

Incorporating Gear Evaluation Studies Data in a Delta Smelt Life Cycle Model (DSLCCM)

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& Considerable Support from CDFW,

particularly Randy Baxter

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Outline

1. Gear Study Objectives and Methods
2. Raw Results
3. Analysis and Gear Selectivity Model Results
4. Application to DSLCM: role in Observation Model

Gear Study Objectives and Methods

- Several fish abundance monitoring programs in the Bay Delta
- Differing Gear Types, Mesh Sizes, & Portion of Water Column Sampled
- **If a Delta Smelt of length L is present at sample location, what is the Probability it is caught?**

Mature/Spawning

Larvae

Juveniles

Sub-Adults

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

1959

1960

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1967

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1980

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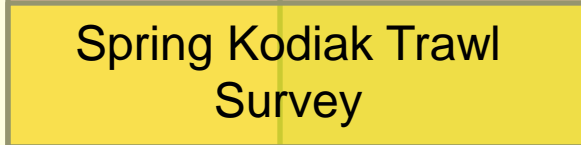
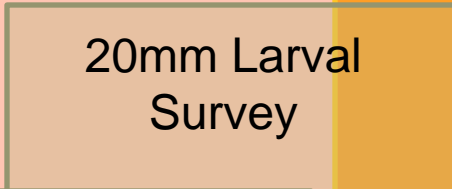
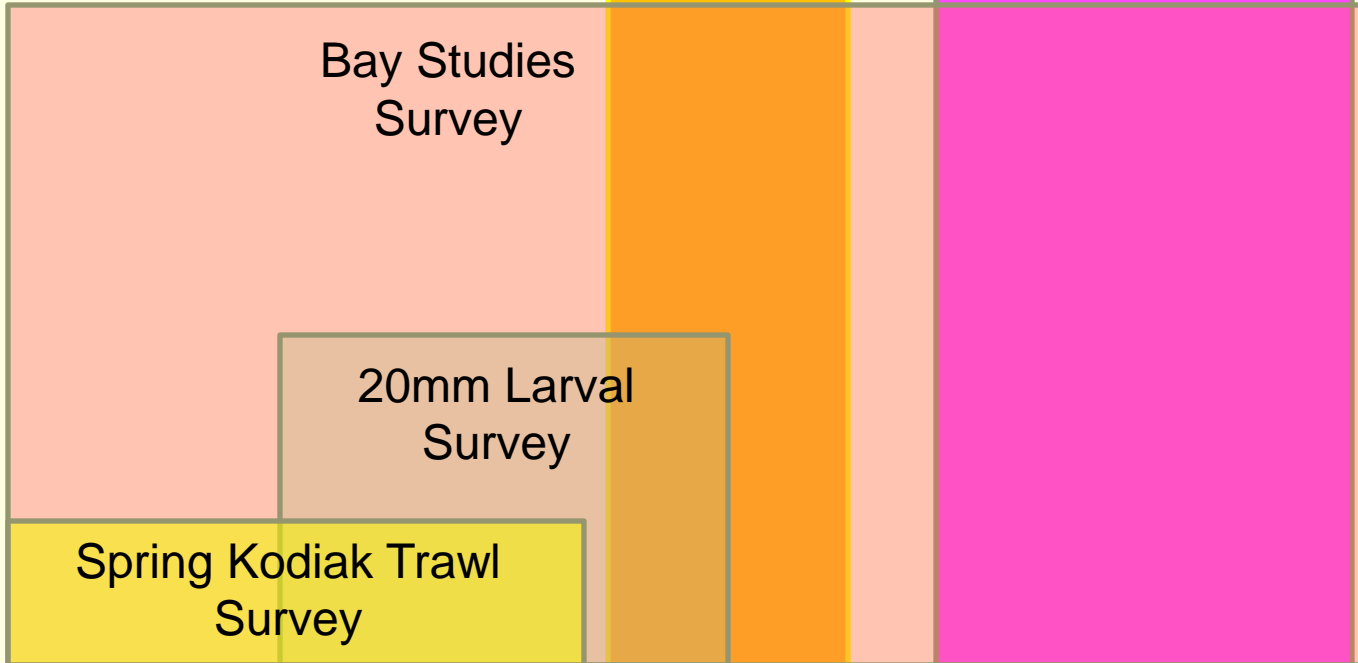
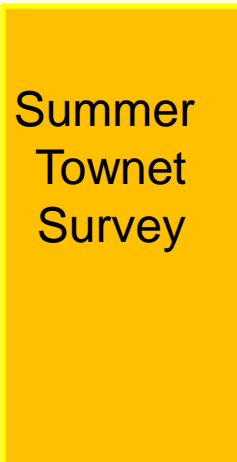
1995

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2001

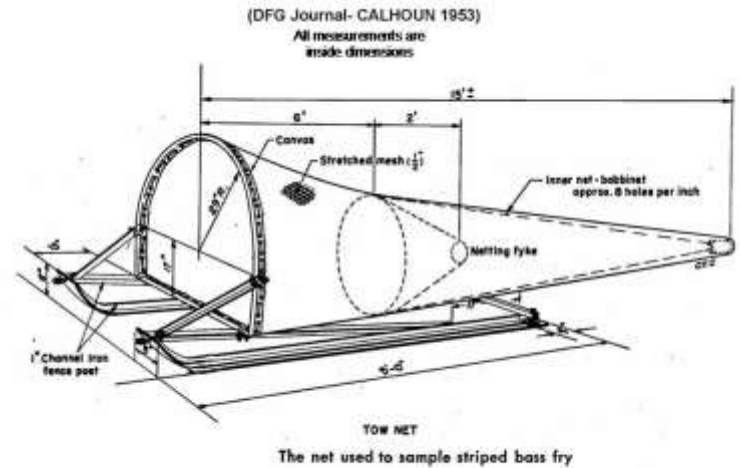
Now



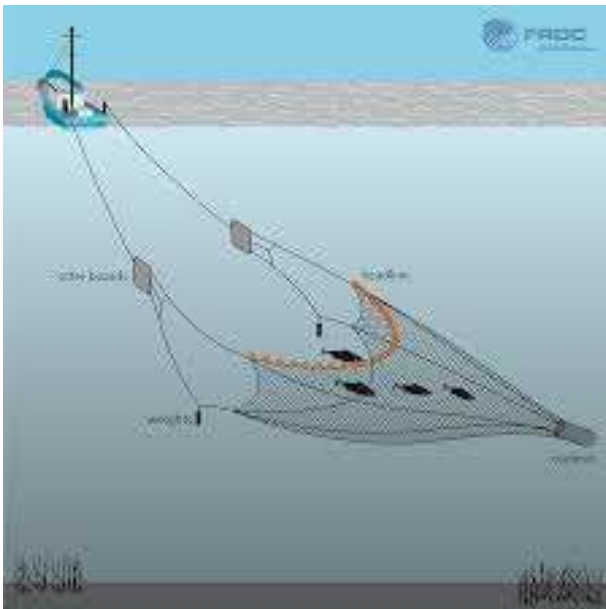
20mm: Egg & Larval



Townet



Midwater Trawl

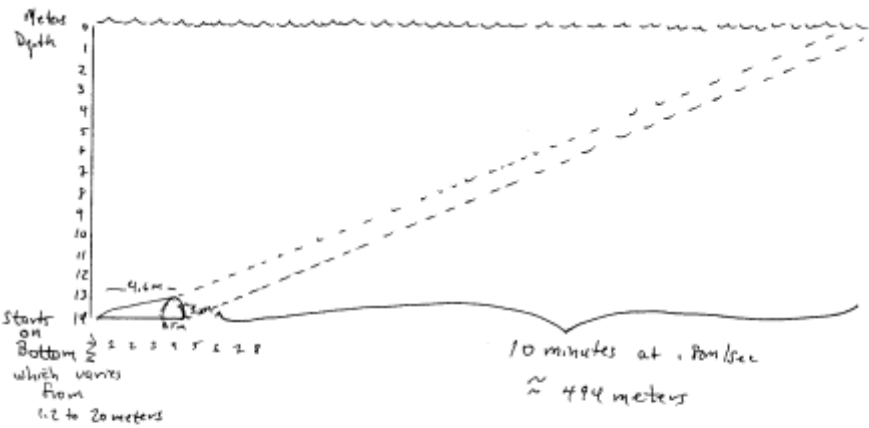


Kodiak Trawl



Oblique Tow

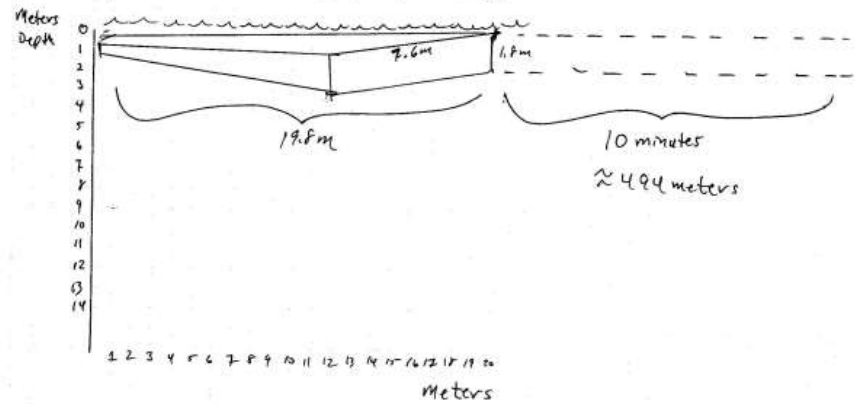
(Summer) Tournet - Depth, Size, + Tow Path



Differing Portions
of Water Column
Sampled

Near Surface Tow

(Spring) Kodrak Trawl - Depth, Size, + Tow Path

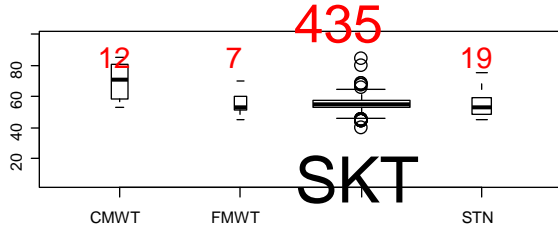


Side-by-side Gear Evaluation Studies

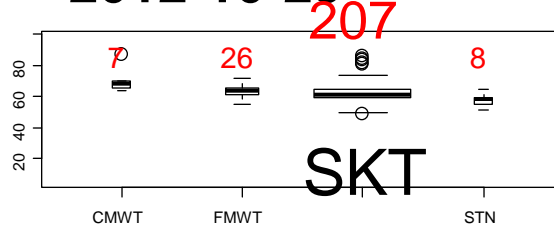
Date	LS	SLS	20mm	STN	FMWT	CMWT	SKT	Other
Sep 2012	Sub-A			X	X	X	X	
Oct 2012	Sub-A			X	X	X	X	
Apr 2013	Larvae	X	X	X				
May 2013	L/Juv	X	X	X				
Jun 2013	L/Juv		X	X				
Sep 2013	Sub-A			X	X	X	X	
Nov 2013	Sub-A			X	X	X	X	
Apr 2014	Larvae	X	X	X				
May 2014	L/Juv	X	X	X				B.Seine
Jun 2014	L/Juv		X	X				
Aug 2014	Juv		X	X			X	
Aug 2014	Juv				X +cc+2boats			Sm Cam
Sep 2014	Sub-A				X +cc+2boats			
Oct 2014	Sub-A				X +cc+2boats			Sm Cam

Delta Smelt Catches & Lengths by Gear Type

2012-09-27



2012-10-25



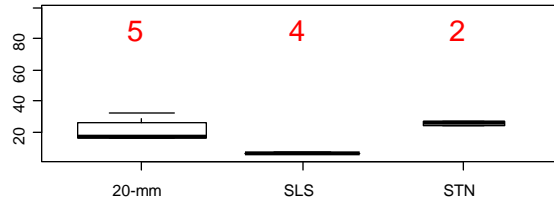
Fall 2012: **SKT dominates**

2013-04-18



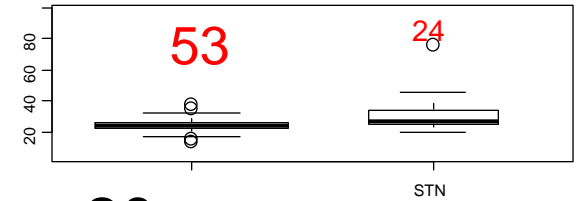
20-mm

2013-05-17



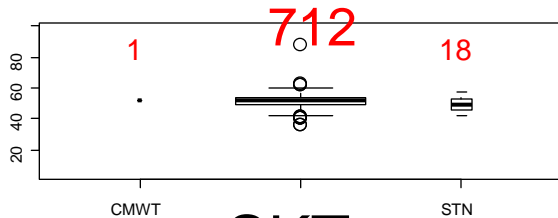
Spring 2013: **20mm dominates**

2013-06-13



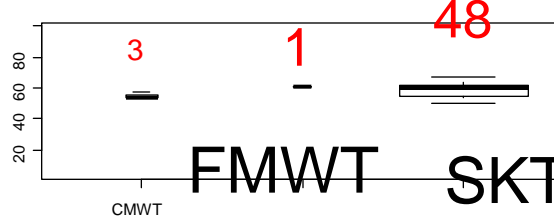
20-mm

2013-09-26



SKT

2013-11-21



FMWT SKT

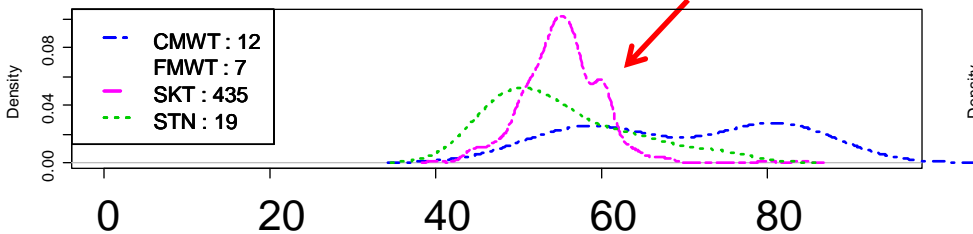
Fall 2013: **SKT dominates**

Lengths of Fish by Gear Type

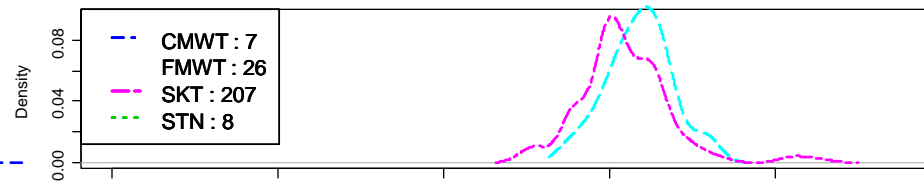
Fall Months

2012-09-27

SKT catching wider range

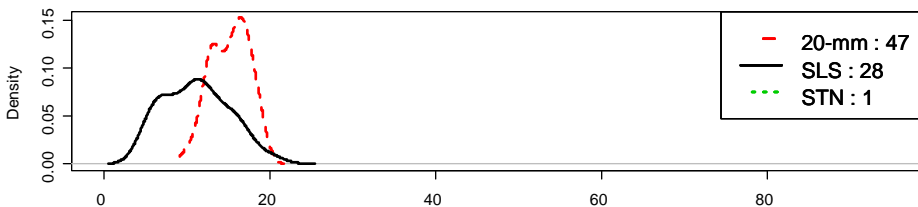


2012-10-25



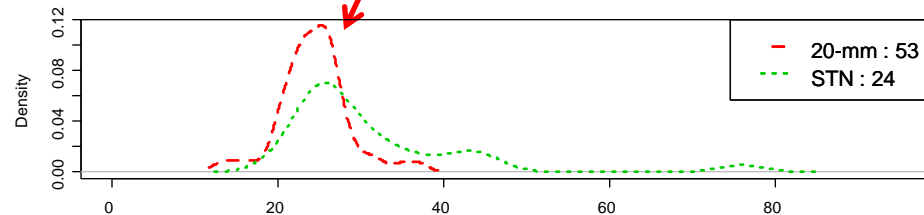
Spring Months

2013-04-18



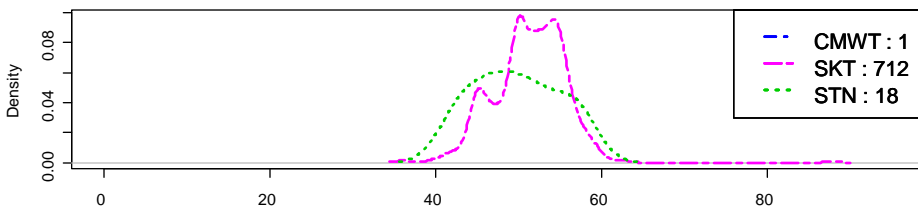
20mm catching wider range

2013-06-13

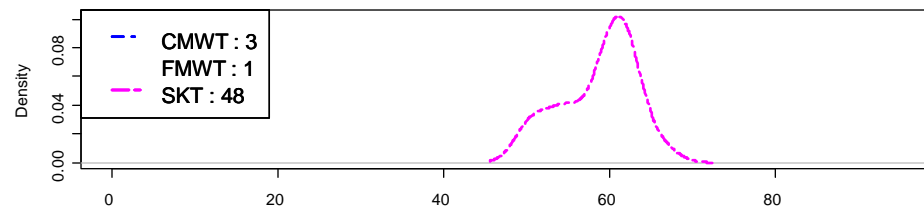


Fall Months

2013-09-26



2013-11-21



Statistical Model

For Gear g , Day d , Tow t , and fish length L

Catch $[g, d, t, L] \sim$

Poisson($\delta_d * \text{volume} * \text{percent}_d(L) * r_g(L)$)

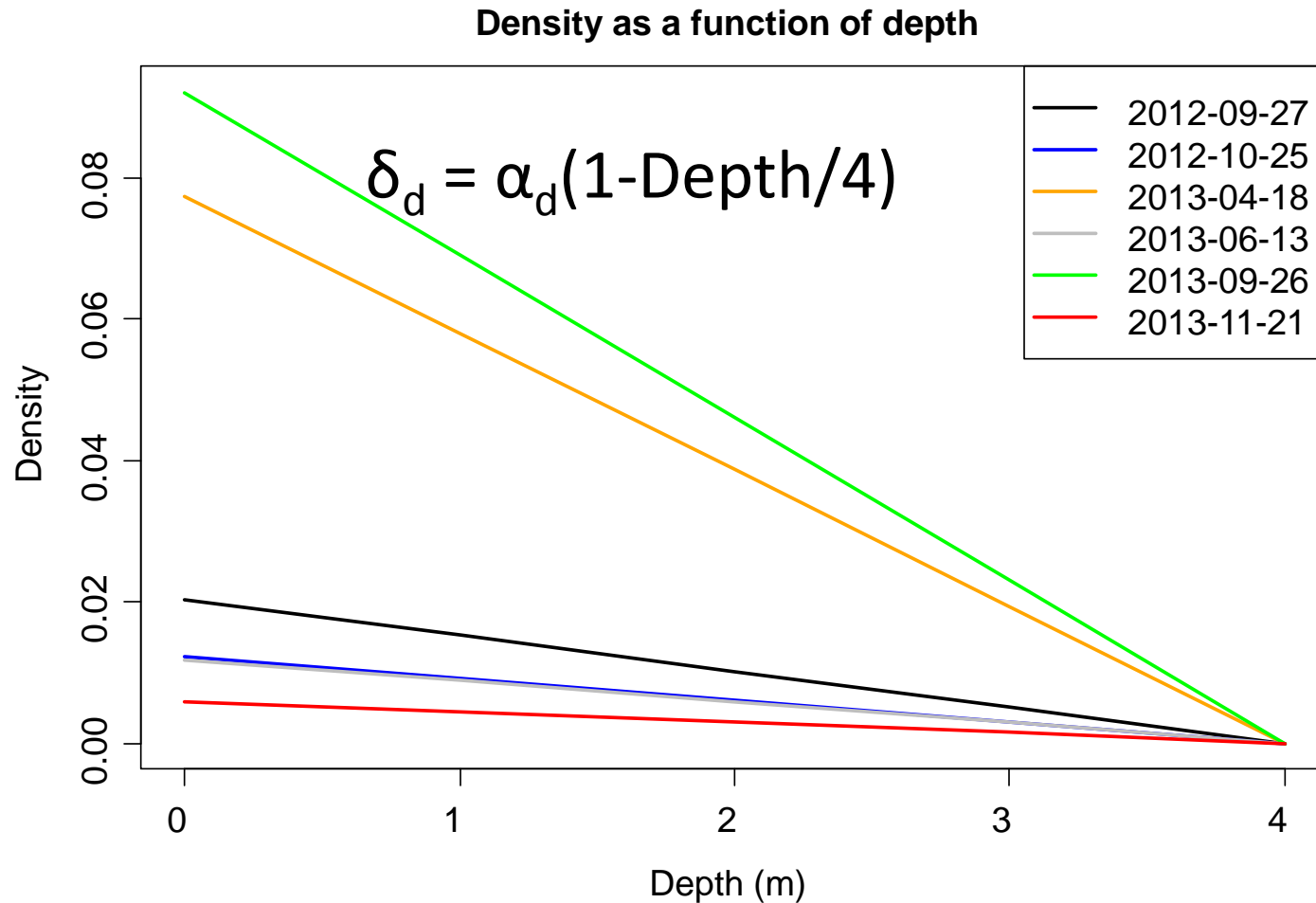
(1) δ_d = Delta smelt density on day d

(2) $\text{percent}_d(L)$ = Percentage of length L fish on day d

(3) $r_g(L)$ = Probability gear g catches a length L fish

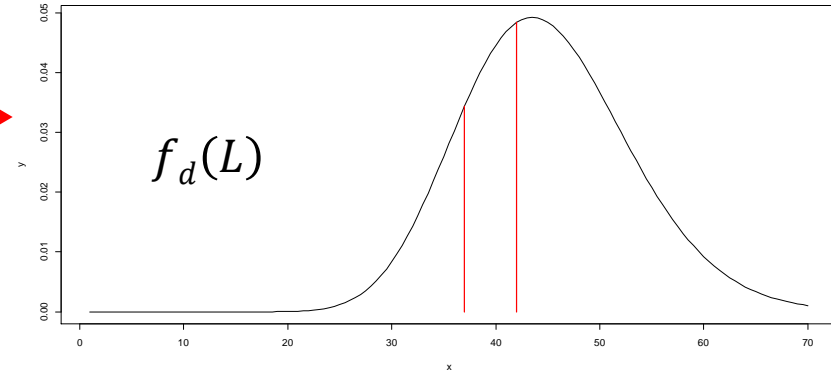
(1) δ_d = Delta smelt density

Day-specific, estimated from data



(2) $\text{percent}_d(L) = \text{Percentage of length } L \text{ fish on day } d$

$$= \int_{L-2.5}^{L+2.5} f_d(L) \partial L$$

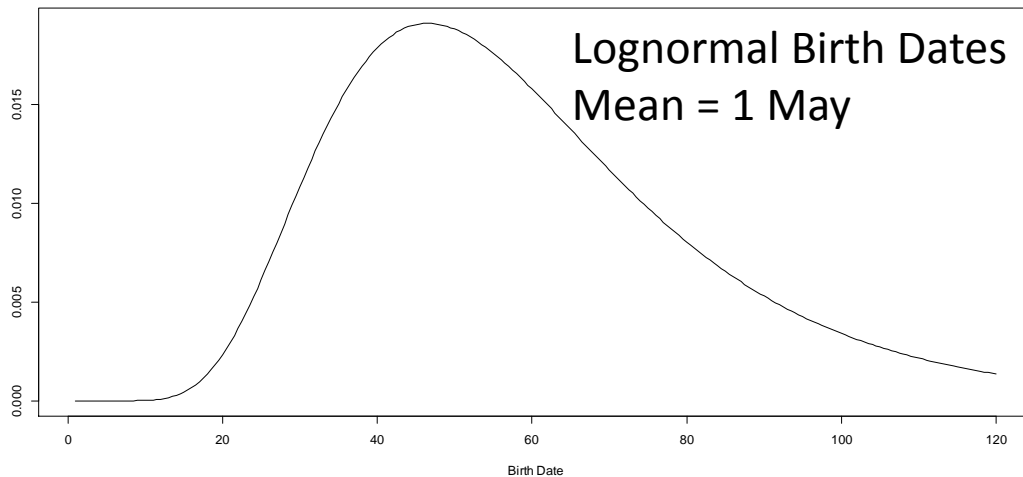


$f_d(L) = \text{Length at Day } d \text{ distribution (used Otolith data)}$

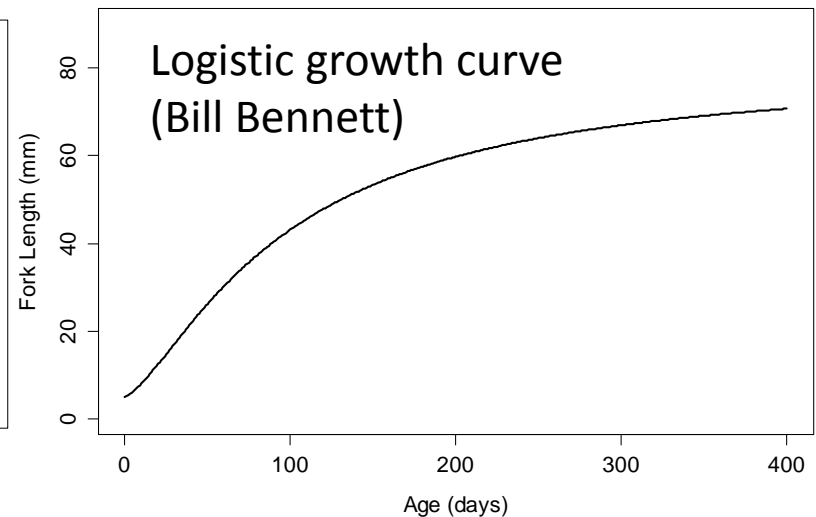
$$= \int_0^d f(\text{Birth} = \text{Day} - \text{Age}) * g(\text{Length} | \text{Age}) \partial \text{Age}$$



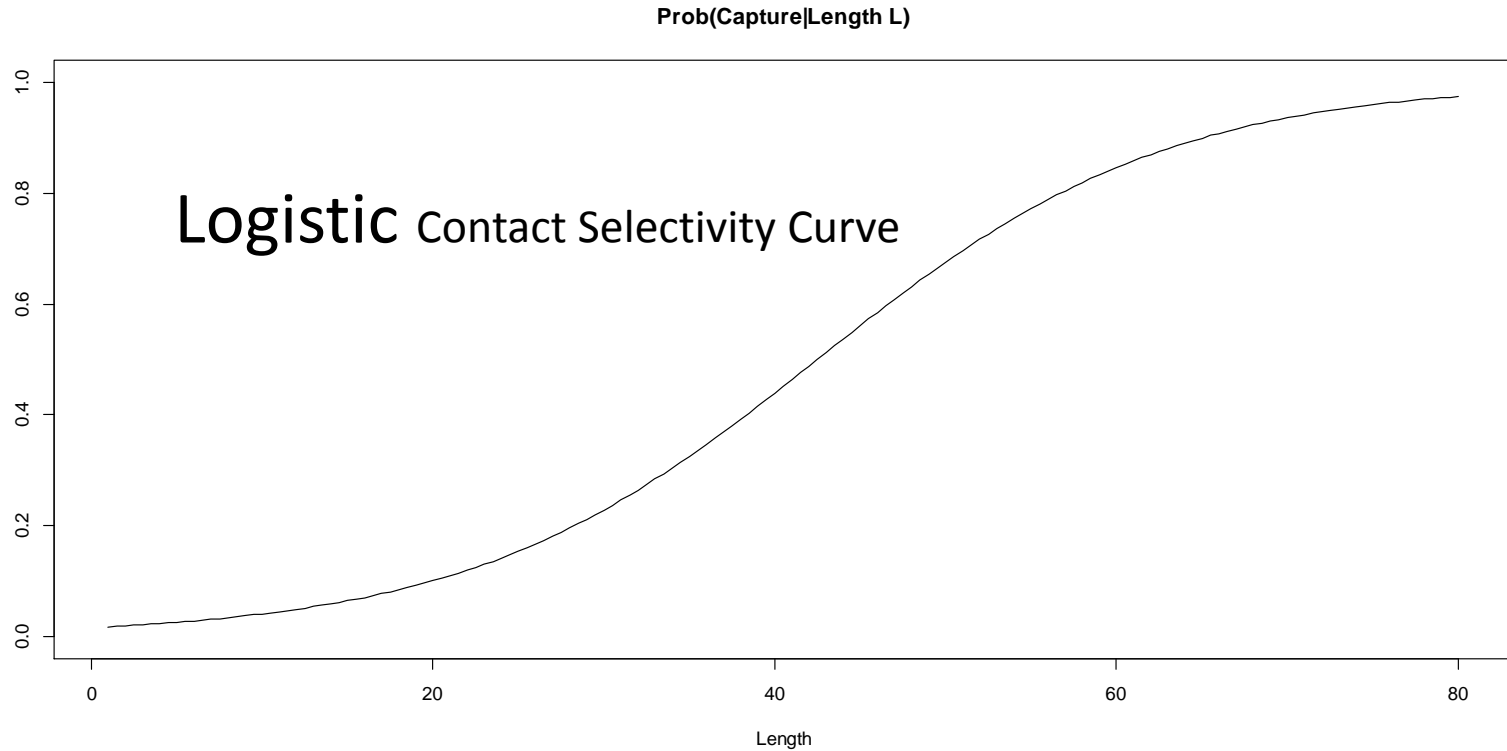
Birth Date Dist'n



Growth curve

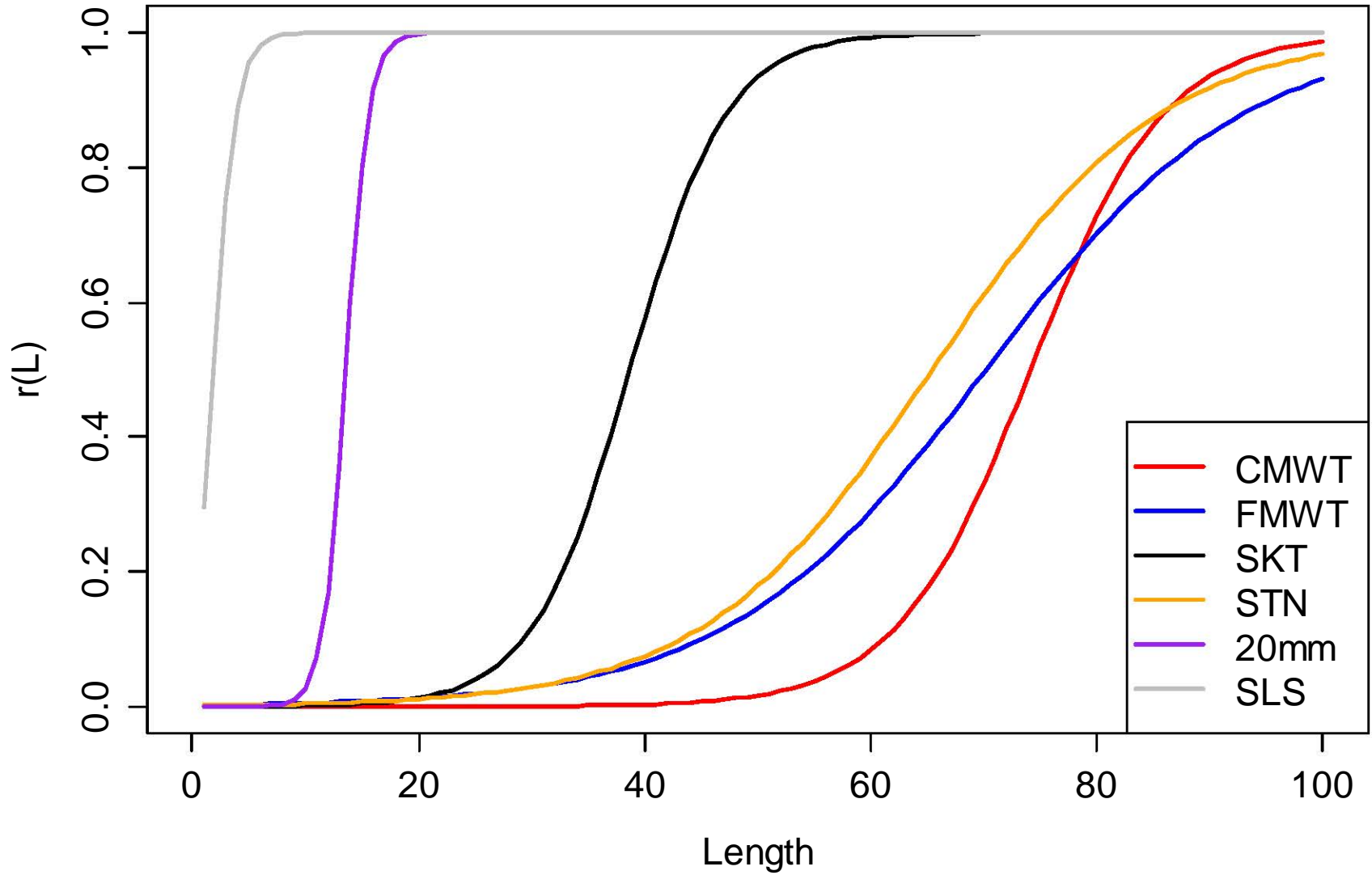


(3) $r_g(L)$ = Probability gear g catches a length L fish



Results:

Gear selectivity curves



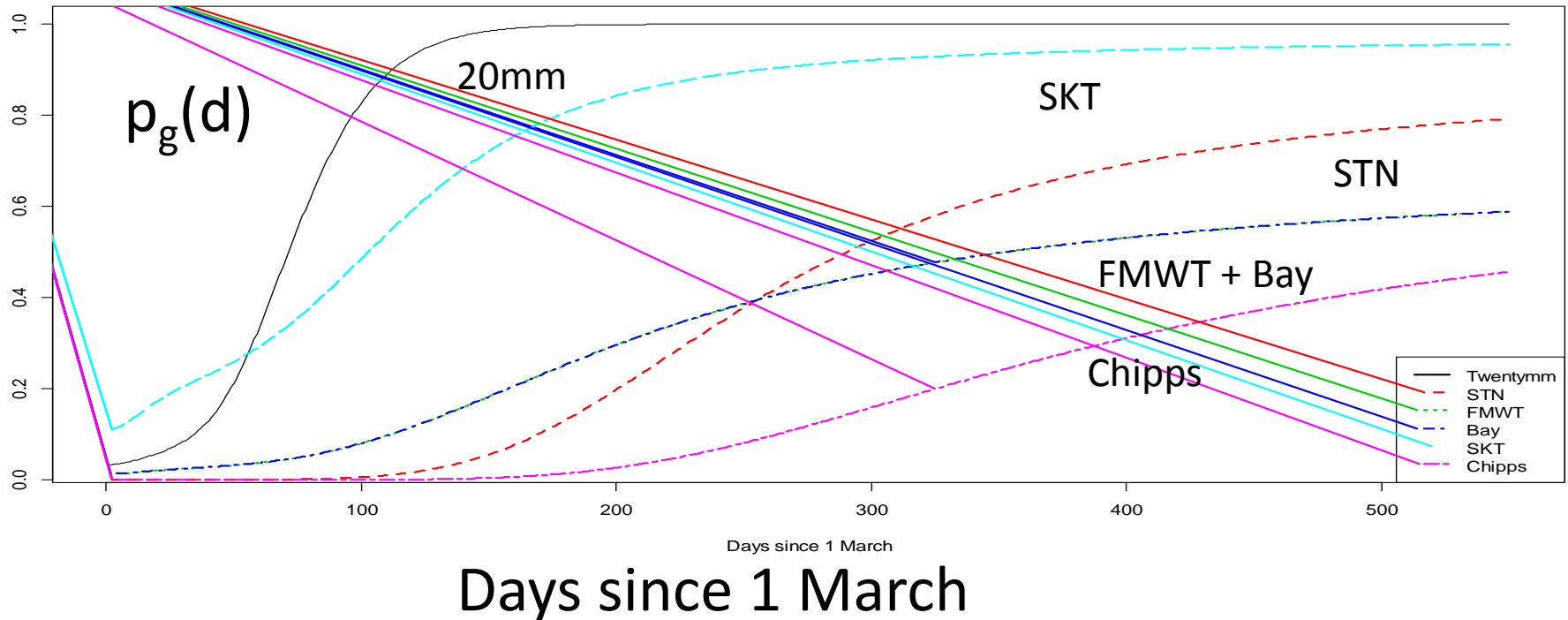
Application to Delta Smelt Life Cycle Model

- Fish survey catches modeled with Zero Inflated probability dist'ns
- Non-zero portion: Negative Binomial, with mean $\mu(\text{region, month, day, gear})$
- $$\mu = \frac{\textit{Abundance}_{\textit{Region}}}{\textit{Volume}_{\textit{Region}}} * \textit{volume}_{\textit{sampled}} * p_g(d)$$
- Where $p_g(d)$ = gear efficiency for length L averaged over dist'n of Lengths for date d

Application to Delta Smelt Life Cycle Model

- $p_g(d) = \int_5^{100} f_d(L) r g(L) \partial L$

The average over the probability of each length for a given “day”



Summary

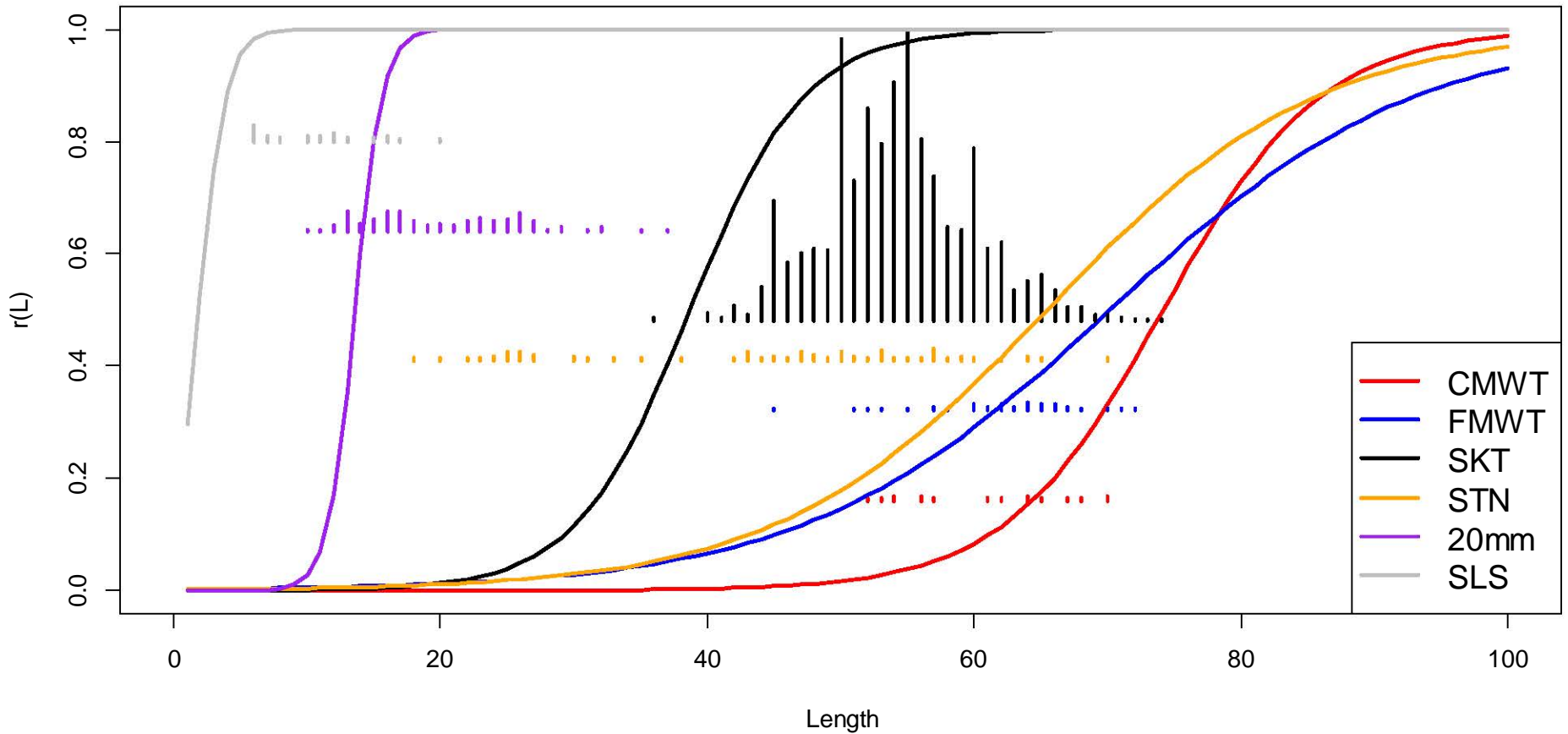
- Gear evaluation studies show just how effective SKT and 20mm gear are relative to others
- Using Gear Evaluation Data, Otolith Data, and Other Catch data =>
 - (a) Estimates of gear selectivity curves
 - (b) Estimates of day-specific capture probabilities per gear type for use in DSLCM

Issues regarding Data

1. Vertical Dist'n: how does density vary?
2. "Herding" with Kodiak trawl (two boats)?
3. "Displacement" with other gear (one boat)?
4. How do gear perform at "edges" of usual lengths?

Limitation: lack of information for wider range of lengths

Gear selectivity curves



Issues regarding Modeling

1. δ_d = Delta smelt density model is sensitive to choice of 4m depth
2. $\text{percent}_d(L)$: constant birth date dist'n
3. Gear selectivity model: sigmoid, not dome