UNIVERSITY OF SKÖVDE

An Interpretation Of Four Years Multi-mesh Gillnet Survey Data From Lake Vättern

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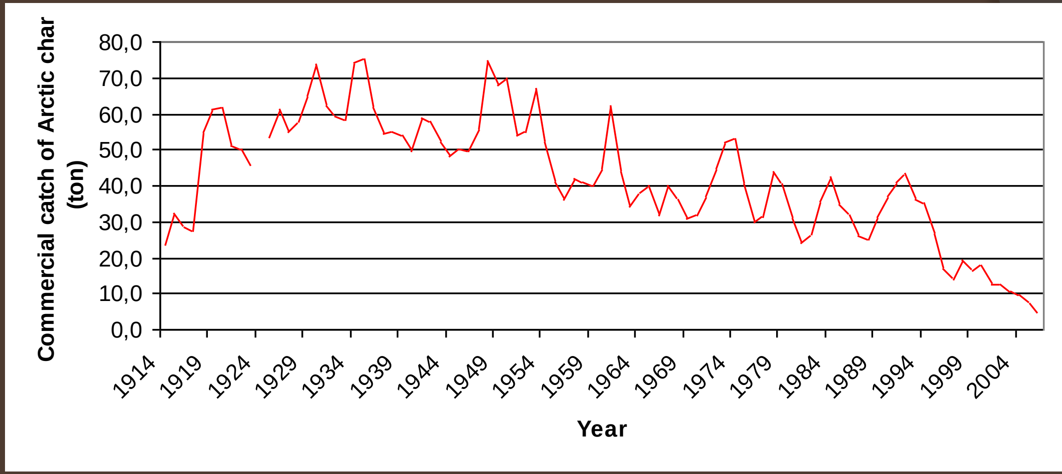
RESEARCH CENTRE

Introduction

- Lake Vättern (Sweden's second largest lake) is a deep, oligotrophic lake with approximatley 30 fish species and 5 of them are redlisted, including a nationally unique stock of largebodied Arctic char (*Salvelinus umbla*).

- 1950s: 60-70 ton/year
- 1985: 30 ton/year
- 1996-2000: 17 ton/year
- 2001-2002: 12,5 ton/year
- 2006: 4 ton/year

Yearly commercial catches of Arctic char in Lake Vättern (1914-2006)



- Catches of Arctic char have decreased since the 1950s…
  - ⇨The stock of Arctic char is assumed to have decreased dramatically!

Why does the stock of Arctic char decrease in Lake Vättern?

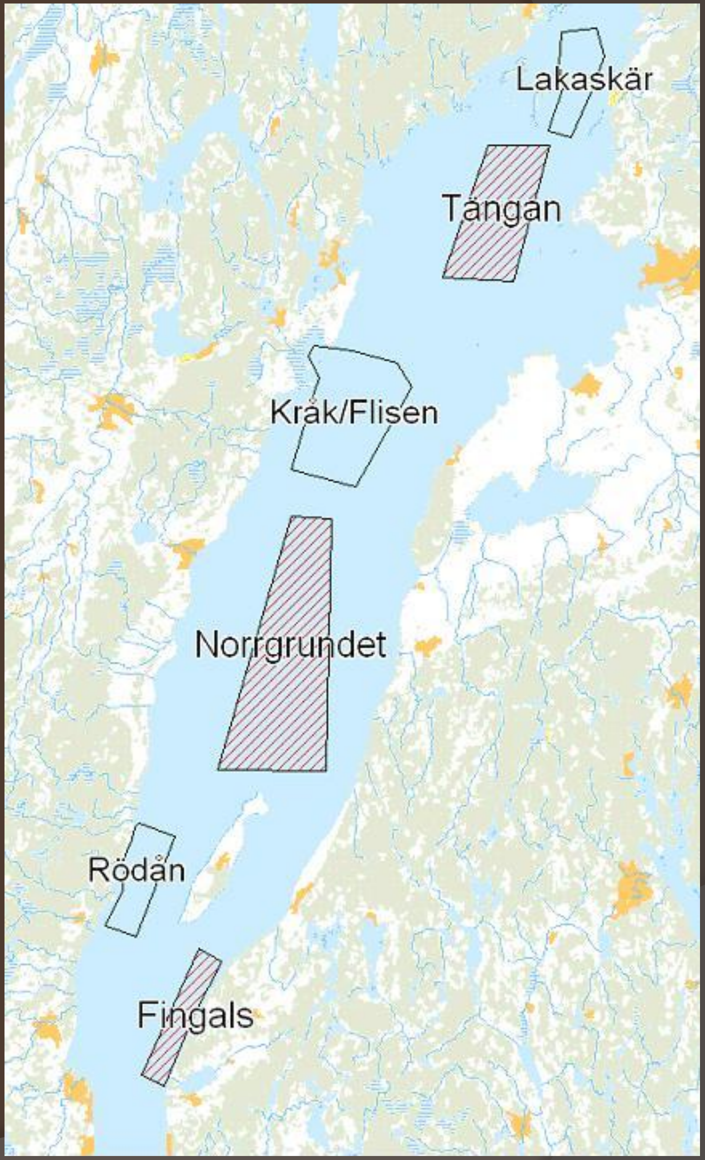
New restrictions in 2005…

- Increased minimumlength from 40-45 cm (from 2008; 50 cm)
- Protected areas all year around (3 area where fishing is prohibited)
- Restrictions for fishing gear; nets, mesh size (not smaller than 60 mm in depth deeper than 30 metres)
- Protected while spawning (15 sept-31 dec)
- Limited catches for sportfishing

  (2 char/person/day, 10 bates/boat)

- During 2006-2009 the Swedish Board of Fisheries have been conducted multi-mesh gillnets survey to see how Arctic char have been responding to the introduced restrictions.
- The main focus of a survey is to get a representation of the population structure and by repeating the survey yearly trends over time can be seen.
- 5 mesh sizes (20, 30, 35, 43 and 60) in 300 metres gillnets.

- 6 target area (3 closed and 3 reference area).
- All the fish caugth in the survey are measured by length and weigth.
- The data from the survey are used in this analyse to estimate the Arctic char population structure.



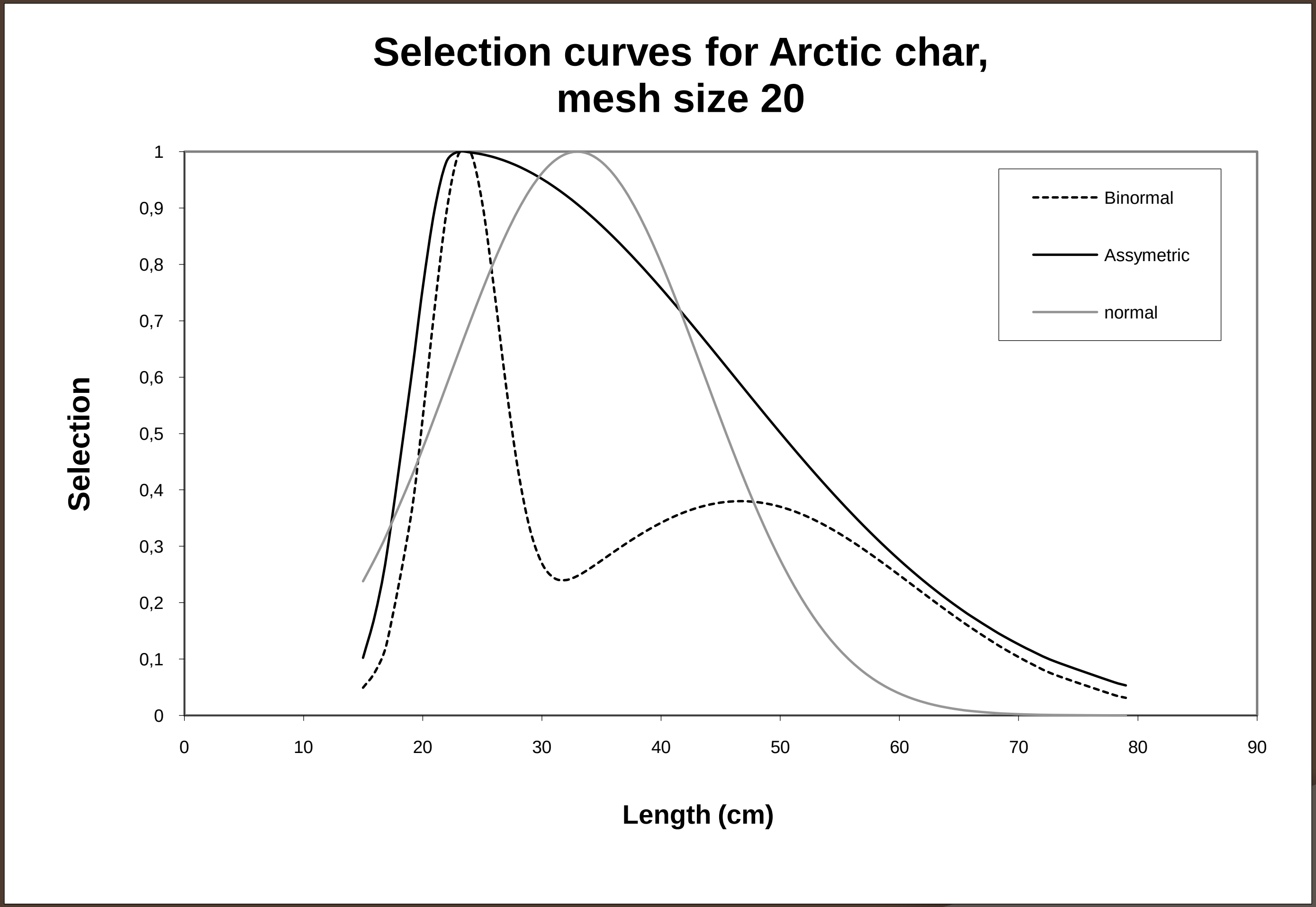
Ex. survey data for 2008

	MESH SIZE					
Length (cm)	20	30	35	43	60	Totalt
15			1			1
19	1					1
20	1	1				2
21	3					3
22	4					4
23	3					3
24	1					1
25	6					6
26	1	1				2
27	1					1
29		1				1
30		1				1
31		2				2
32		1				1
33	1	2	1			4
34		1	1			2
35	1	3				4
36		3	1			4
37		3	1			4
38	1	3	3			7
39	1	2	1	3		7
40			2		1	3
41	1	2	3			6
42		3				3
43	1	2	2	3		8
44			2	1		3
45		1	1	2		4
46		1	1			2
47		2	1	2		5
49			1	2		3
52		1		1		2
53					1	1
54				1		1
55	1	1	1		1	4
57	1		1			2
58		1	1			2
59		2	1	1	2	6
60			1			1
61		1		1		2
62		1				1
66	1					1
68					1	1
69	1					1
70	1			2	1	4
71					1	1
73		1				1
78			1			1
79		1				1
Totalt	32	44	28	19	8	131

Selection curves

- Every mesh size have different selection depending on the probability of a fish getting caugth in the net. It also depend on the length of the fish, some mesh size have higher probability of catching a fish in a certain length comparing with other mesh size.
- They have different selectioncurves.
- A selection curve tells us the probability of catching a fish of a given size.
- The selection curves can be used to (Millar & Fryer, 1999, Reviews in Fish Biology and Fishery):
  - Estimate the mortality discards and of fish escaping the gear
  - Yield-per-recruit analyse.
  - Age- and lenght-based population models.
  - Estimates of the population length frequency by correcting the observed catch length frequency.

Example of selection curves



SELECT model

- Share Each Lenghtclass's Catch Total
- We use the SELECT model to estimate the selection curves for Arctic char in Lake Vättern.
- SELECT method is working with the proportion of the total observed catch (n_{lj}) for each length class (*l*) for each mesh size (*j*).
- Every n_{lj} depends on three processes:
  - Abundance of length *l*, λ_l
  - Relative fishing intensity for mesh size *j*, p_j
  - Contact-selection curve for mesh size *j*, $r_j(l)$

- By working with the proportions of the total catch the λ_l dont need to be estimated at all.
- The proportions, y_{lj} ,j =1,….,J, have a multinomial distribution

$$\phi_{lj} = E(y_{lj}) = \frac{p_j r_j(l)}{\sum_j p_j r_j(l)}, \quad j = 1,\ldots,J$$

where E is the expected value

- By maximize the log-likelihood we estimate the parameters defining the selection curves. In our case the parameters *α*, *σ* and *ω* that define the form of the selection curves.
- The log-likelihood for the data y_{lj} , $l = 1, \ldots, L$, $j = 1, \ldots, J$ is then:

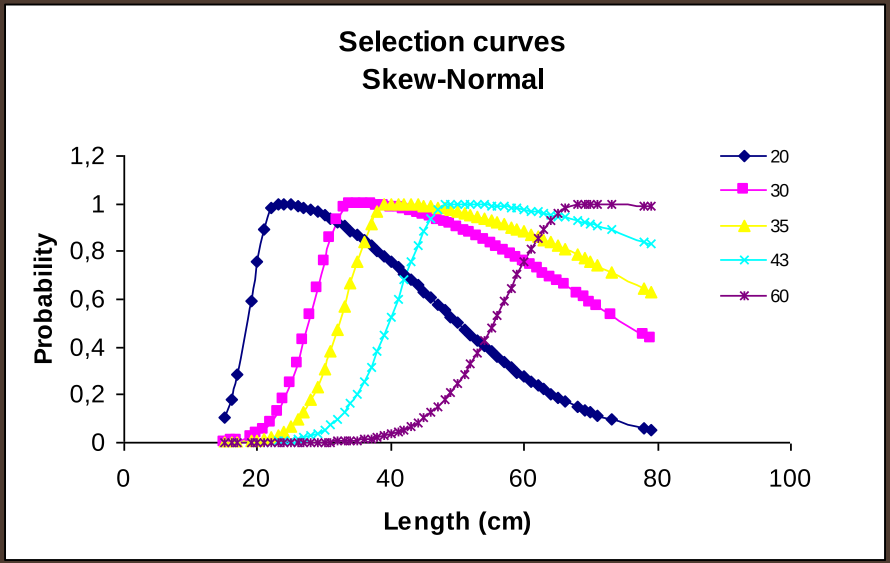
$$\sum_{l} \sum_{j} n_{lj} \log_{e}(\phi_{lj})$$

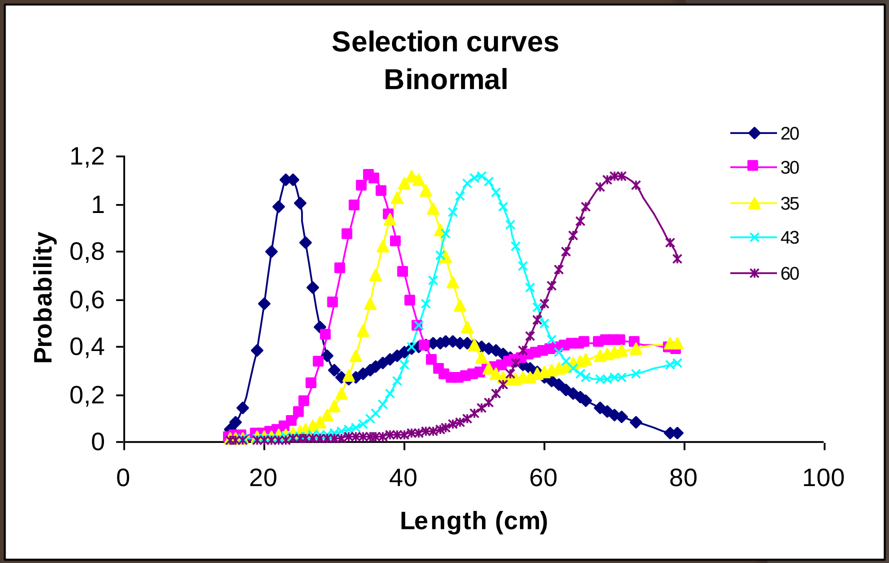
- Three kinds of functional models are applied to the selectivity curve to see which gives the best fit to the observed data. They are normal, assymetric (skew-normal) and binormal.
- In our case the binormal functional model gives the best fit.

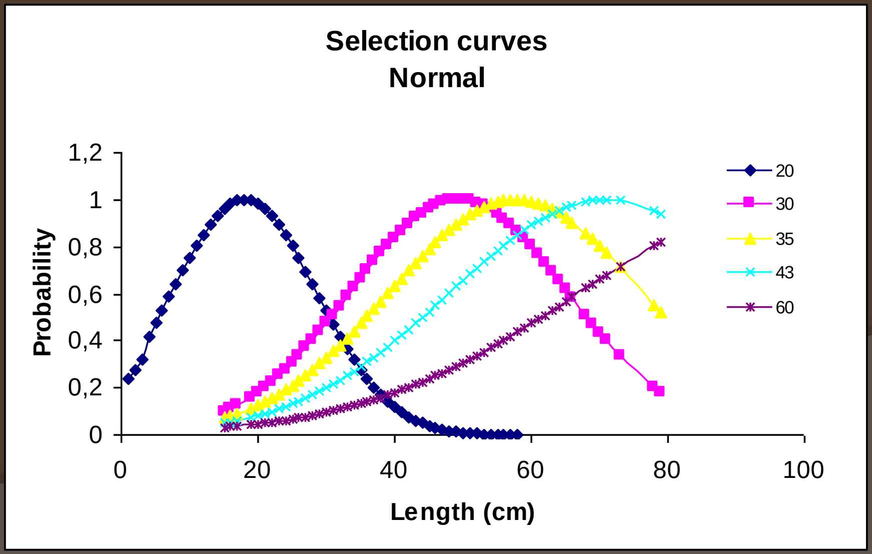
Results

Model	α1	σ1	α2	σ2	ω	MLL	Model deviance
Normal	1,649	0,530	-	-	-	-666,15	628,91
Skew-normal	1,134	0,180	-	1,162	-	-573,56	384,39
Binormal	1,172	0,147	2,334	0,723	0,420	-548,73	304,50

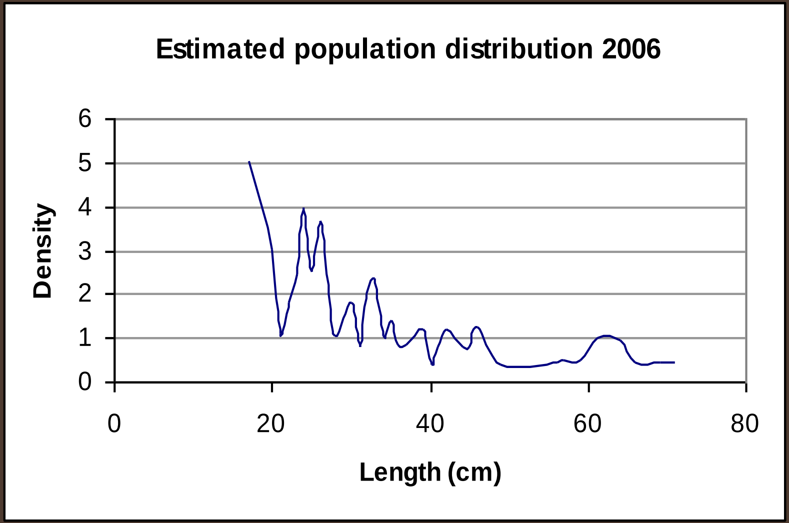
Selection curves

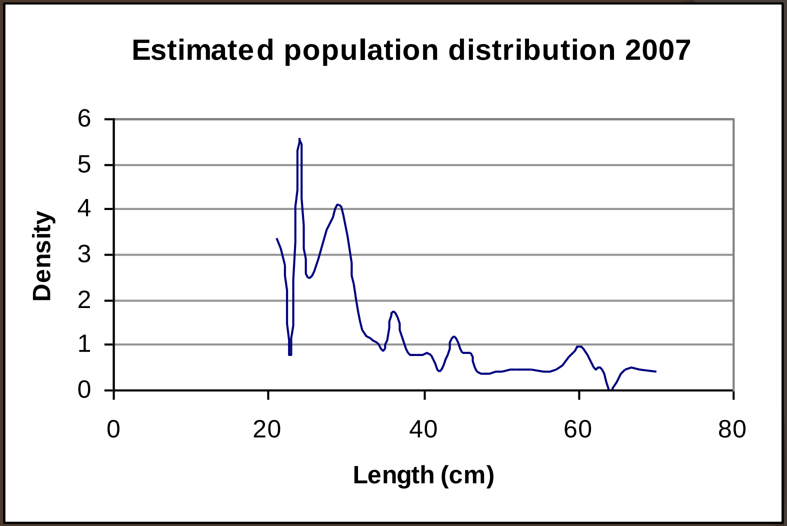


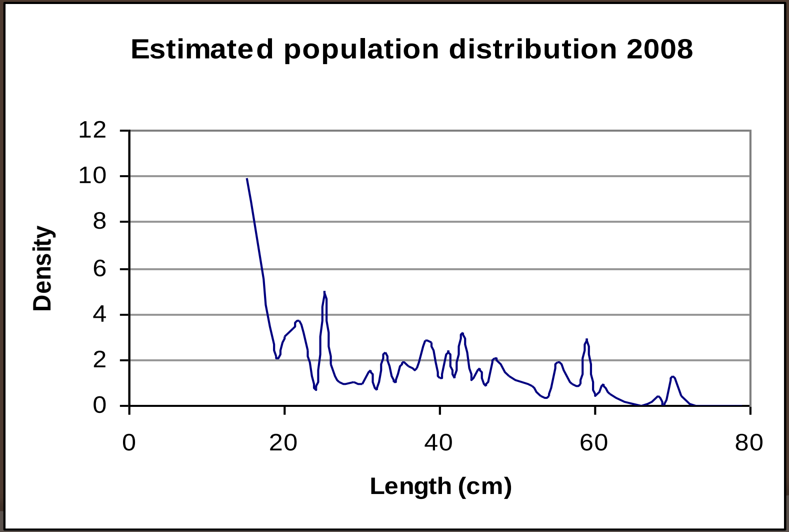


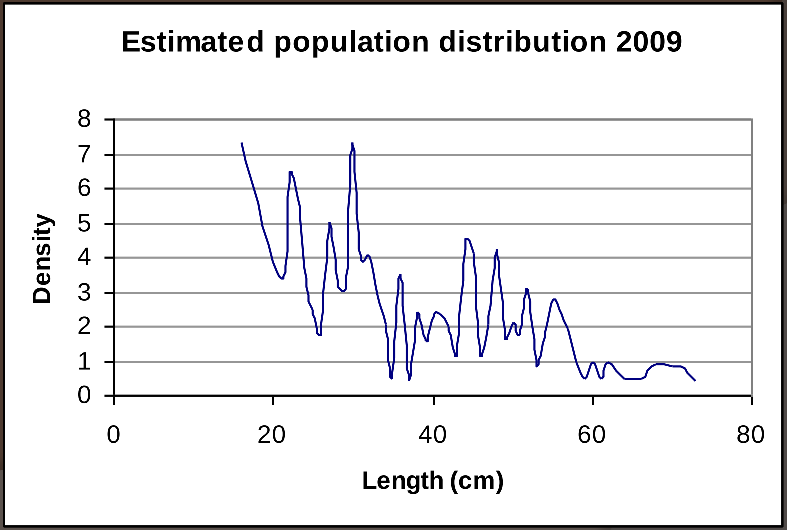


Estimated population distribution of Arctic char based on the binormal model

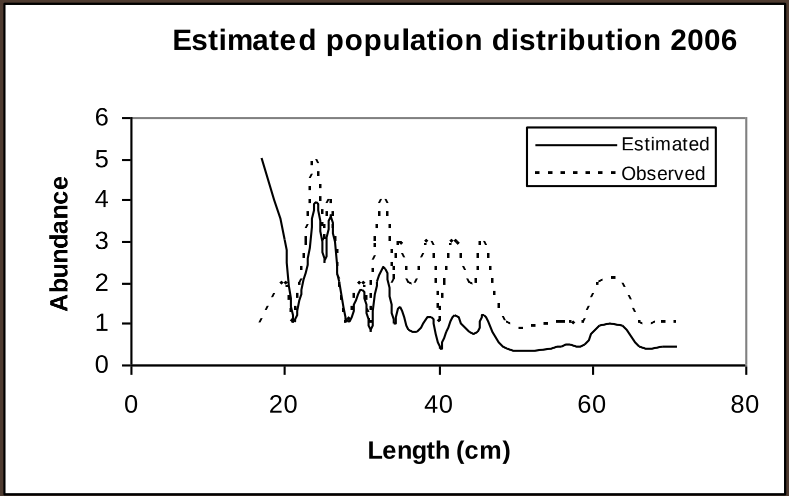


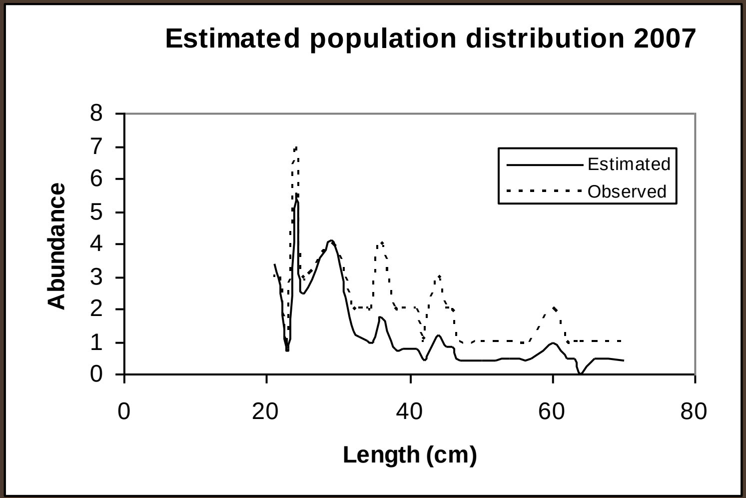


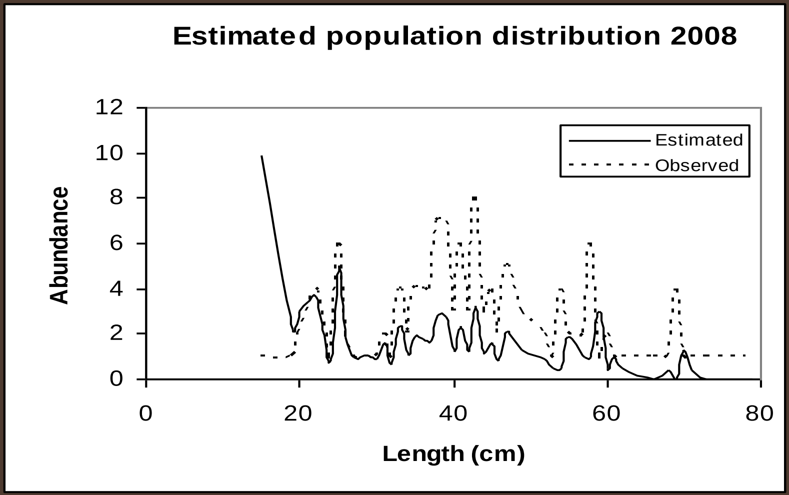


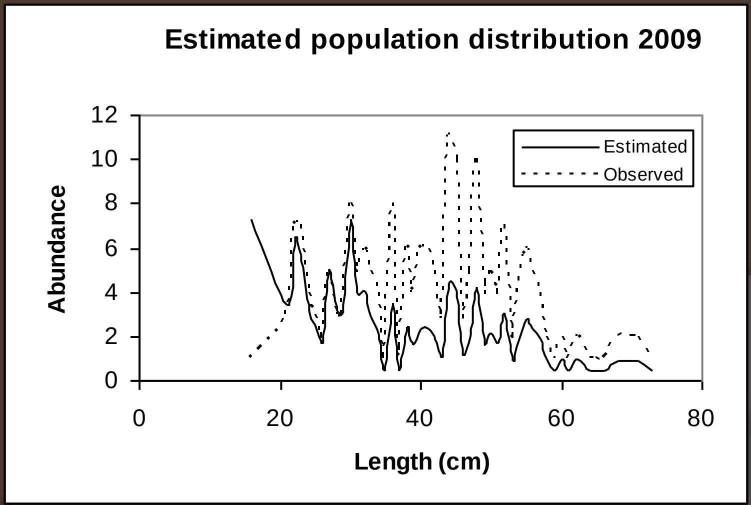


Population structure for Arctic char 2006-2009









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