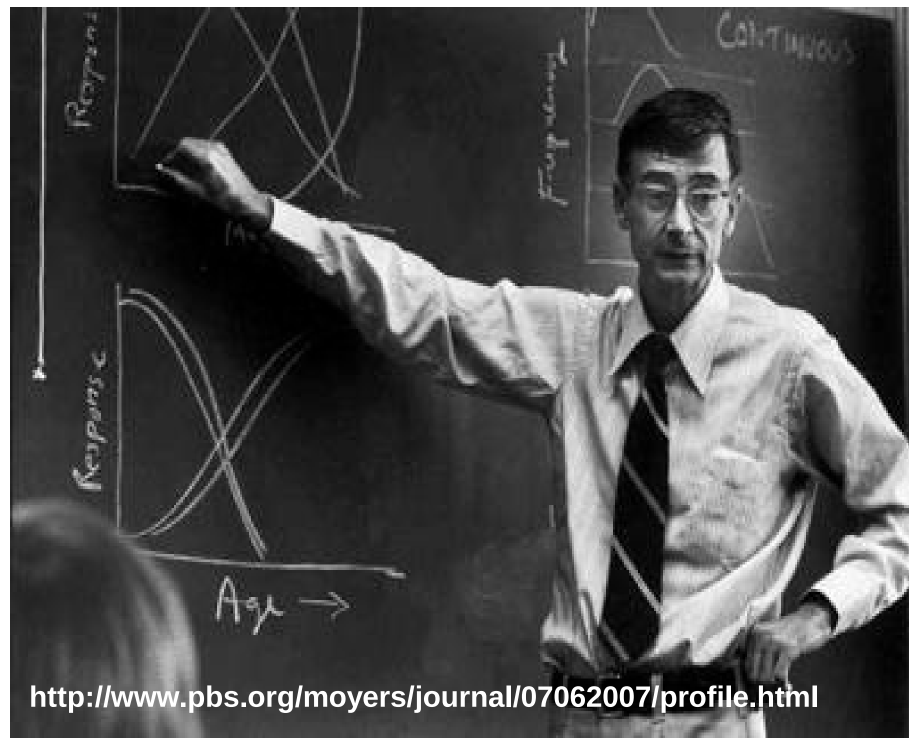
Table 8-1. Calculation of yield by Ricker's method

Age	Weight (g)	g	F	M	Z	g − Z	Weight change factor exp(g − Z)	Initial weight (kg)	Average weight	Yield
II	86							1000		
		0.51	0	0.2	0.2	0.31	1.36		1181	0
II¼	143							1361		
		0.36	0.02	0.2	0.22	0.14	1.15		1463	29
II½	205							1565		
		0.18	0.17	0.2	0.37	−0.19	0.83		1432	243
II¾	246							1299		
		0	0	0.2	0.2	−0.4	0.67		1085	0
III	246							870		
		0.31	0.2	0.2	0.4	−0.09	0.91		831	166
III¼	335							792		
		0.14	0.2	0.2	0.4	−0.26	0.77		701	140
III½	385							610		
		0.10	0.2	0.2	0.4	−0.30	0.74		531	106
III¾	427							451		
									Total	684

Use models

E. O. Wilson's (1998:269) observation that ''we are drowning in information'' and that successful conservation and resource management depend ultimately on the rigorous synthesis of information.

- Ainsworth et al. 2010



Ainsworth, C. H., I. C. Kaplan, P. S. Levin, and M. Mangel. 2010. A statistical approach for estimating fish diet compositions from multiple data sources: Gulf of California case study. Ecological Applications 20(8):2188-2202.

Wilson, E. O. 1998. Consilience: the unity of knowledge. Alfred A. Knopf, New York, New York, USA.

What others think…

- Modeling is a great and perhaps necessary way for scientists to force themselves to think clearly and to put claims to understanding on the table in the form of specific predictions

- Prediction in some form is required for management choice

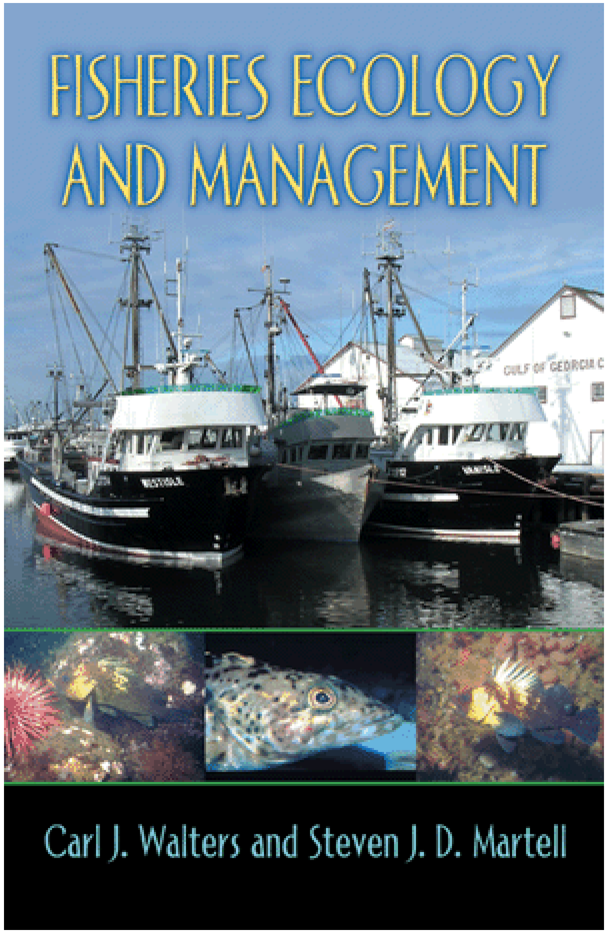
- There are some predictable regularities in the way natural populations and ecosystems respond to human disturbance, so … some kinds of useful predictions are not as likely to fail as they appear

Walters and Martell 2004 p. 3

- "It is useful to test prospective management strategies against ecosystem models: if they don't work on simple models why should they work in reality"

Keith Sainsbury (ICES/SCOR Conference, Montpellier March 1999)

“…we make no apologies for demanding that people who would engage in fisheries assessment and management should at least be able to read and understand some basic mathematics. (Walters and Martell 2004, Preface)”



Walters, C. J., and S. J. D. Martell. 2004. Fisheries Ecology and Management. Princeton University Press, Princeton, NJ.

If you want to be successful, here are four things you need to “get”:

Get ready for math. Few of us get into natural resource science simply because we enjoy math. Most of us just want to be outside, on a boat or in the creek doing field work. Believe me, there will be plenty of that…but fisheries science is *way more interesting* than ‘just being outside’.

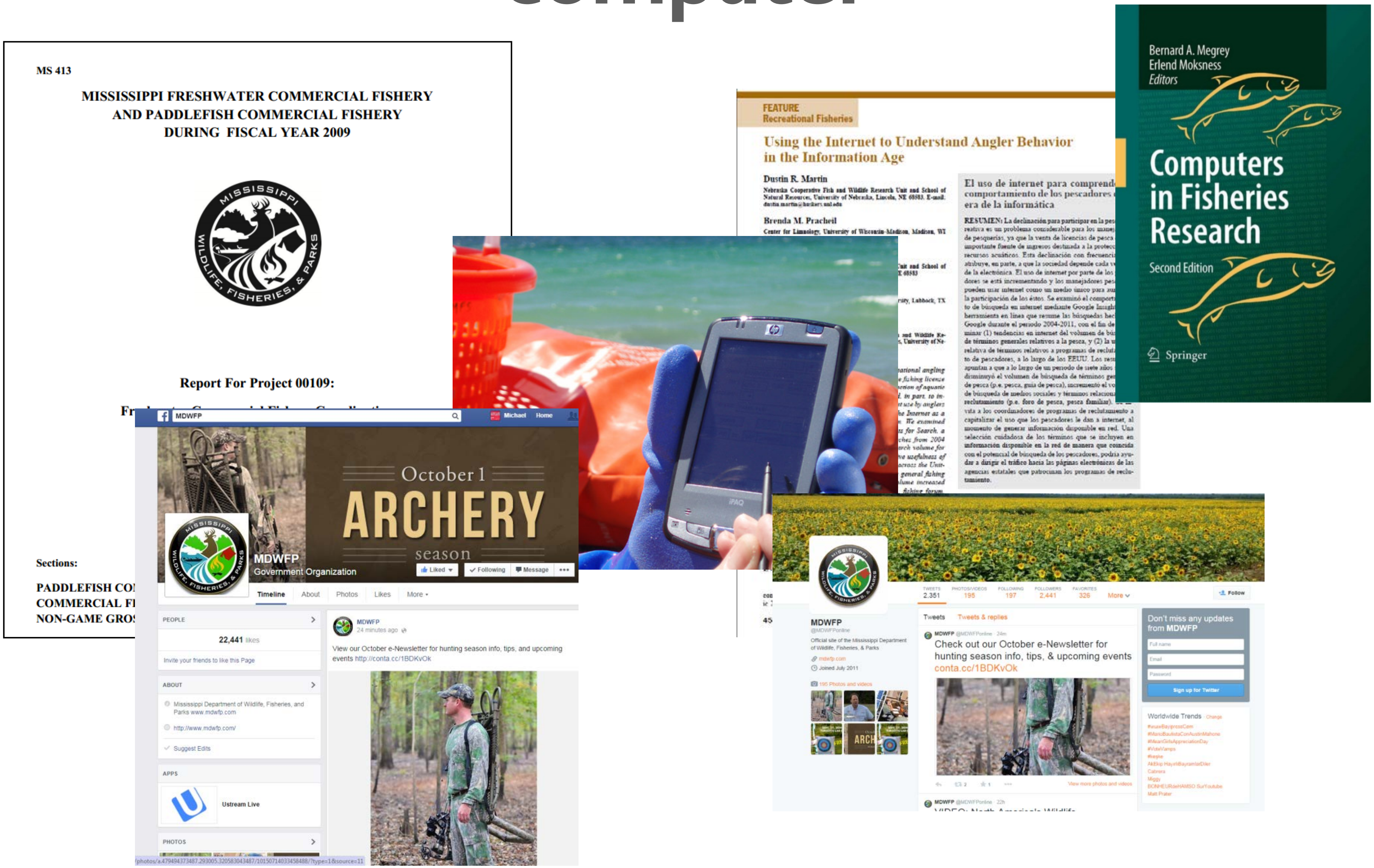
Learning solid field methods is critical, but all that time on the water won’t mean anything unless you know how to analyze your data. And trust me—once all those number actually *mean something*, you’ll enjoy it much more. Statistics are one of scientists’ most powerful tools. Without stats, we can’t do our jobs.

http://thefisheriesblog.com/2014/09/22/4-must-get-items-for-freshman-fisheries-students/

Deal with mental models?

http://guide.cred.columbia.edu/guide/sec1.html

You will spend time at a computer



Work with others

Work with the public

Be interdisciplinary

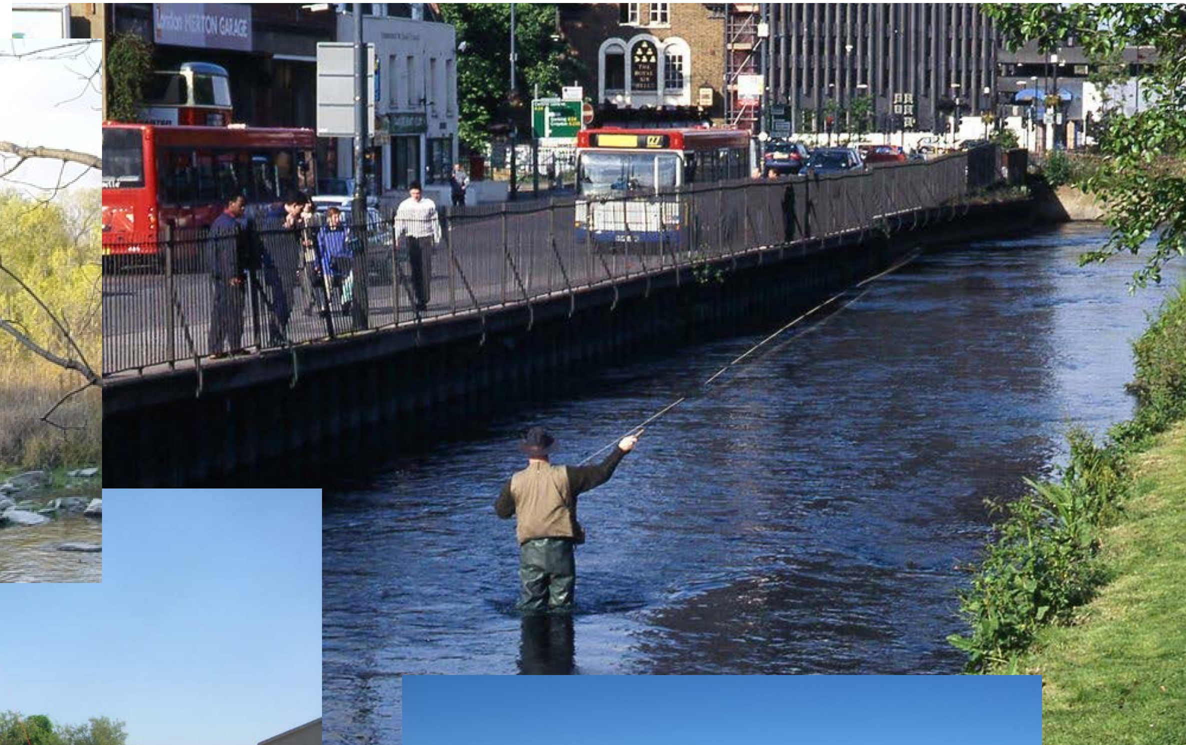
"For fishery science is interdisciplinary. Rigid educational backgrounds for fishery biologists are impractical, and the continually increasing mass of scientific data makes it more and more likely that the solution of future problems will come from teams of specialists— teams that might include experts like the biometrician and the water chemist, whose cooperation is commonplace in fishery agencies today. "

Everhart et al 1975

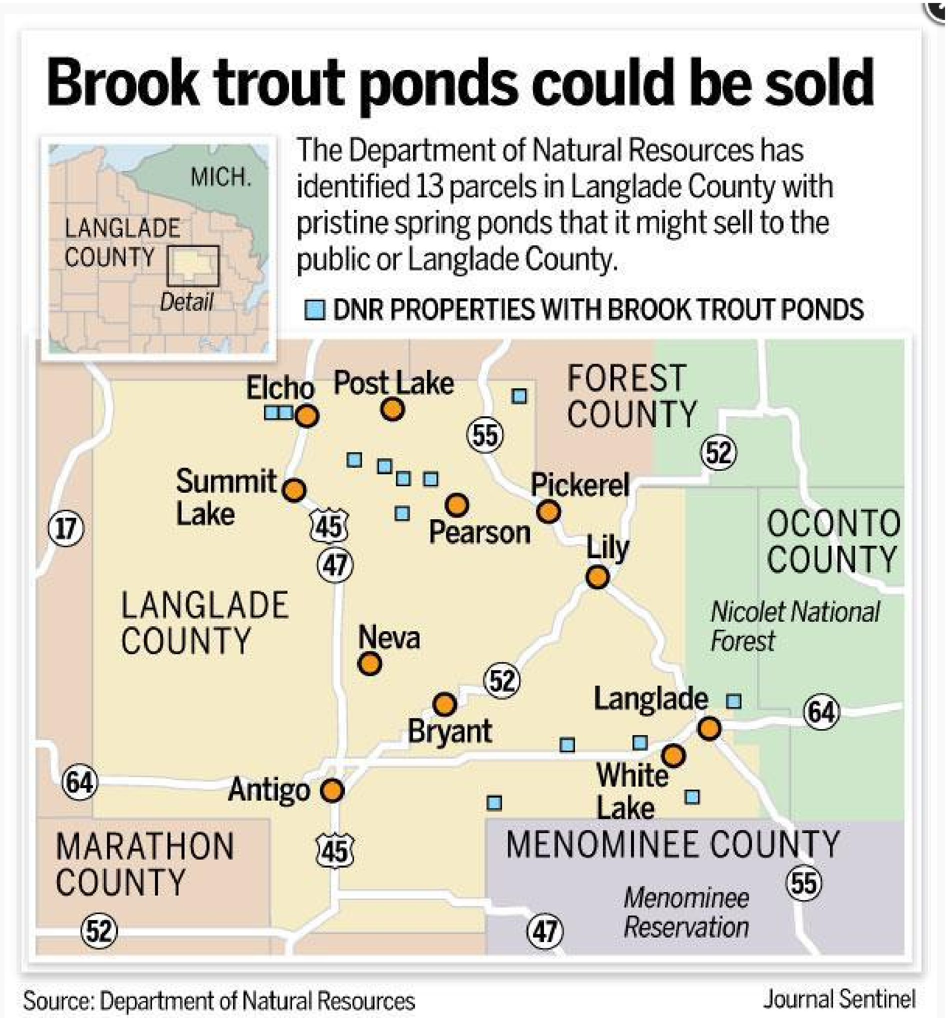
Be a team player

- Work with others:
  - –Within agency
  - –Among agencies
  - –Stakeholders: lake associations, fishing clubs
  - –Disciplines: fisheries, wildlife, water quality
- Do more with less
  - –Distance teams
  - –Webex, Skype, conference calls

Work in urban environments



Deal with politics



Wisconsin

Home » News » Wisconsin

DNR move to sell prime spring ponds outrages trout anglers

State official hopes Langlade County will buy land

By Lee Bergquist of the Journal Sentinel

Aug. 19, 2015

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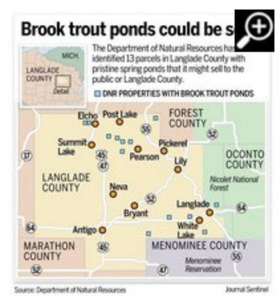


The state Department of Natural Resources has identified more than 1,000 acres of state-owned land in Langlade County that could go on the auction block — a move that has angered trout anglers because the properties contain a cache of ecologically significant spring ponds with native brook trout populations.

The ponds, gouged by glaciers thousands of years ago, are fed by rich sources of groundwater that sustain the fish and neighboring streams, rivers and lakes.

The DNR recently posted 13 properties in Langlade County on its website that contain the small ponds. They are among 118 parcels, covering approximately 8,300 acres, the DNR could sell to private parties or other units of government.

The driving force is a directive by the Legislature to put 10,000 acres of state-owned land up for sale. The property must be made available to the public by June 30, 2017. It's part of a broader effort by lawmakers to exert more control over the agency's sprawling land holdings, and the state stewardship program that buys land for recreational use.

During the budget debate this year, GOP lawmakers and Republican Gov. Scott Walker expressed concerns about interest payments on the debt for the Knowles-Nelson Stewardship program that is currently running at $1 million a week. The program is named for former Govs. Warren Knowles, a Republican, and Gaylord Nelson, a Democrat, who also served in the U.S. Senate.

The state owns about 1.5 million acres and has conservation easements on more than 300,000 acres.

Doug Haag, deputy bureau director in charge of land sales and acquisitions, said the properties must still be reviewed by DNR field staff, including fisheries experts.

He acknowledged some fisheries staff have already raised objections to selling land where ponds are located. The Natural Resources Board will review the final list in December or January.

Haag said the hope is to sell to Langlade County because parcels reside within the 129,968-acre county forest boundaries. But he said the DNR hasn't yet approached county officials on any of the sales.

"It's news to me," said Erik Rantala, administrator of Langlade County forests. Rantala said it was premature to say whether the county would be interested in buying the land.

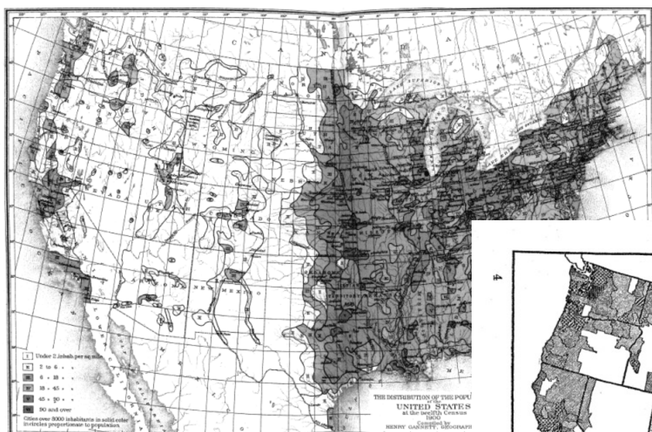
SCARED?

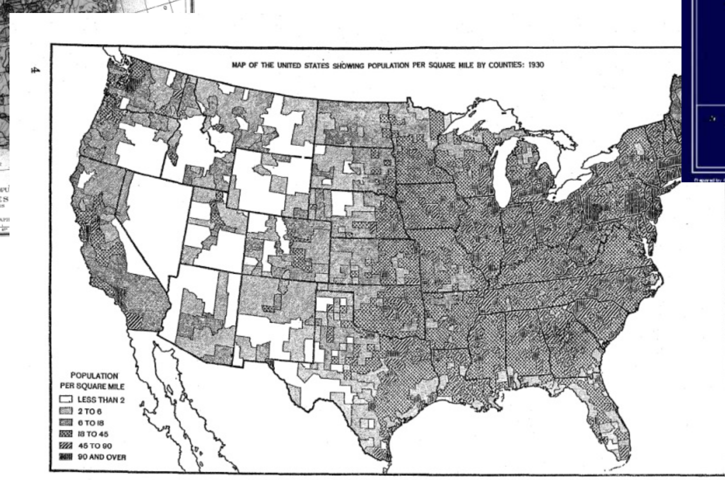
When the Boogeyman goes to sleep every night he checks his closet for Chuck Norris.

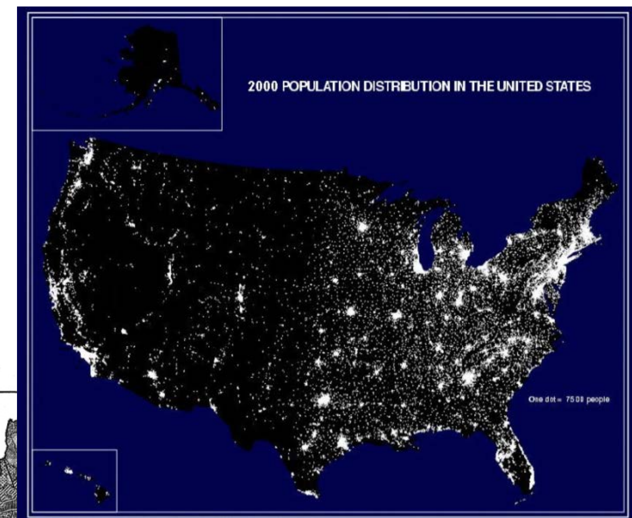
Fisheries and fisheries management history

History of the human-fish relationship in NA

- Pre-European Settlement: Natives not a big impact due to
  - Low densities







T. H. H. Opening Fisheries Exhibition(1882)

B.B.C. Hulton PIcture Library

Inaugural Address

Fisheries Exhibition, London (1883)
The Fisheries Exhibition Literature (1885)
Scientific Memoirs V

"I believe, then, that the cod fishery, the herring fishery, the pilchard fishery, the mackerel fishery, and probably all the great sea fisheries, are inexhaustible; that is to say, that nothing we do seriously affects the number of the fish. And any attempt to regulate these fisheries seems consequently, from the nature of the case, to be useless."

Estimating the Size of Historical Oregon Salmon Runs[1]

Chad C. Meengs
Environmental Sciences Program
Oregon State University

and

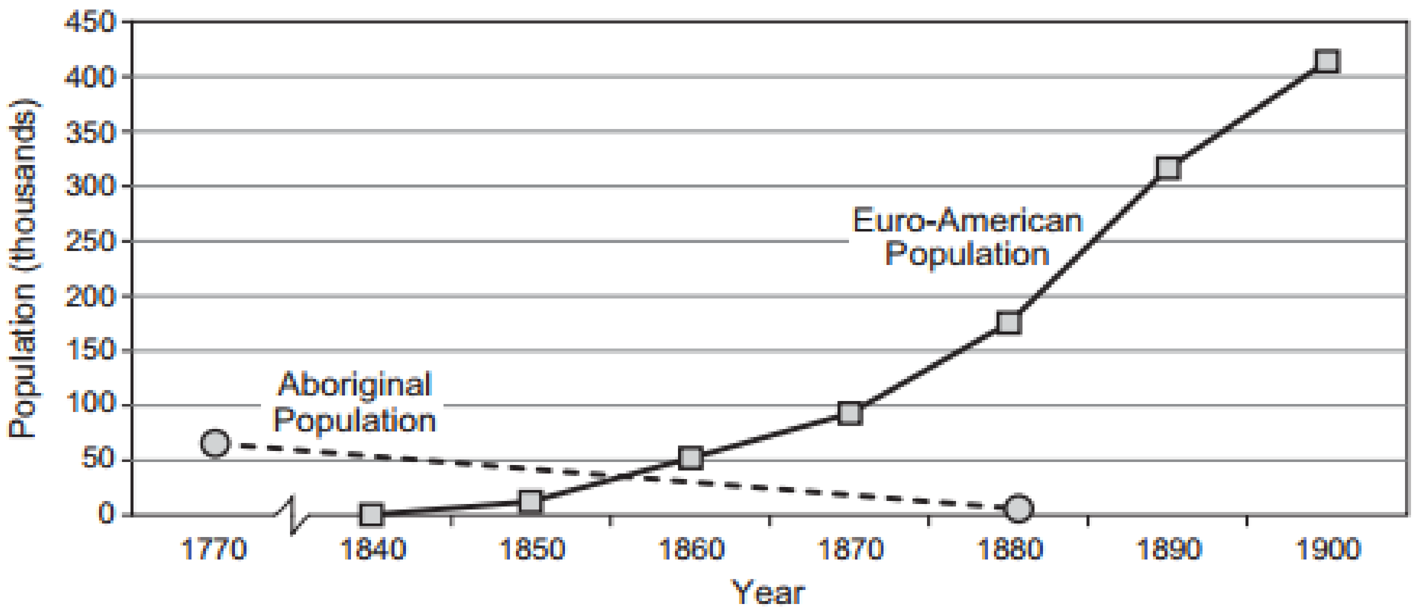
Robert T. Lackey
National Health and Environmental Effects Research Laboratory
U.S. Environmental Protection Agency

Abstract

Increasing the abundance of salmon in Oregon's rivers and streams is a high priority public policy objective. Salmon runs have been reduced from pre-development conditions (typically defined as prior to 1850), but it is unclear by how much. Considerable public and private resources have been devoted to restoring salmon runs, but it is uncertain what the current recovery potential is because much of the freshwater and estuarine habitat for salmon has been altered and there is no expectation that it will be returned to a pre-development condition. The goals of all salmon recovery efforts are based on assumptions about the size of the runs prior to significant habitat alteration, coupled with an estimate of the amount and quality of freshwater and estuarine habitat currently available. We estimated the historical aggregate salmon run size

Meengs, C. C., and L. R.T. 2005. Estimating the size of historical Oregon salmon runs. Reviews in Fisheries Science 13:51-66.

Because of their close nutritional tie to salmon (and therefore salmon runs loosely regulated aboriginal population size), it is possible to roughly extrapolate salmon run size using the estimated aboriginal population size and likely consumption rate. The extent of aboriginal dependence on salmon is well documented (Craig and Hacker, 1940).



Meengs, C. C., and L. R.T. 2005. Estimating the size of historical Oregon salmon runs. Reviews in Fisheries Science 13:51-66.

"The precipitous decline in the aboriginal population likely affected the size of salmon runs. Salmon runs may have been larger in the 1850s than just about any other time in postglacial history because the aboriginals were no longer harvesting large quantities of fish (Craig and Hacker, 1940; Hewes, 1947). Another hypotheses, however, is that salmon runs would briefly increase, but then fall to a new equilibrium due to the increased intraspecific competition on the spawning grounds (Van Hyning, 1973; Chapman et al. 1982)."

Meengs, C. C., and L. R.T. 2005. Estimating the size of historical Oregon salmon runs. Reviews in Fisheries Science 13:51-66.

History of the human-fish relationship in NA

- Natives not a big impact due to
  – Capable of overfishing bug didn’t due to complex social and cultural traditions (Taylor 1999)

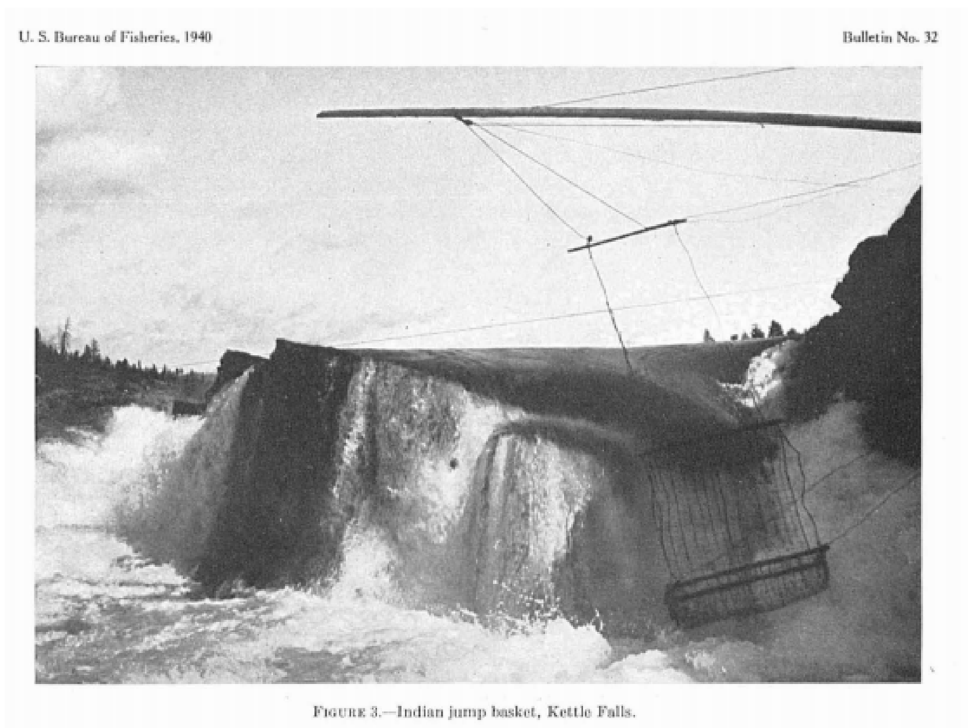


FIGURE 3.—Indian jump basket, Kettle Falls.

Pre-European Settlement

- Aquatic sources of protein