

# Aquaculture's Role in the 21<sup>st</sup> Century & Associated Issues

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Recirculating Aquaculture Systems Short Course

Species	2003		1995	1990	
	Rank	lbs	lbs	lbs	Rank
<b>Shrimp</b>	<b>1</b>	<b>4.00</b>	<b>2.50</b>	<b>2.20</b>	<b>2</b>
Tuna	2	3.40	3.40	3.70	1
<b>Salmon</b>	<b>3</b>	<b>2.22</b>	<b>1.19</b>	<b>0.73</b>	<b>5</b>
Pollock	4	1.71	1.52	1.27	4
<b>Catfish</b>	<b>5</b>	<b>1.14</b>	<b>0.86</b>	<b>0.70</b>	<b>6</b>
Cod	6	0.64	0.98	1.38	3
Crabs	7	0.61	0.32	0.29	10
<b>Tilapia</b>	<b>8</b>	<b>0.54</b>	<b>0.00</b>	<b>0.00</b>	<b>NR</b>
Clams	9	0.53	0.57	0.61	7
Scallops	10	0.33	0.24	0.30	9
Flatfish	11	0.32	0.30	0.57	8

Current US  
Seafood  
Consumption  
lb/capita

**RED => Aquaculture**

# World Market Needs

## Challenges for the Future

\* where will the fish come from?

# World Food Fish Supply

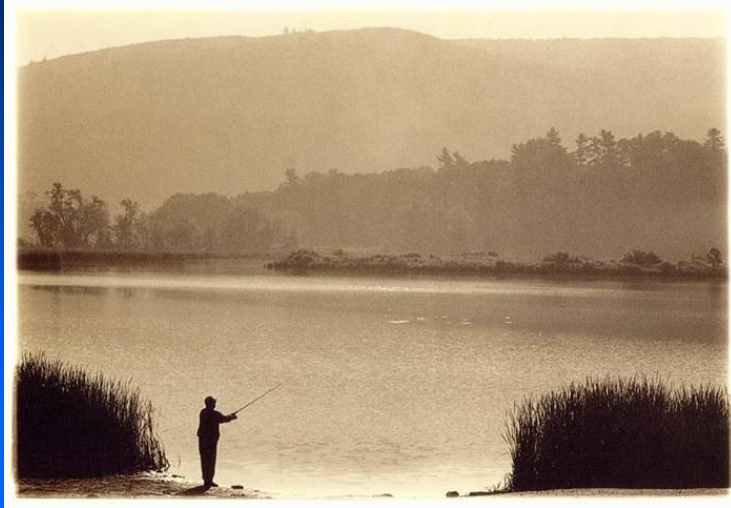
(million tonnes)

	1994	1997	1999	estimated 2010
Capture fisheries	91.4	93.6	92.3	93.0
Aquaculture	20.8	28.8	32.9	49.1
Total	112.3	122.4	125.2	142.1
% Aquaculture	18.5%	23.5%	26.3%	34.6%
 World Population (billions)	5.605	5.844	6.002	6.812
 Per Capita Food Fish Supply, kg	14.3	16.1	15.4	15.4

# Where are the fish going to be produced?

- 90% of our fish is imported
- Low-income countries will dominate supply
- What are the environmental concerns?
- Why **can't** the USA compete?

# What we think of ...



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# Conventional Aquaculture Production (opposite of Urban Aquaculture)



# My background... Fingerlakes Aquaculture

1.0 million lbs per year of tilapia production  
located in upstate NY



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# Why Reuse Water ?

- Stricter effluent regulations
- Competition for water resources
- Disease and biosecurity issues
- Cost effectiveness:
  - optimized feeding & temperatures; stocking density
- Minimize water use
  - Conserve heat, reduce discharge and water source needs
- Maximize bio-security
- Flexibility in where farm is located (near market-Urban applications)

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Tank-based production is challenged by:

strict effluent regulations

increased competition for water resources

regulatory and social pressures to conserve  
resources

lower farm gate prices

disease and biosecurity issues

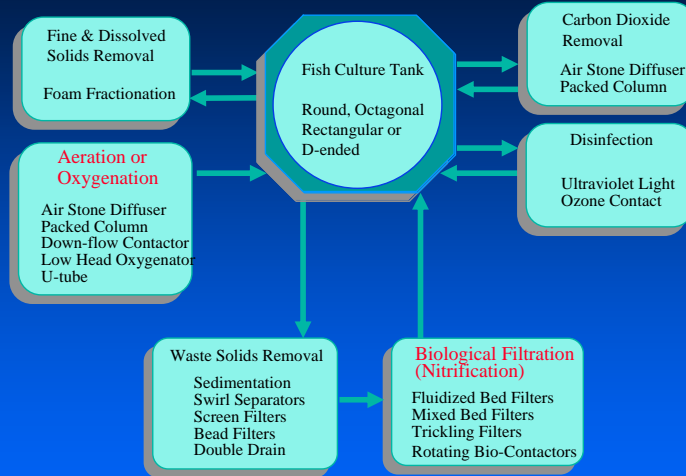
# Water and Land Use Issues:

Ratio of Land and Water Use for Various Systems *versus*

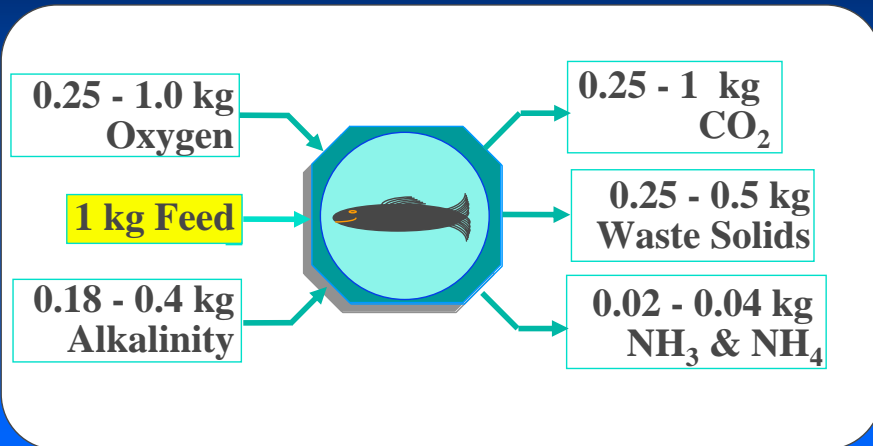
Indoor Recirculating Tilapia Production

Species and System	Production Intensity (kg/ha/y)	Water required (Liter/kg)	Ratio = Land or Water Use to RAS Use	
			Land	Water
<i>O. niloticus</i> (Nile tilapia) ponds	17,400	21,000	77	210
<i>I. punctatus</i> (Channel catfish) ponds	3,000	3,000 - 5,000	448	400
<i>S. gairdneri</i> (Rainbow trout) raceways	150,000	210,000	9	2,100
Panaeid shrimp pond (Taiwan)	4,200 - 11,000	11,000 - 21,340	177	160
<i>O. niloticus</i> (Nile tilapia) RAS	1,340,000	100	<b>1</b>	<b>1</b>

# Design of a Water Recirculation System



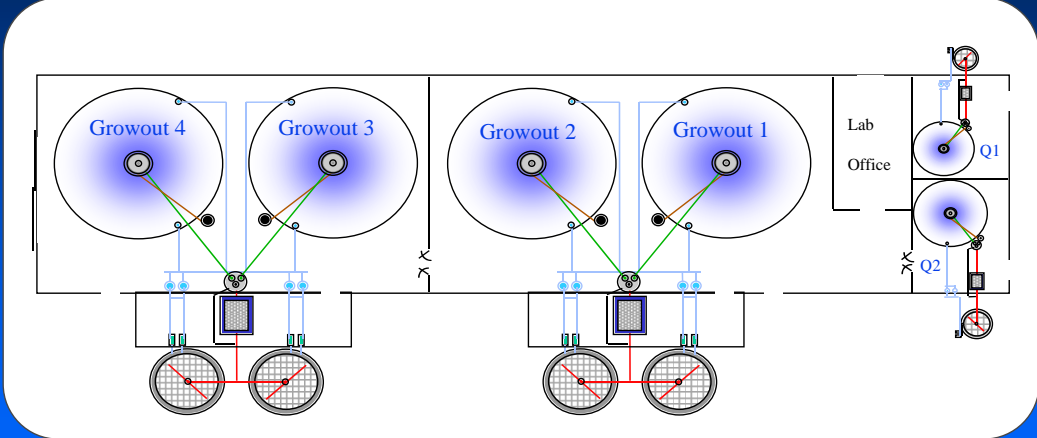
## All design parameters are proportional to feeding rate





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# Recirculating Tank System

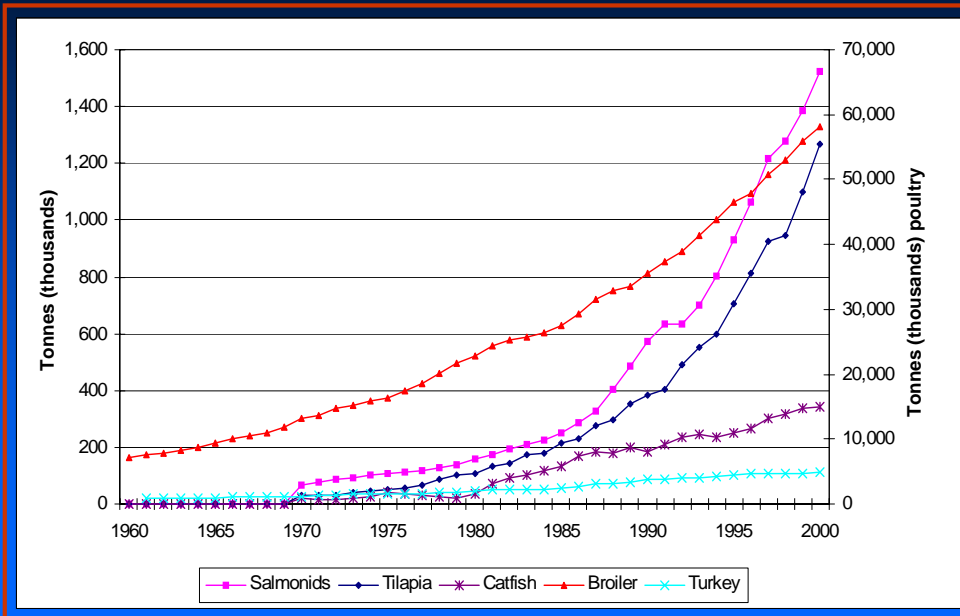


North Carolina State Fish Barn Layout

# Aquaculture Success will depend upon:

- Low cost production
- Environmental sustainability
- Appropriate technology (country specific)
- Matching production to appropriate markets

# Growth of Meat Consumption



# Consumers are looking for

- Quality
- Value VALUE VALUE
- Convenience
  - Ready to eat salad mixes
  - Bottled water

*Do you care where your food comes from?*

# QUIZ

Rank the following for concentration of PCB's

1. Chicken Breast
2. Butter (w/ salt)
3. Farmed Salmon
4. Corn Bread

# Answers

Rank the following for concentration of PCB's

1. Butter (w/ salt) (70 ppb)
2. Farmed Salmon (37 ppb)
3. Chicken Breast (32 ppb)
4. Corn Bread (11 ppb)

# QUIZ

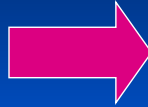
What is the allowable FDA level of pcb's in our food?

- 10 ppb
- 100 ppb
- 1000 ppb
- 2000 ppb (2 mg per kg or 2 ppm)

## Farmed Salmon vs Wild?

- Salted butter (70 ppb); chicken breast (32 ppb); popcorn (17 ppb); cornbread (11 ppb)
- Science reported (Cornell authors, no less)
  - PCB's of 17 to 50 ppb in farmed (36.6 avg)
  - PCB's of wild were 5 ppb
- FDA allowed level is 2000 ppb !!
- Heart disease **reduced** by 25% by eating one meal a week of "fatty" fish

## Challenges to Producing a Fillet for \$3.50/lb



30% yield



Assume Farmer produces product for \$1.00 per lb DIRECT cost  
WHAT is the retail cost to the consumer?

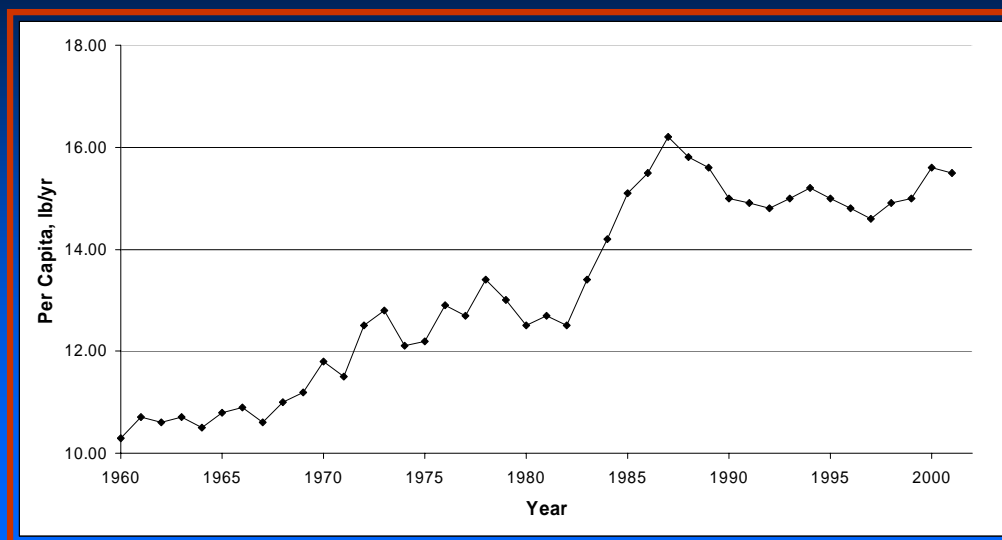
## Farm to Market

Farm Cost (whole fish), \$/lb	\$ 1.00
Farmer margin	20.0%
Processor	
yield on fillet	30.0%
margin	35.0%
Wholesaler margin	35.0%
Distributor margin	10.0%
Retailer Margin	35.0%
Retail Price, \$/lb	\$7.22

# Farmed Salmon Growth

Year	million lb per year	Growth % last 5 years
1980	44	
1985	110	20.1%
1990	550	38.0%
1995	1,210	17.1%
2000	2,420	14.9%

# US Seafood Per Capita Consumption



**Why has US Seafood  
consumption stayed flat?**

**Why can't we mimic the  
explosive growth of the  
Poultry Industry?**



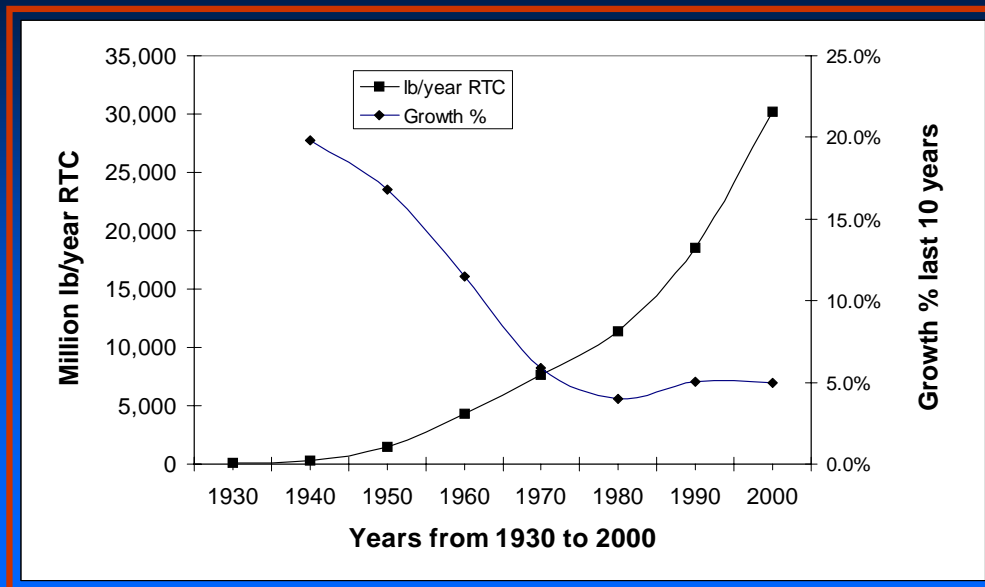
# Marketing & Scale of Operation

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# 1943

- Jesse Jewell (Gainesville, GA) started the beginning of the commercial broiler industry
- JJ owned a feed mill and a processing plant
- This initiated a period of 20% growth
- Will it happen for indoor aquaculture?

## US Broiler Industry Growth and % Growth



## How USA Broiler Meat Is Marketed

Year	Whole	Cut-up	Further Processed
1962	83	15	2
1965	78	19	3
1970	70	26	4
1975	61	32	7
1980	50	40	10
1985	29	53	17
1990	18	56	26
1995	11	53	36
2000	9	46	45

## RAS Tilapia Production Costs (scale effects)

	Small Farms	Medium Scale	Integrated Farms
Lbs/yr	250K	1.5 million	12 million
Labor	\$0.65/lb	\$0.25/lb	\$0.11/lb
Feed	\$0.39/lb	\$0.25/lb	\$0.15/lb
Utilities	<u>\$0.36/lb</u>	<u>\$0.15/lb</u>	<u>\$0.10/lb</u>
Total Direct Cost	\$1.51/lb	\$0.75/lb	\$0.50/lb

## World Tilapia Production Costs

COUNTRY	Cost of Production	
	\$/lb	\$/kg
Brasil, Ecuador, Cuba	\$0.50	\$1.10/kg
Costa Rica, Jamaica	\$0.55	\$1.20/kg
Colombia, México	\$0.68	\$1.50/kg
USA	\$0.91	\$2.00/kg

## Relative Costs of Animal Feed

Component	Cost \$/ton	Hog	Broiler	Tilapia	Salmon
Protein		16%	21%	36%	55%
ME of diet, Kcal/kg		3,465	3,300	2,800	4,400
Fat (bulk)	\$ 260	6%	6%		
Corn	\$ 112	70%	62%	15%	
Soy (48% )	\$ 187	23%	21%	40%	20%
Wheat	\$ 153			20%	
Fish Meal (62% Protein)	\$ 550		2.5%	10%	50%
Fish Oil	\$ 508			2%	12%
Blended Ingredient Cost \$/Kcal		\$ 0.044	\$ 0.046	\$ 0.074	\$ 0.093
Blended Ingredient Cost \$/ton		\$ 137	\$ 138	\$ 187	\$ 373

## Can RAS produced fish compete?

### Reminders--

- Catfish farm side @ \$0.70/lb and 45% fillet yield  
=> tilapia farm gate at \$0.51/lb (33% yield)
- Broiler production
  - 1,000,000 kg/yr per person (vs. 100,000 kg for fish)
  - \$0.10/kg for broiler labor, capital costs, utilities
  - twice feed requirements per unit of broiler meat produced
  - productivity per unit space only 50% indoor fish

# Issues & Applications to Developing Countries

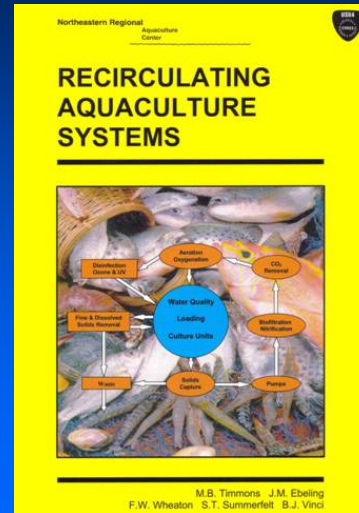
- Issue: in LDC's, Environmental protection, sustainability, job creation & economic growth
- China: selenium deficiency for 2/3 country
  - Plants and Animals are deficient => human deficiency (cancer, poor neural development)
  - Use a cultured fish tank to deliver selenium enriched feed; people eat fish etc etc.

# New Book

## Recirculating Aquaculture Systems

by  
M.B. Timmons, J.M. Ebeling, F.W. Wheaton,  
S.T. Summerfelt, & B.J. Vinci

- 760 pages + CD Rom of Software Programs
- Available through:  
Amazon; Aquatic Eco Systems, WAS;  
Cornell Book Store



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# Closing thoughts?



QUESTIONS ?

