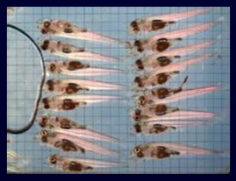



Walleye culture from fry to fingerlings:
Foundation of research in sport fish culture

J. Alan Johnson
Rathbun Fish Hatchery and Research Facility, Moravia, IA

DNR

Why walleye culture?

Why walleye culture?

Demand for walleye

- Walleye are a valued as sportfish and table fare.
- Cultured primarily for sport fishery enhancement.
- Market for all life stages - egg to adult.
- Limited food fish production in the US.
  - 7-10 million lbs of Canadian walleye or pike perch imports.
  - Retail $11 to $16/lb
    - 2010 Des Moines, IA
    - R. C. Summerfelt

Progress in walleye culture

In the past, the suitability of walleye for intensive production was questioned:

- Poor survival on feed,
- Poor growth rates,
- Poor feed conversion,
- Prone to disease.

Rathbun Fish Hatchery data is proof to the contrary.

- 1.35 feed conversion ratio.
- 1.5 mm/d growth rate
- Survival >70% fry to 9”

Overview

Walleye production on formulated feed.

- Consider challenging characteristics
  - Wild Broodstock sources.
- Feeding and culture techniques for walleye:
  - Larvaculture.
  - Tandem pond-tank culture.
    - Habituation.
    - Grow out to 9-10”.

Characteristics

Gas bladder inflation – physoclistus

Piscivorous from fingerling to adult

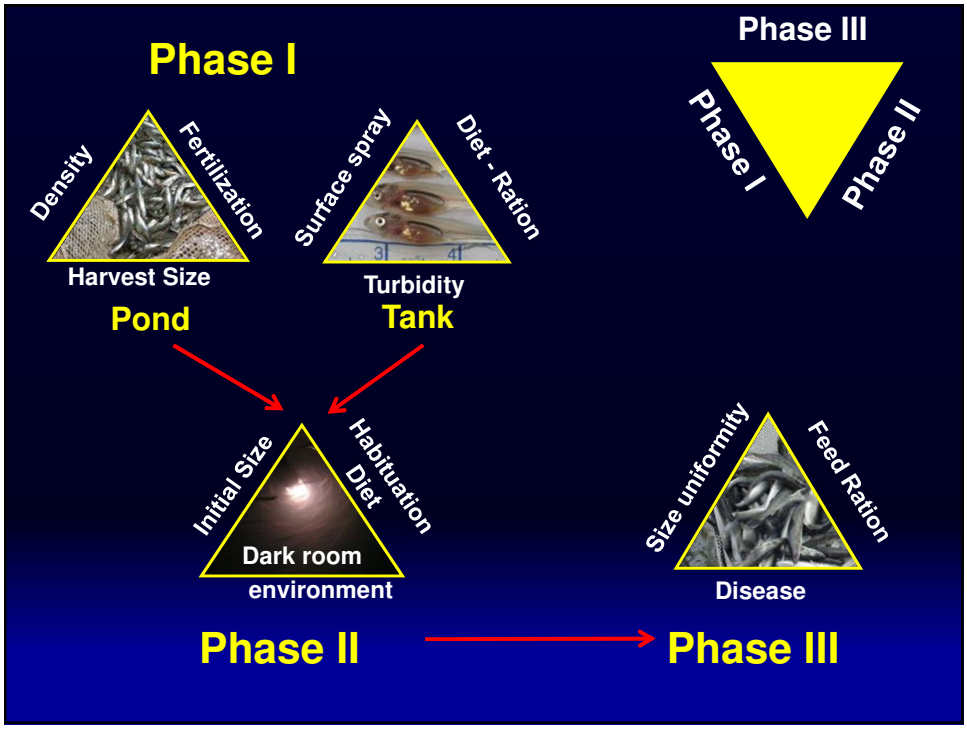
Coolwater species.

Tapetum lucidum

- Reflective surface at the back of the retina.
- Preadapted to life in low light environments (Moore 1944).

Phototaxis

- Positive - hatch to 21 days.
- Negative - 21 days through adulthood.

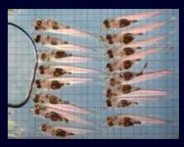


Phase I Larviculture

Larva

Prolarval to early juvenile stage (Summerfelt et al. 2011).

"ends when all organs and structures related to food acquisition are completely developed and functional." (Yufera 2011)



Culture: maintain in conditions suitable for growth.

Tank = Intensive culture

Production can be increased at will.

Pond = Extensive culture

Production is limited by the food web.

Larvaculture

Comparative Risks

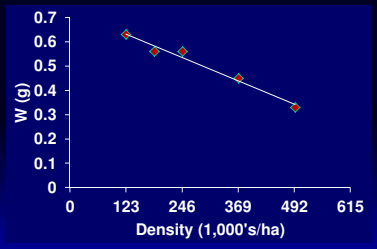
	Pond Culture	Tank Culture
Biosecurity	**Low**	**High**
Fingerling supply	**Seasonal**	**Year round**
Capitol costs	**Land, ponds**	**Building, tanks**
Larval care	**Low**	**High**
Deformity	**Rare**	**Low**
Controlled environment	**Vulnerable**	**Controlled**
Mechanical failure	**Low**	**Vulnerable**

Bottom Line: Food fish systems will require intensive fry culture.

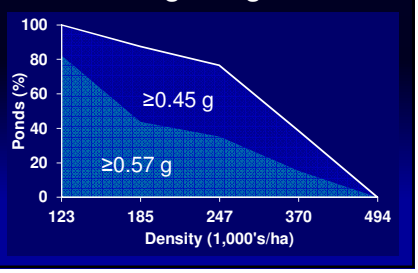
Phase I: Ponds

1-ac plastic-lined ponds.
Alfalfa pellet fertilization
100 lbs initial, 100 lbs/wk.
Producing quality fingerlings.
Quality = size.

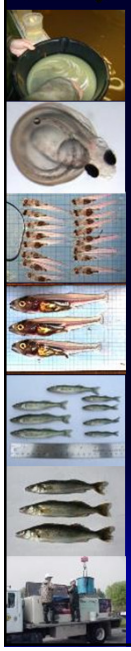
Density vs. Fish weight



Meeting size goals



Phase I: Ponds



Can higher nitrogen application result in more quality fish?

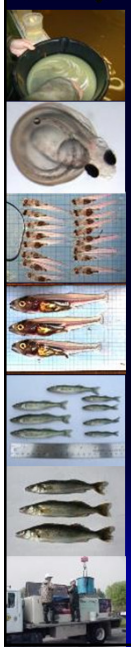
YES

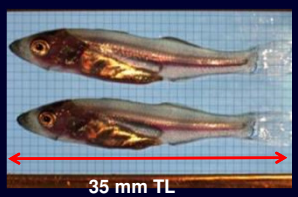
Definition of quality fish revised:

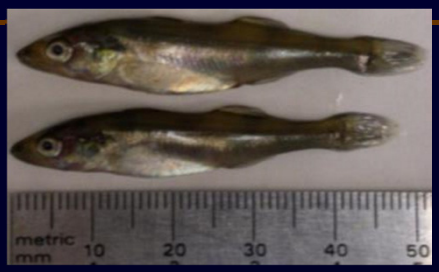
- 800/lb (0.57 g) for habituation to feed.
- 1000/lb (0.45 g) for stocking in stream fisheries.

Year	Density #/ha	Fertilizer	N (kg/ha)	W (g)	% Ponds ≥ 0.57 g	% Ponds ≥ 0.45 g
2011	123K	ALF	16.8	0.74	100	100
	123K	SBM	34.8	0.78	100	100
	185K	SBM	34.8	0.66	100	100
2013	123K	ALF	20.7	0.55	33	100
	185K	Mix	30.4	0.69	85	100

Why >800/lb?





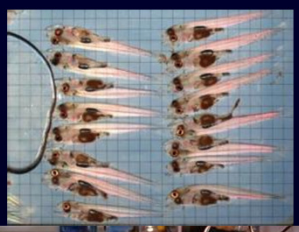


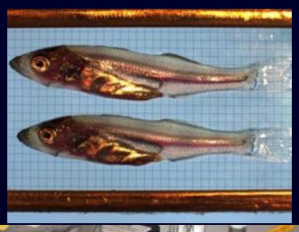
800/lb = >42 mm; 1000/lb= 37 mm.

- Habituation of pond reared fingerlings best above 0.57 g. (about 42 mm). Johnson and Rudacille (2010).
- Scale development initiated at 24 mm complete at 45 mm.
  - Priegel (1964)
- Mechanical damage allows entry of Columnaris.
  - Huissain and Summerfelt (1991)

Theory: fingerlings larger than 0.57 g are fully scaled and therefore more resilient to handling.

Phase I Larvaculture in tanks



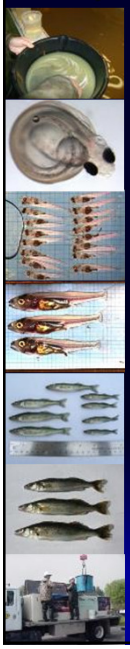


Larvaculture - Artemia

1. First feeding to 125 mm.
   - Quebec's La Station Piscicole de Baldwin-Coaticook.
     - 25% survival during habituation to feed.
     - To a fall fingerling – 70% survival
     - 17.5% overall survival – 107 mm.
   - New York's Oneida Hatchery
     - 40 days of Artemia, 10 day habituation to diets (50d)
     - 30-50% mortality during habituation to feed.
     - 25% survival from fry to 125 mm.

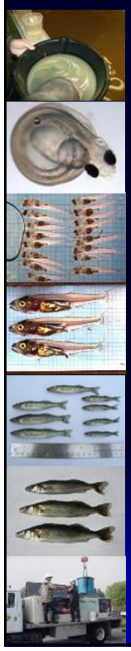

Oneida Fish Hatchery, NY

Larvaculture - diets



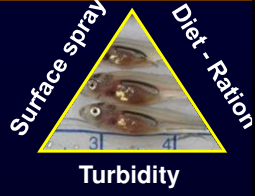
2. **Manufactured diets.**
   - Research at Rathbun and ISU, production in VT.
   - First feed at 2 days post hatch.
   - 50% to 80% survival at day 25 post hatch.
   - Key techniques:
   - Surface spray
   - Turbid water
   - 100 lx light
   - Frequent feeding
   - Diet - Otohime.

Larvaculture - diets

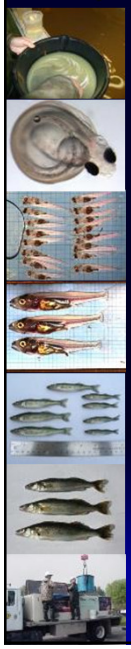


Key culture techniques:

- Turbid water (50 NTU) to prevent surface cling.
- Surface spray to facilitate gas bladder inflation.
- Palatable diet and precision feeding.



Larvaculture - diets

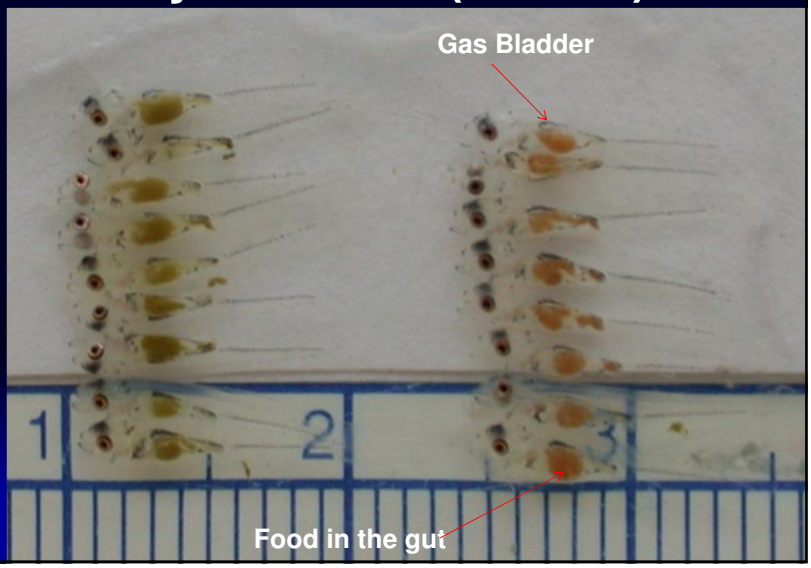


Changing strategies:

- Goal to produce 42 mm fish, 0.57 g.
- Reduce density from 40 fry/L to 30 fry/L.
- Increase temperature from 18.5˚ C to 21˚ C.
- Longer culture interval: up to 35 dph.
- Flow rates from 0.5 to 2 exchanges/hour.
- Started on grower diet.

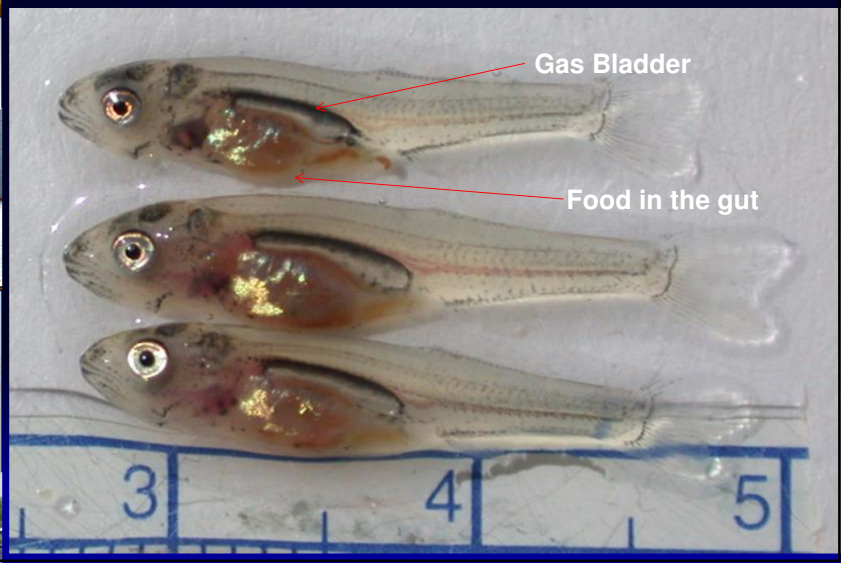
Larvaculture - diets

7 day old larva (11 mm)



Larvaculture - diets

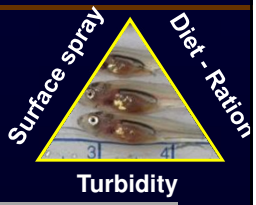
21 day old larva (23 mm)

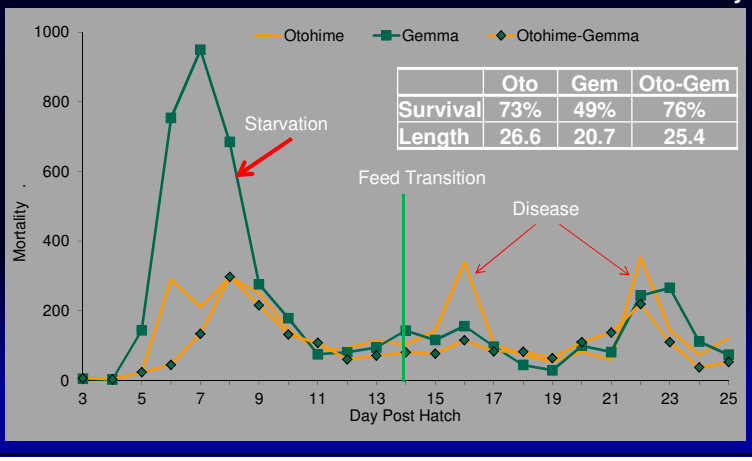


Larvaculture - diets

Starvation vs disease:

- Palatability differences in diets.
- 2007 diet trial.

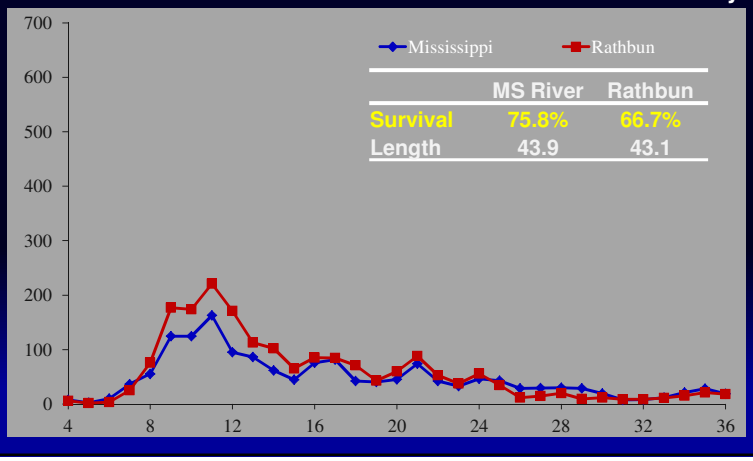


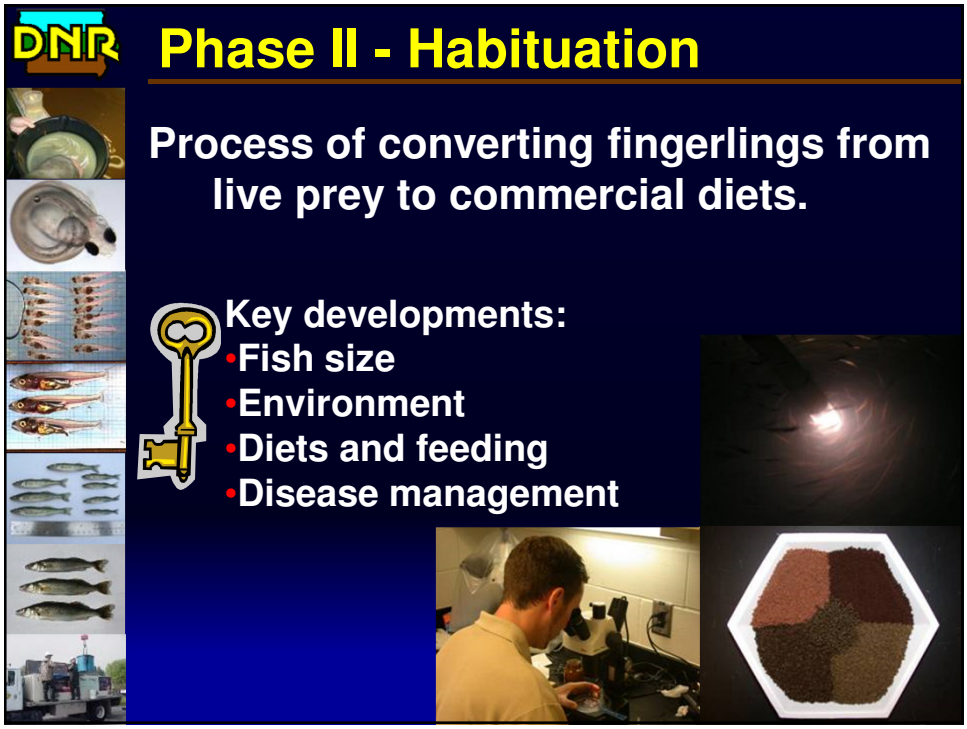


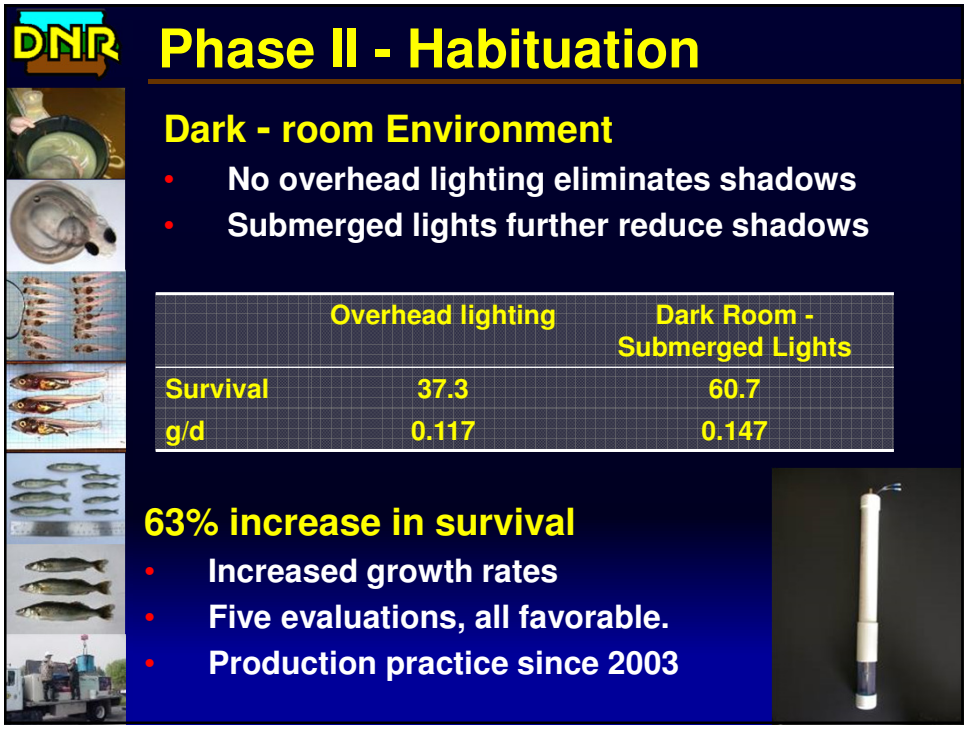
Larvaculture - diets

Broodstock sources:

- Mississippi River or Rathbun
- 2012

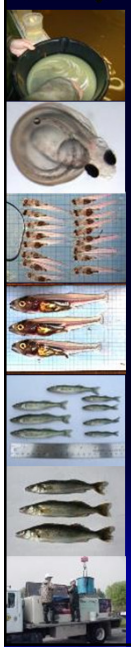






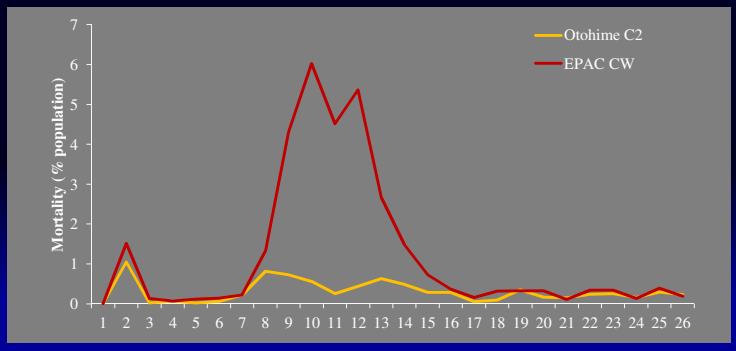
	Overhead lighting	Dark Room - Submerged Lights
Survival	37.3	60.7
g/d	0.117	0.147

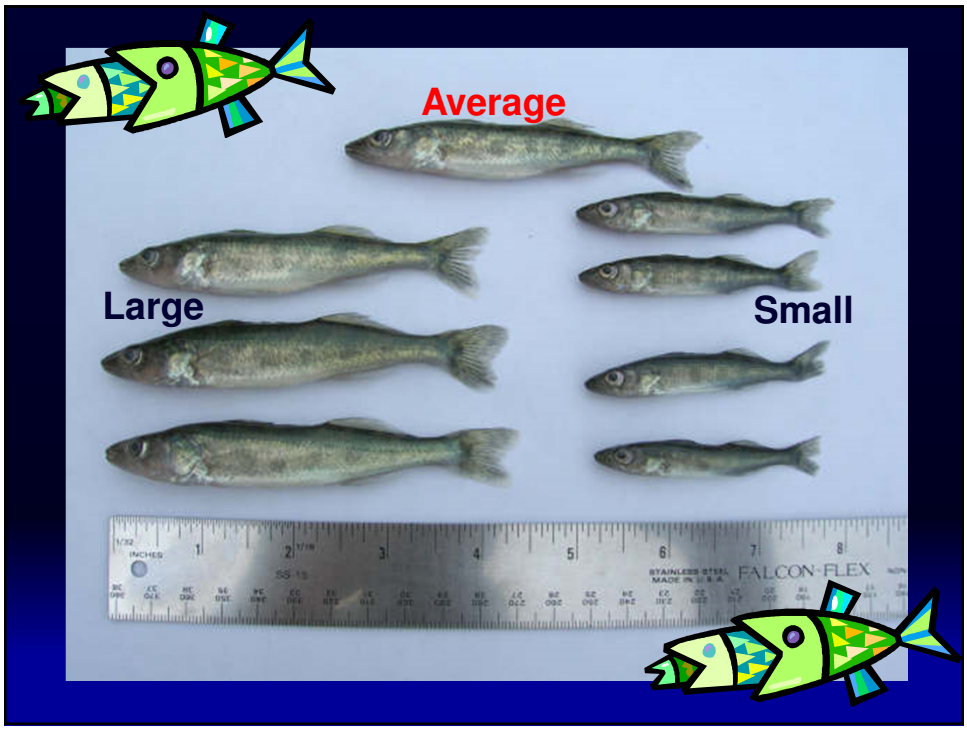
Phase II



Keys to success:

- 0.57 g fingerling.
- Dark room environment, subm. light.
- Habituation feeding regime:
  - Day 1-10: Otohime C2.
  - Day 11-17: Mix of Otohime C2, Walleye Grower 1. 0.
  - Day 18-35: WG 1.0 to 2.0.





Phase II - Grading

- High habituation survival - up to 15% cannibalism during Phase III grow out.

	Graded	Ungraded
Cannibalism	2%	10%
Survival	94%	78%
FCR	1.6	1.9

Phase III - Growout

Growout to 9 inches:

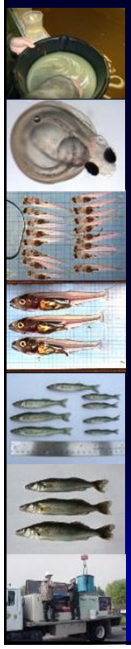
- 75% of fish cost incurred.
  - Feed; FCR = 2.0.
  - Therapeutants; Formalin $32,000.

How can we improve efficiency?

Improve FCR

Year	Research Project	FCR	$ Savings/tank
2008	Phase II grading	1.6	$1780
2009	Measure fish, Feed the gain	1.4	$700

Phase III

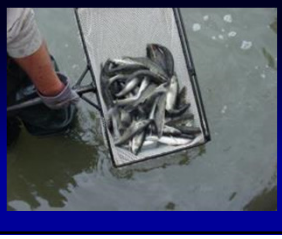


Growth period – July – October

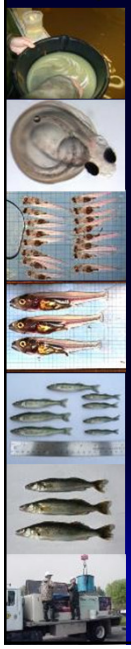
3.75 in. to 9-10 inches

Culture System:

- 10 outdoor circular tanks
  - 40,000 gal.
- Flow rate 0.45 exchanges/hour
- Final density 0.15 lb/gal



Larvaculture



2011 Growout to 200 mm

2011 Data	Fry culture	Pond – Tank[a]
Phase I	3-37	3-35
Survival (%)	46.3	91.9
Final L (mm)	42.3	50.6
Phase II	38-67	36-67
Survival (%)	69.4	71.5
Final L (mm)	91.6	93.8
Phase III		
Survival (%)	91.4	88.6
Final L (mm)	207.5	209.7
Deformity (%)		
Opercula	0.60	<0.01
Jaw	0.30	<0.01
Sloped head	1.60	<0.01
Normal	97.40	100.0

[a] Values for Phase I and III pond culture fingerlings were obtained from Rathbun Fish Hatchery production averages for 2011. Phase II results were obtained in a research trial at Rathbun Fish Culture Research Facility.

Growth rates

75-78º F Optimal Growth Temperature

- Fry
  - Pond Culture: 1.2 mm/d
  - Intensive Fry culture: 1.0 mm/d 18.3º C
- Fingerlings: 45 to 90 mm
  - 1.75 to 2.0 mm/d
- Fingerlings: 90 to 230 mm
  - 1.5 to 1.75 mm/d

Survival (%) by Culture Phase

Year	I	II	III	Fry to fall fingerling
2001	71.5	28.9	88.7	46.6
2002	89.6	26.0	90.8	59.7
2003	84.6	33.1	97.4	60.5
2004	81.7	46.9	92.7	35.5
2005	99.6	52.9	83.0	60.7
2006	87.7	67.3	82.8	48.8
2007	95.0	91.8	85.5	74.4
2008	85.0	89.1	88.7	67.2
2009	100.9	87.5	85.6	74.9
2010	92.9	84.0	94.1	73.4
2011	90.7	85.1	82.8	63.9
2012	89.0	61.0	82.9	45.0
2013	89.8	71.4	80.2	51.4

For more information

North Central Regional Aquaculture Center:

Walleye Culture Manual (1996)

R. C. Summerfelt, Editor

Production of walleye as potential food fish (2010)

R. C. Summerfelt et al. NCRAC Pub #116

American Fisheries Society

Biology, management, and culture of walleye and sauger. B. Barton Ed.

Walleye Culture Chapter

Summerfelt, Johnson, Clouse.