



# *Nutrient Criteria in Colorado: An Ecological Perspective*

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# Economic Impacts of Fishing in Colorado

<http://wildlife.state.co.us/About/Reports/EconomicImpacts/>

## Hunting and Fishing Activity Days, 2007

Activity	Resident activity days (thousands)	Non-resident activity days (thousands)	Total activity days (thousands)
Big game hunting	1,005	596	1,601
Small game hunting	582	23	605
Fishing	<u>9,995</u>	<u>471</u>	<u>10,466</u>
Total	11,582	1,090	12,672

Source: BBC Research & Consulting, based on fishing and hunting activity data provided by CDOW.

## Average Expenditures per Hunter and Angler per Day, 2007

Activity	Resident \$ per day	Non-resident \$ per day
Big game hunting	\$106	\$216
Small game hunting	\$94	\$87
Fishing	\$67	\$118

Note: Measured in 2007 dollars.

Source: BBC Research & Consulting, based on 2006 USFWS national survey.

## Statewide Economic Impacts of Hunting and Fishing in 2007

Activity	Direct expenditures <sup>1</sup> (\$ in thousands)	Total impact <sup>2</sup> (\$ in thousands)	Total <sup>3</sup> jobs
Elk hunting	\$172,700	\$295,500	3,400
Deer hunting	58,300	99,900	1,160
Other big game hunting	4,700	8,300	100
Fishing	725,200	1,259,400	14,610
Small game hunting	56,900	98,700	1,350
CDOW expenditures	<u>58,500</u>	<u>81,500</u>	<u>730</u>
<b>Total</b>	<b>\$1,076,300</b>	<b>\$1,843,300</b>	<b>21,350</b>

Note: Measured in 2007 dollars.

1. Trip and equipment expenditures and CDOW expenditures in support of these activities.

2. Direct expenditures plus secondary spending by businesses and households (multiplier effects).

3. Includes job creation from direct and secondary expenditures.

Source: BBC Research & Consulting, based on data from CDOW and USFWS 2006 national survey.

*\*Note that dollar figures are in 1,000s of dollars (e.g., "725,200" = \$725,200,000.00).*

# Influence of Nutrients on Recreational Fisheries: Lakes and Reservoirs

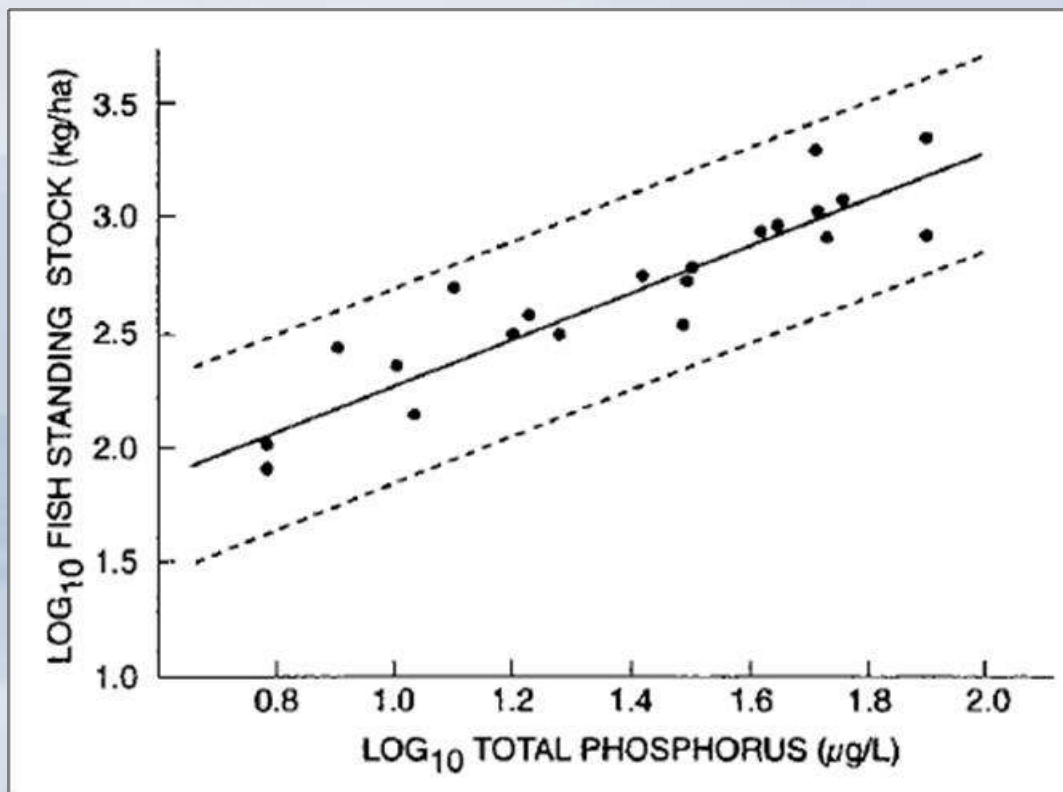


Figure from Ney et al. 1990

# The New Reservoir Effect

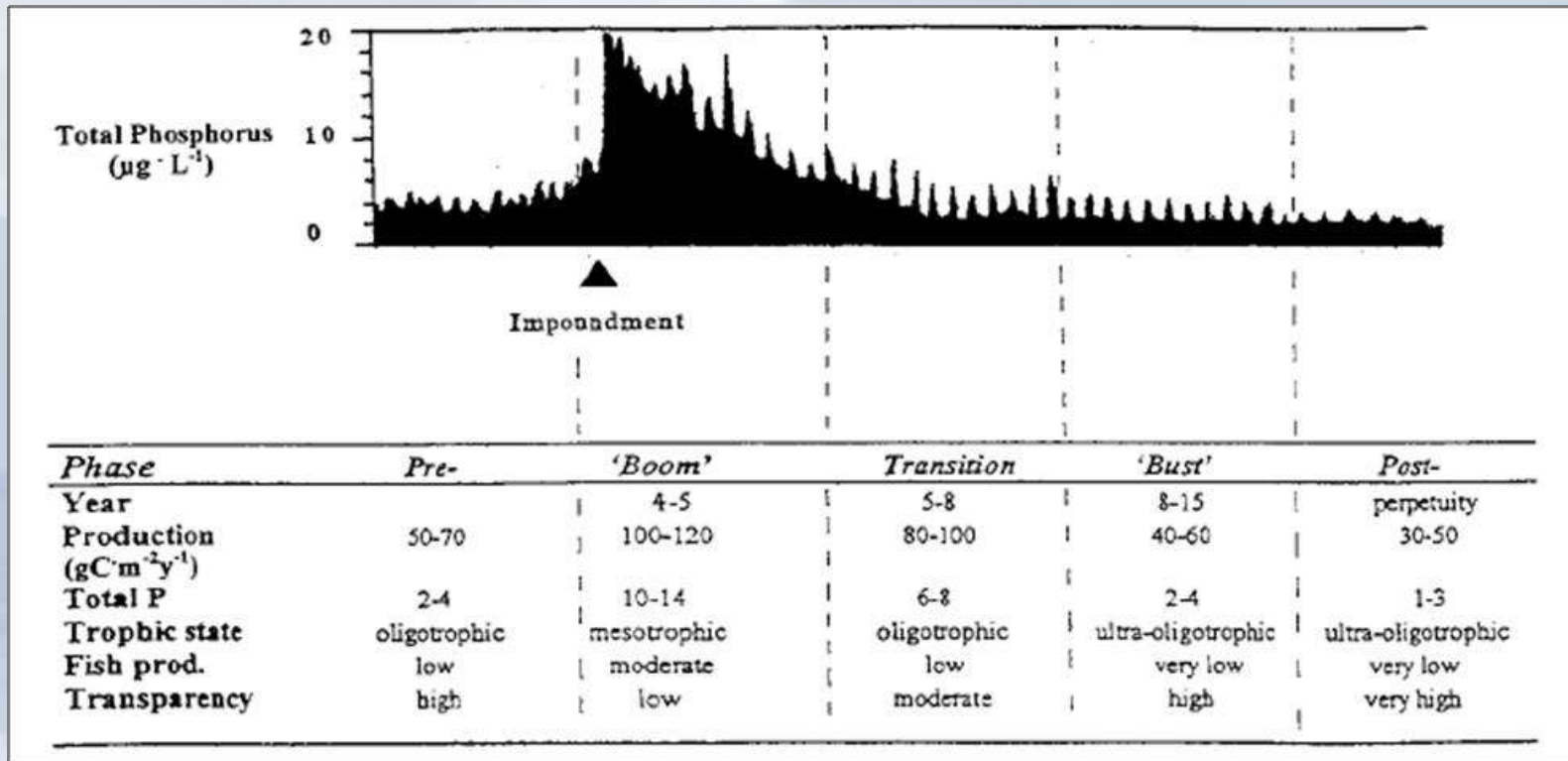
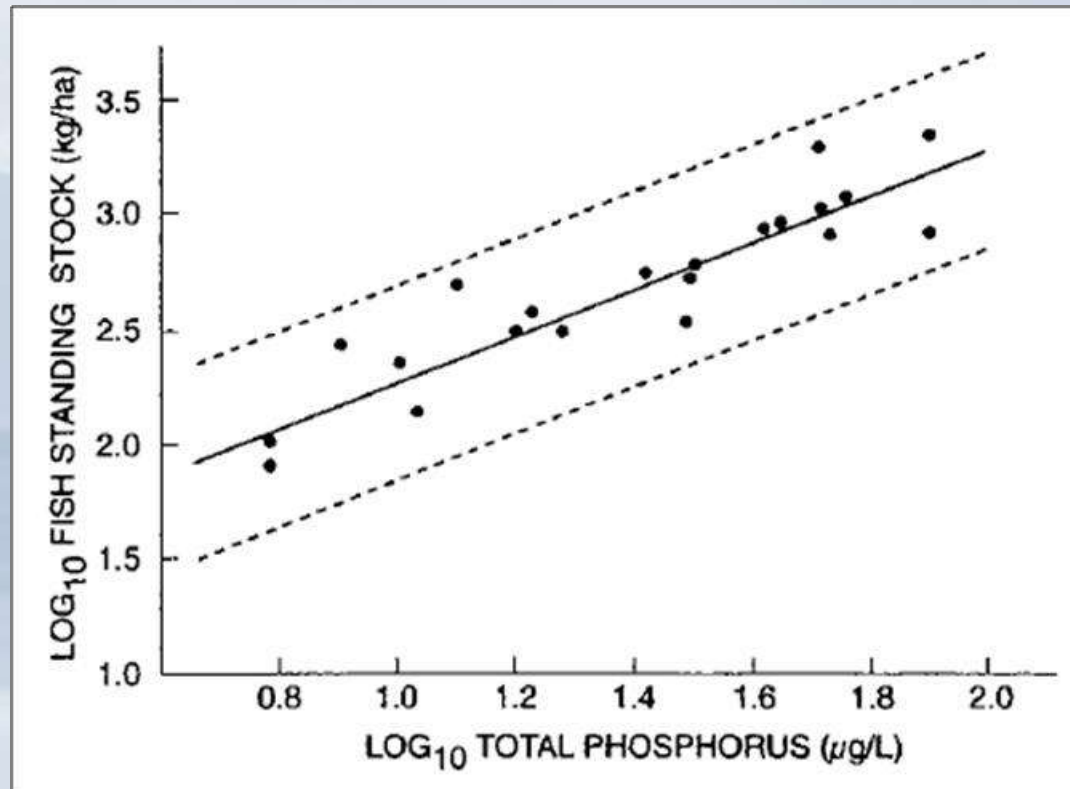


Figure from Stockner et al. 2000

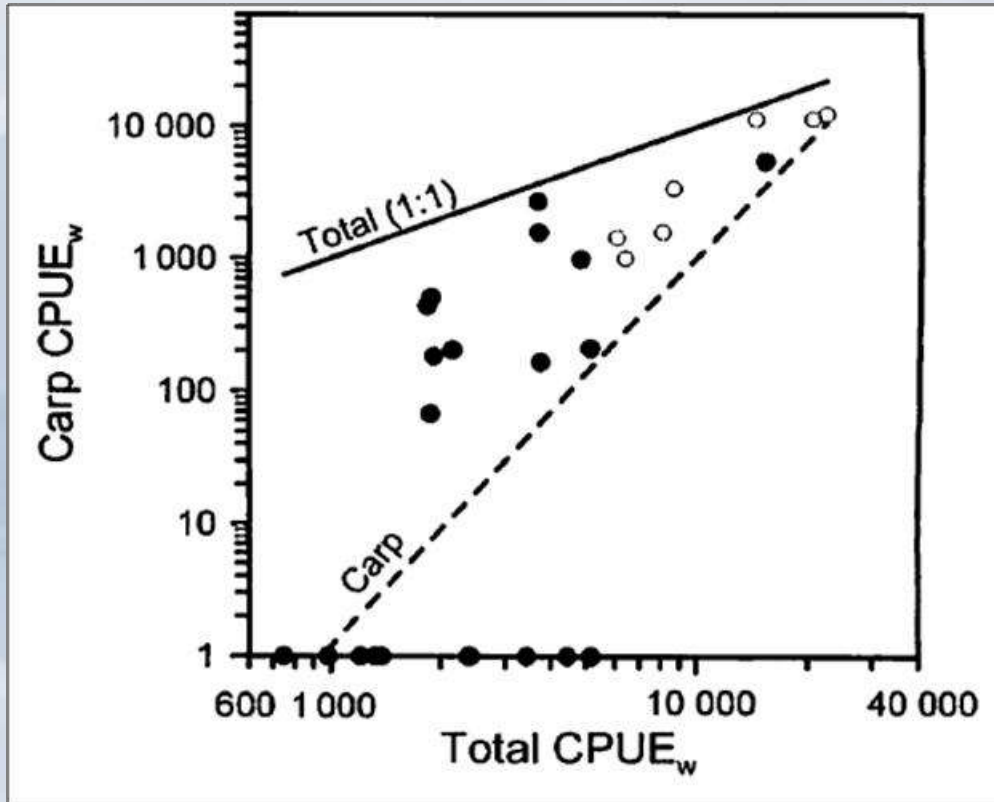
Fish production increases with lake or reservoir productivity.



*But there are caveats...*

Figure from Ney et al. 1990

High total fish biomass doesn't necessarily imply high sportfish production.



*Figures from Egertson and Downing, 2004*



# What do we mean by the term “sportfish”?

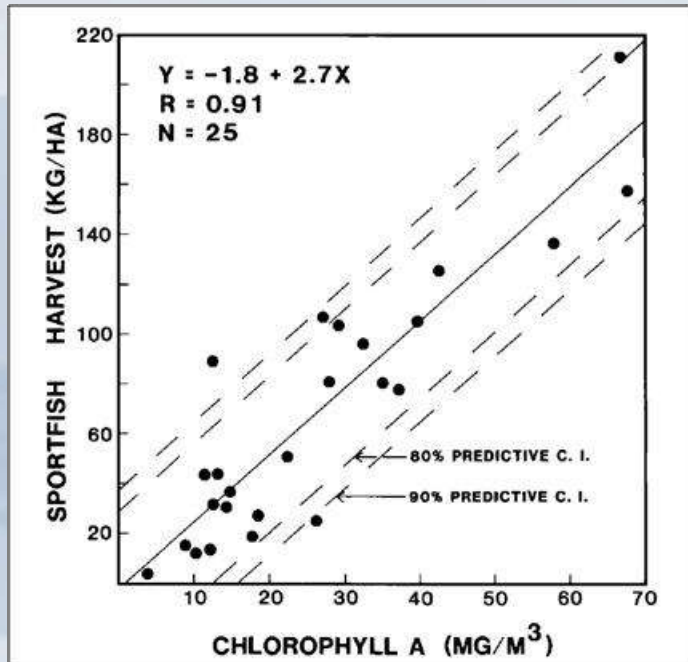
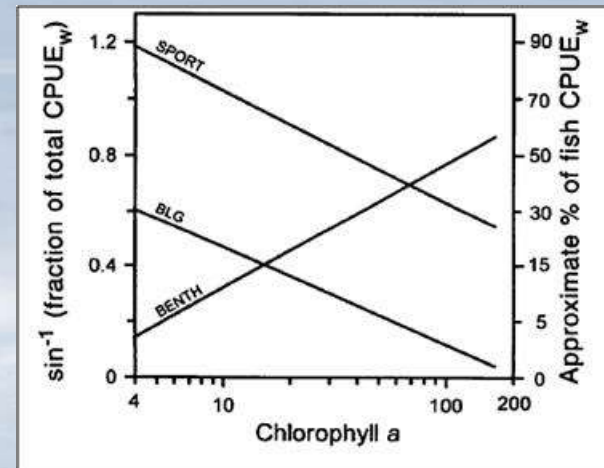
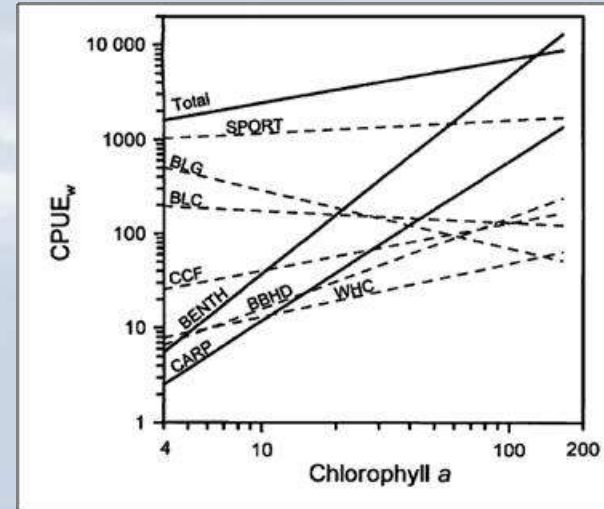
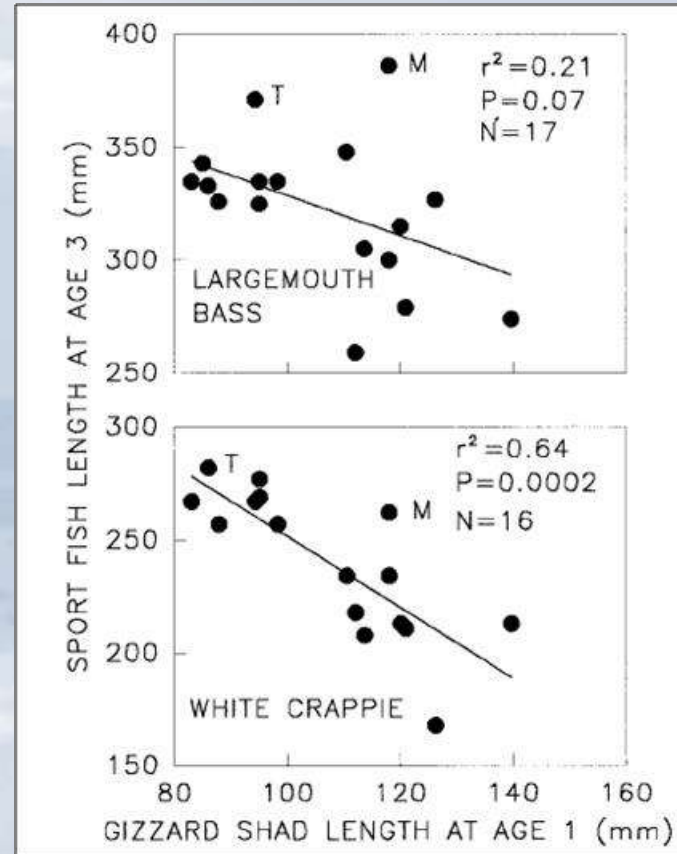
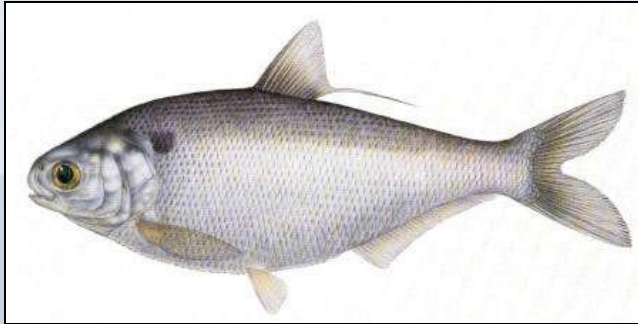


Figure from Jones and Hoyer, 1982



Figures from Egertson and Downing, 2004

# Gizzard Shad (*Dorosoma cepedianum*)



Figures from Michaletz 1998

# So, in theory...

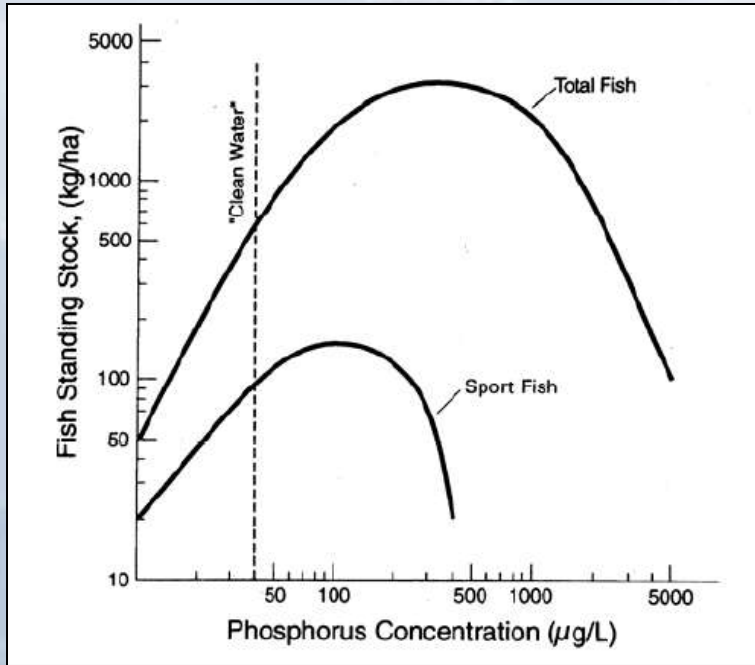


Figure from Ney et al. 1996

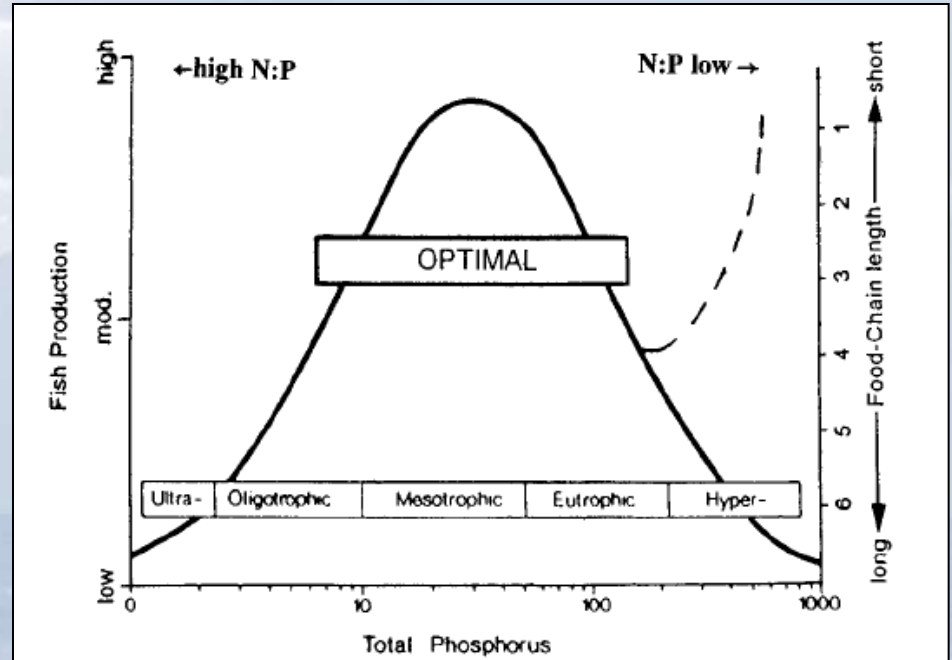


Figure from Stockner et al. 2000

## Very Low Productivity

- Lower Abundance
- Longer Lifespan
- Large Maximum Size?
- Body Condition?
- Piscivores?

← Species shifts? →

## Very High Productivity

- Higher Abundance
- Shorter Lifespan
- Small Maximum Size
- Poor Condition
- Herbivores?

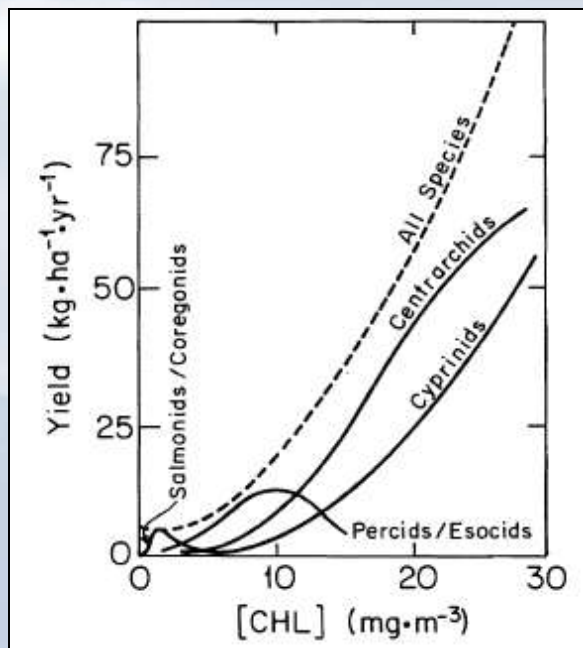


Figure from Oglesby et al. 1987

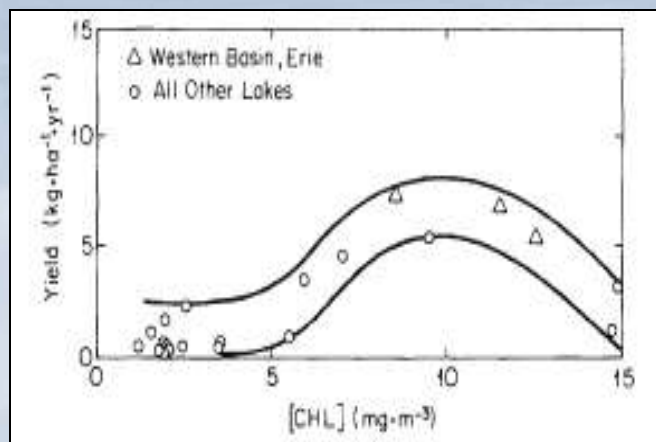
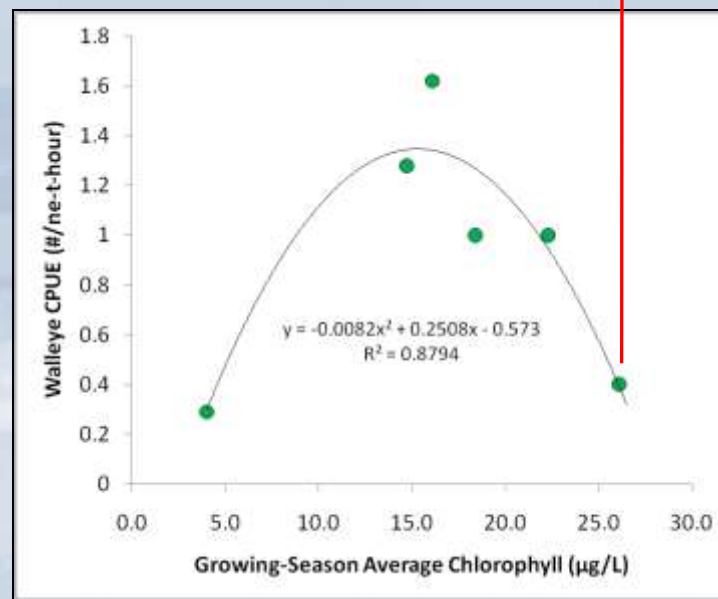


Figure from Oglesby et al. 1987



*Record fish don't always come from the most productive waters...*

Species	Location	Weight
Channel Catfish	Aurora Reservoir - 2010	43.4 lbs
Smallmouth Bass	Navajo Reservoir - 1993	5.75 lbs
Walleye	Standley Lake - 1996	18.8 lbs
Wiper	Pueblo Reservoir - 2004	26.9 lbs
Lake Trout	Blue Mesa Reservoir - 2007	53.4 lbs
Rainbow Trout	Morrow Point Reservoir - 2003	19.6 lbs
Native Cutthroat Trout	Twin Lakes - 1964	16.0 lbs



*... but recreational fishing is about more than trophies.*



# Nutrient Criteria for Recreational Fisheries



- Productivity of recreational fisheries may be constrained when nutrients are too low.
- Productivity of recreational fisheries may be constrained by water-quality and density-dependence when nutrients are too high.
- Lost or reduced-quality fisheries have economic consequences.
- Fishery restoration is expensive and takes time.

# What about streams?

The same general ecological principles apply but...

- Secondary productivity is more likely to be based on some combination of autochthonous production (e.g., periphyton, etc.) and allochthonous production (e.g., leaves, etc.).
- Not all streams are autotrophic.
- Water-quality conditions (e.g., pH, DO) may change more rapidly where nutrient enrichment supports high periphyton production.



# What about native and non-game species and protection of high-quality waters?



# Economic Value of Non-Consumptive Use of Wildlife Resources in Colorado

## Exhibit III-8. Activity Days and Daily Direct Expenditures for Wildlife Watching, 2006

Note: Per day expenditures measured in 2007 dollars.

Source: BBC Research & Consulting, based on 2006 USFWS national survey.

	Activity days (thousands)	Per day expenditure
Non-resident	2,394	\$174
Resident	<u>7,010</u>	\$41
<b>Total</b>	<b>9,404</b>	<b>N/A</b>

## Exhibit III-7. Economic Impact of Wildlife Watching in Colorado, 2006

Note: Measured in 2007 dollars.

1. Trip and equipment expenditures in support of wildlife watching.
2. Direct expenditures plus secondary spending by businesses and households (multiplier effects).
3. Includes job creation from direct and secondary expenditures.

Source: BBC Research & Consulting, based on 2006 USFWS national survey.

	Direct expenditures <sup>1</sup> (\$ in thousands)	Total impact <sup>2</sup> (\$ in thousands)	Total <sup>3</sup> jobs
Non-resident	\$417,400	\$720,300	7,220
Resident	<u>285,800</u>	<u>497,900</u>	<u>5,560</u>
<b>Total</b>	<b>\$703,200</b>	<b>\$1,218,200</b>	<b>12,780</b>

# A Perspective on Nutrient Control: Prevention



- TP: 188  $\mu\text{g/L}$
- TN: 2.4 mg/L
- Chl-a: 42  $\mu\text{g/L}$  (up to > 200  $\mu\text{g/L}$ )
- Secchi: 0.4 meters
- Cyanobacteria > 80% of algal biomass

Restoration to date: Over \$17 million in Federal, State, and Local \$



