One-Fish, Two-Fish, Red-Fish, Blue-Fish:

Results from Recent Snorkel Surveys of Rainbow Trout in the Lee's Ferry Reach of the Colorado River

Josh Korman, Mike Yard, Dave Speas

Supported by AGF - GCMRC

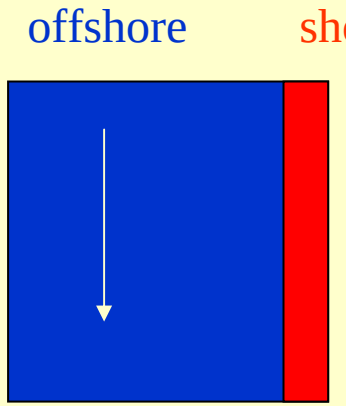
Objectives of Snorkel Surveys

- Boat electrofishing is used to estimate Catch Per Effort (CPE) of shoreline areas. It is the primary method of indexing rainbow trout abundance in Lee's Ferry

- Use snorkel surveys to evaluate assumptions inherent in boat electrofishing.

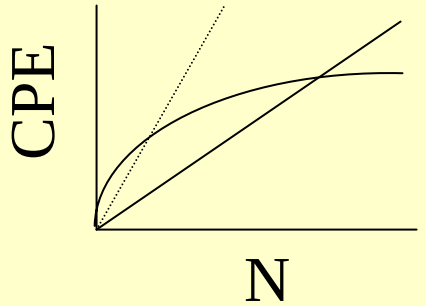
$CPE = q * N$

$q = q_{shore} * q_{off\text{-}on}$



•q is constant

•q is independent of N



- Evaluate potential as a long-term monitoring tool to supplement electrofishing program

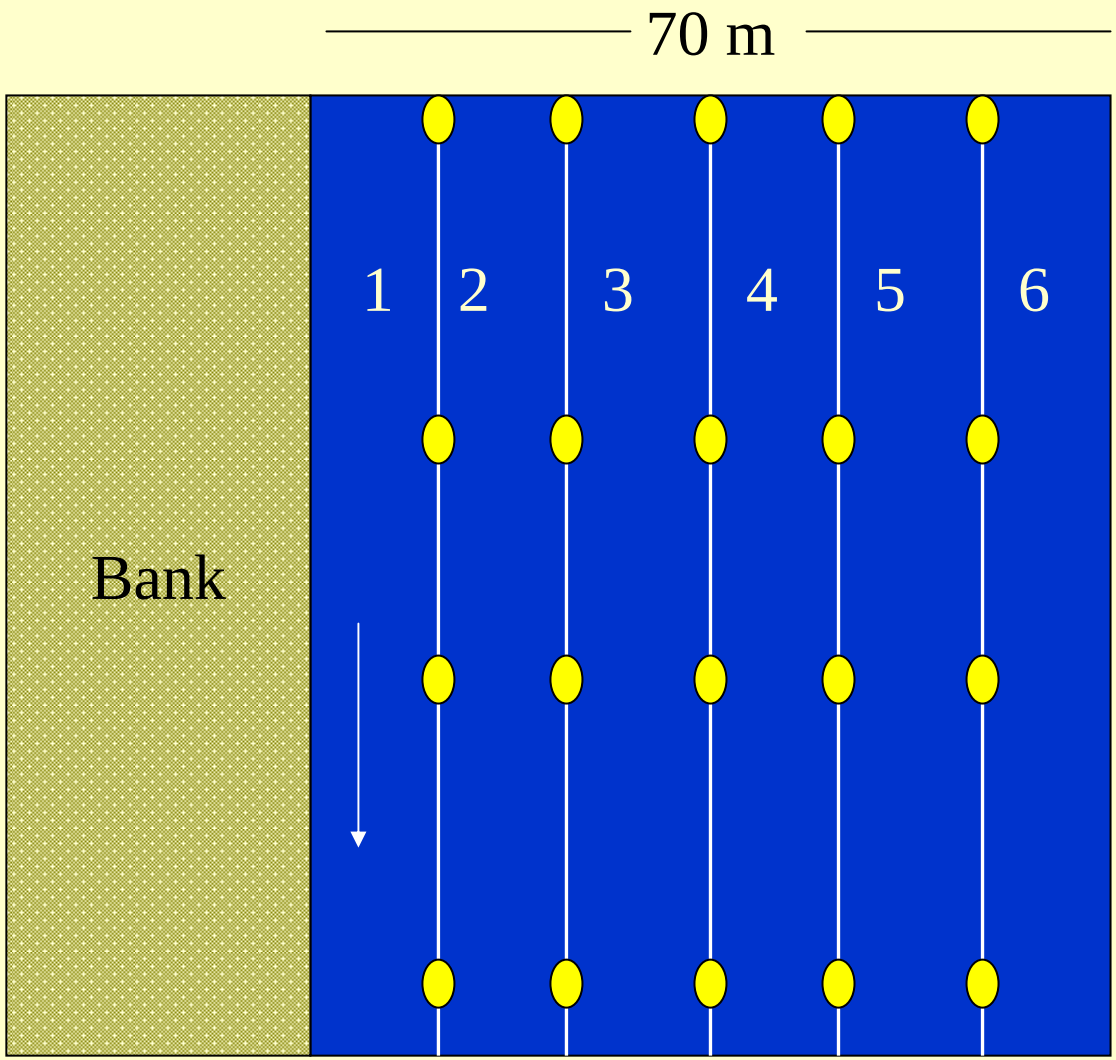
Components of Snorkel Survey Program

- Daytime shoreline surveys at 36 sites (9 fixed, 27 random)
  - 3 replicated counts as an index of density/site
  - Compare with nightime boat EF densities
- Cross-sectional transects at each shoreline site
  - 6 replicated estimates of apparent density in shoreline and offshore areas
- Diel survey at up to 3 sites
  - Changes in apparent density in offshore and shoreline areas due to movement and catchability responses to discharge and light

Summary of Sampling Effort

	Snorkel			EF vs.
Trip	Shoreline	Sites with Transects	Diel	Shoreline
Date	Sites	(Total # Transects)	Sites	Sites
Jun. '01	36		0	23
Jun. '02	30	28 (144)	1	29
Oct. '02	36	36 (218)	3	36
Apr. 03	30	30 (182)	2	28

Diel Study Sites



$C_1 = q_1 * N_1$
$C_2 = q_2 * N_2$
….

Alternate Models for Interpreting Diel Count Data

- Model 1: Equal q across lanes and time
  - Differences in counts among lanes over time represent real differences in density (note: $N_{1\text{-}6,t} = N_{1\text{-}6,t+1}$)

- Model 2: Equal q across lanes, but not over time
  - Differences in counts among lanes within a time period represent real differences in density

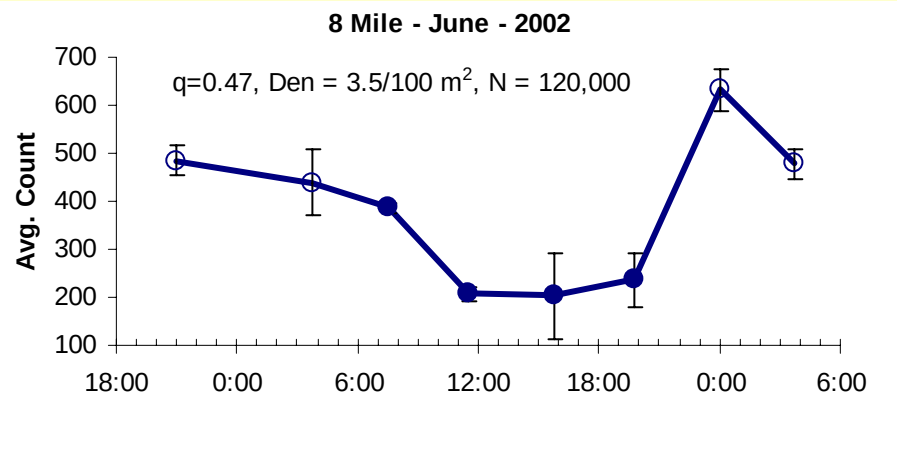
    $C_{x,t}/C_{x+1,t} <> C_{x,t+1}/C_{x+1,t+1}$ caused by movement

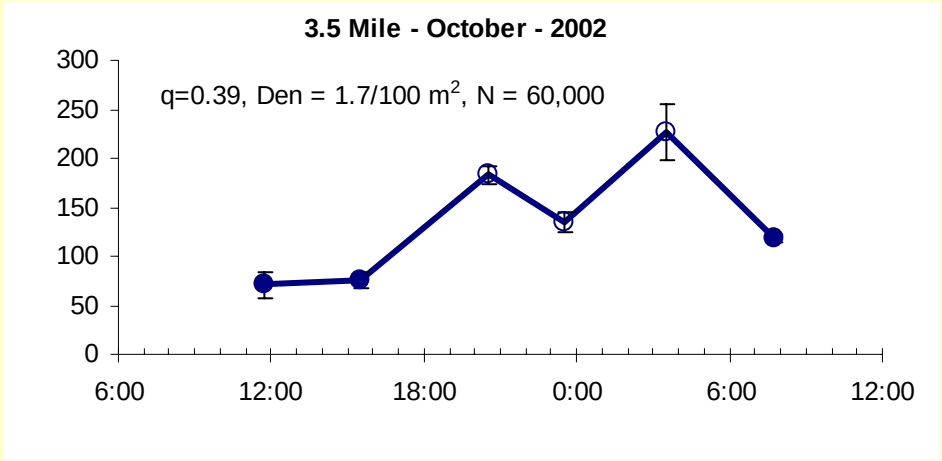
- Model 3: Unequal q across lanes and time, but relative differences in q among lanes are constant over time
  - Counts by lane dependent on both density and catchability

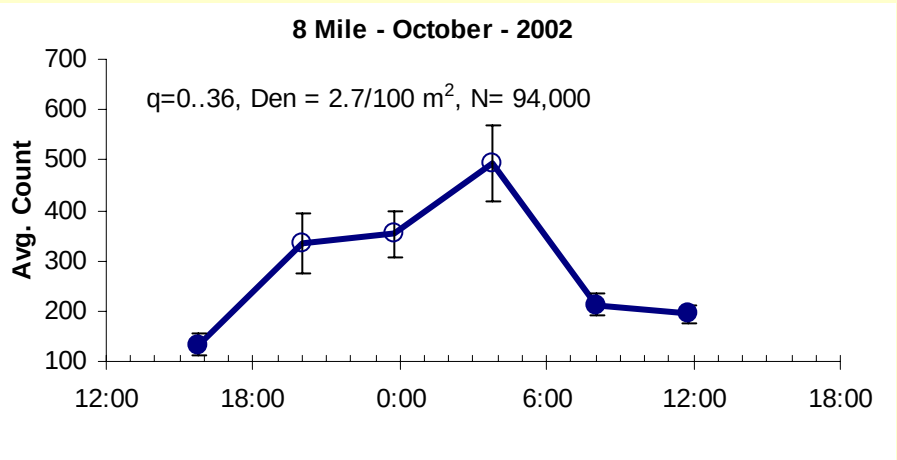
    $C_{x,t}/C_{x+1,t} <> C_{x,t+1}/C_{x+1,t+1}$ caused by movement

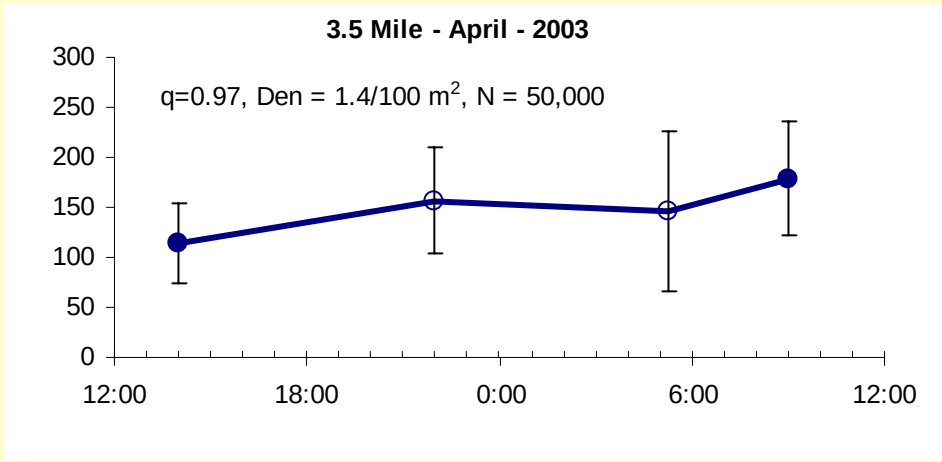
- Model 4: Unequal q across lanes and time, relative differences in q among lanes are not constant over time

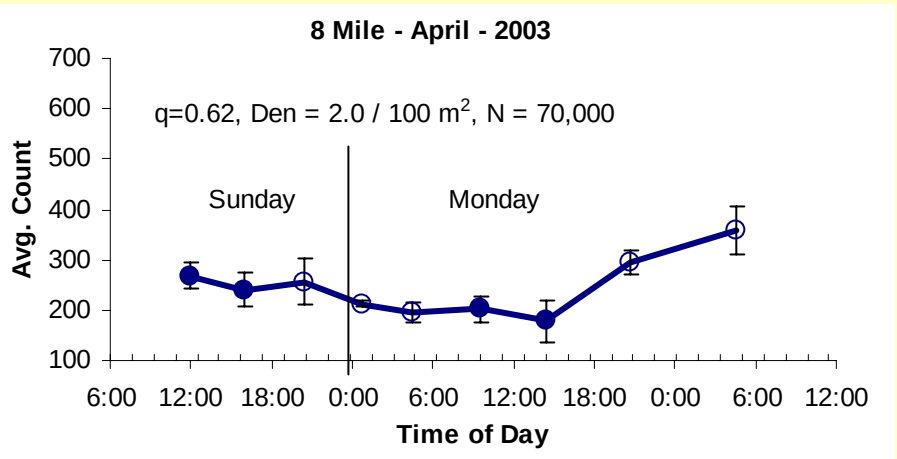
  $C_{x,t}/C_{x+1,t} <> C_{x,t+1}/C_{x+1,t+1}$ caused by movement or changing q

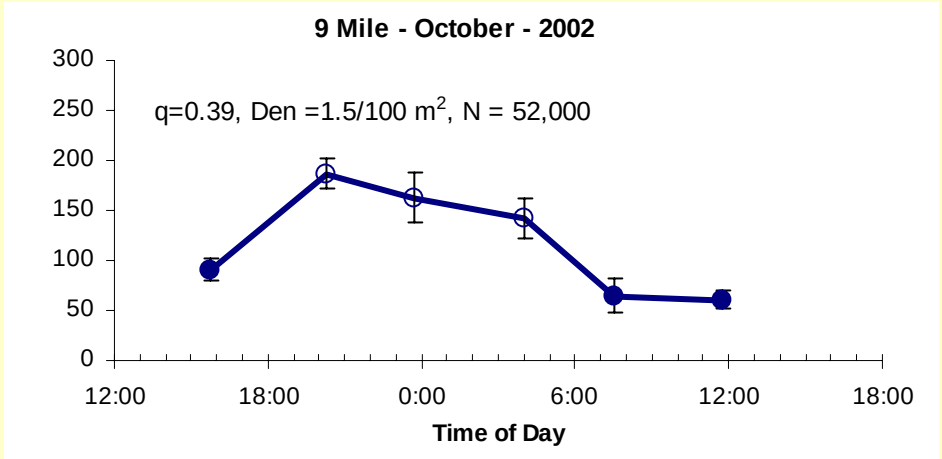

8 Mile - June - 2002
q=0.47, Den = 3.5/100 m2, N = 120,000
Avg. Count
700
600
500
400
300
200
100
18:00
0:00
6:00
12:00
18:00
0:00
6:00

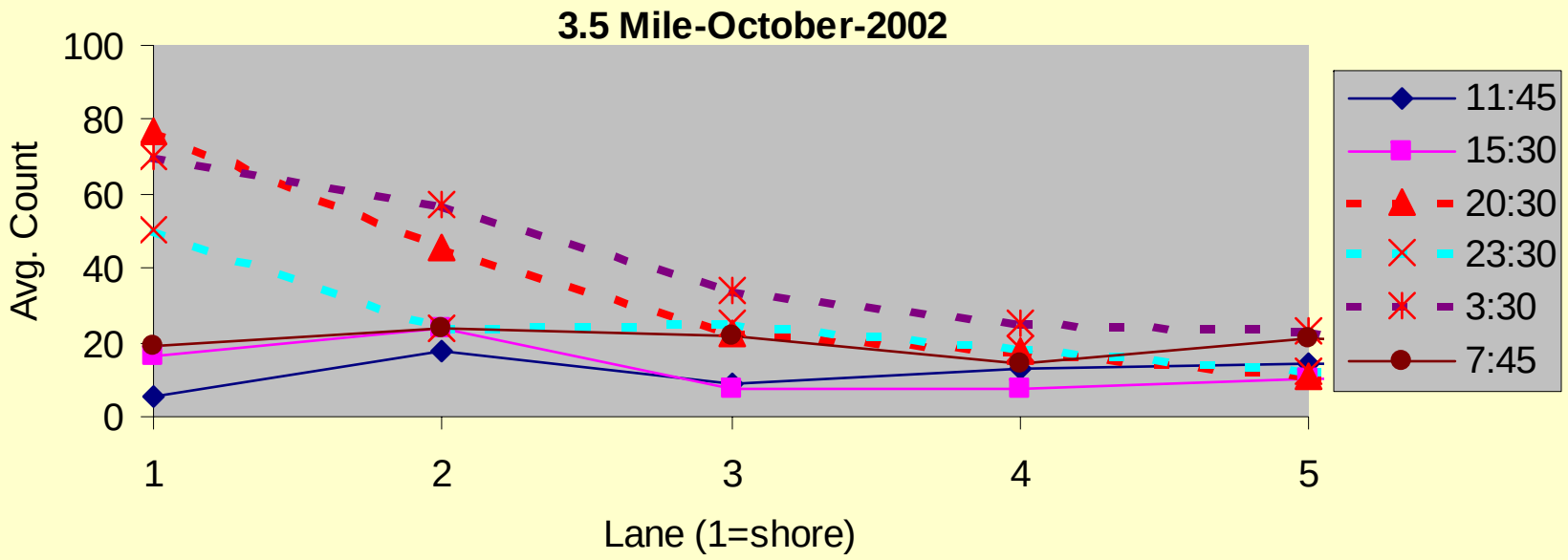

3.5 Mile - October - 2002
q=0.39, Den = 1.7/100 m2, N = 60,000
300
250
200
150
100
50
0
6:00
12:00
18:00
0:00
6:00
12:00

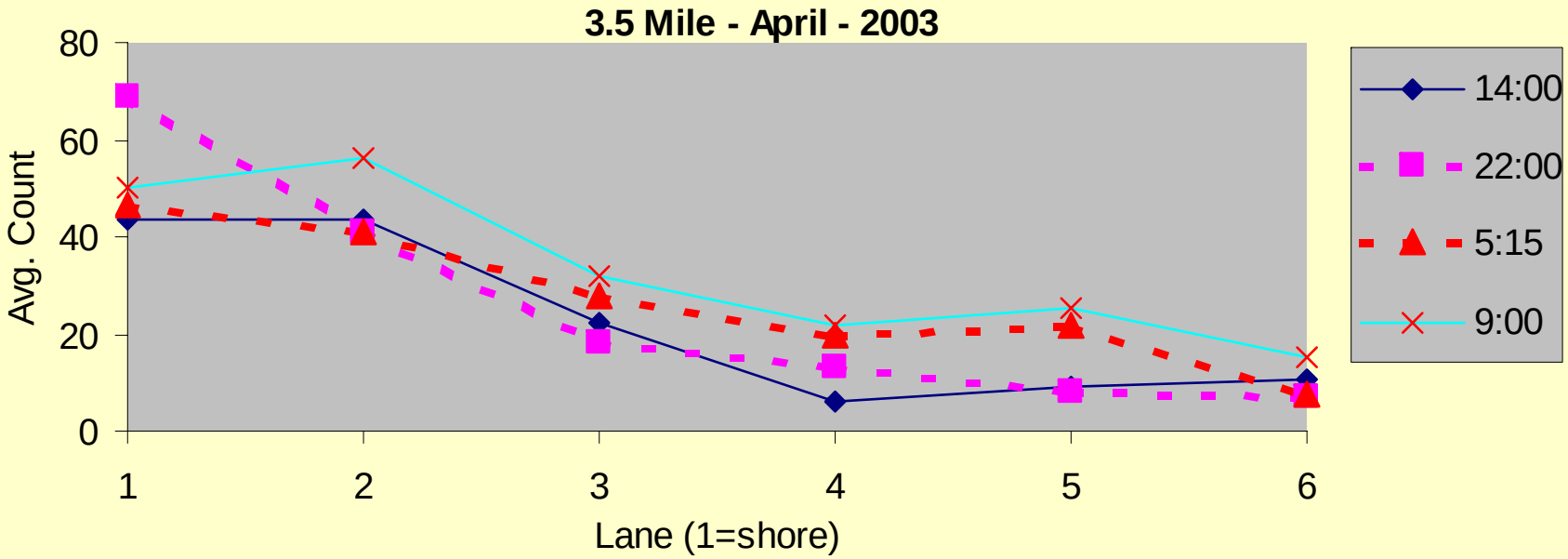

8 Mile - October - 2002
q=0..36, Den = 2.7/100 m2, N= 94,000
Avg. Count
700
600
500
400
300
200
100
12:00
18:00
0:00
6:00
12:00
18:00

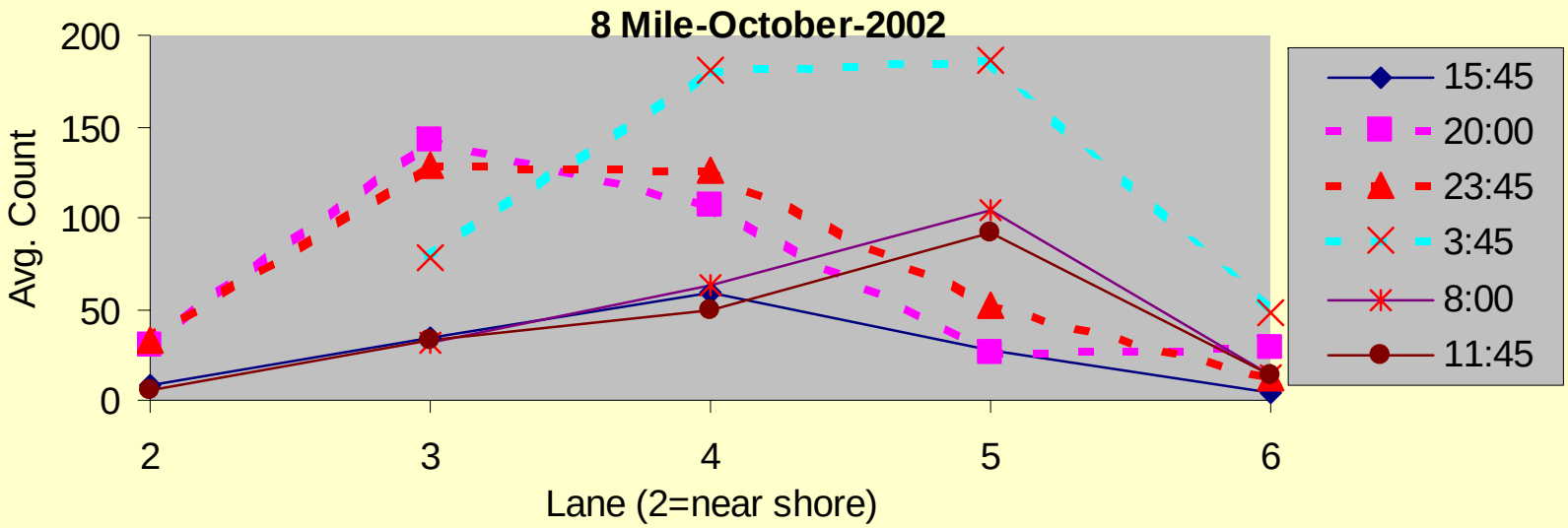

3.5 Mile - April - 2003
q=0.97, Den = 1.4/100 m2, N = 50,000
300
250
200
150
100
50
0
12:00
18:00
0:00
6:00
12:00

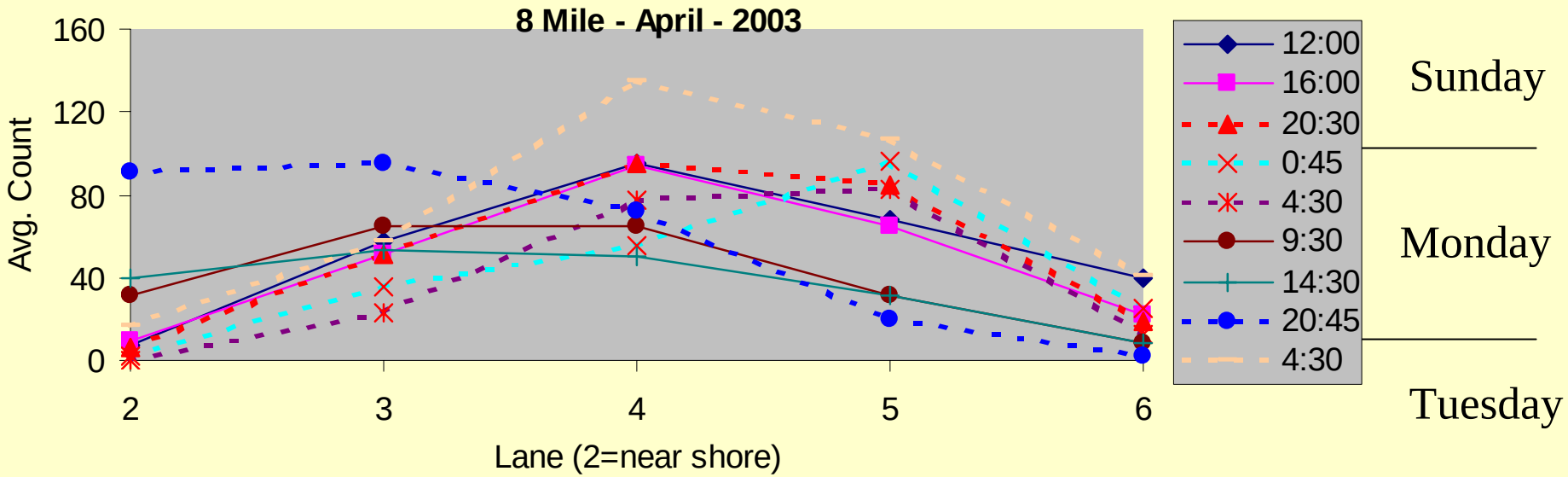

8 Mile - April - 2003
q=0.62, Den = 2.0 / 100 m2, N = 70,000
Sunday
Monday
Avg. Count
700
600
500
400
300
200
100
6:00
12:00
18:00
0:00
6:00
12:00
18:00
0:00
6:00
12:00
Time of Day

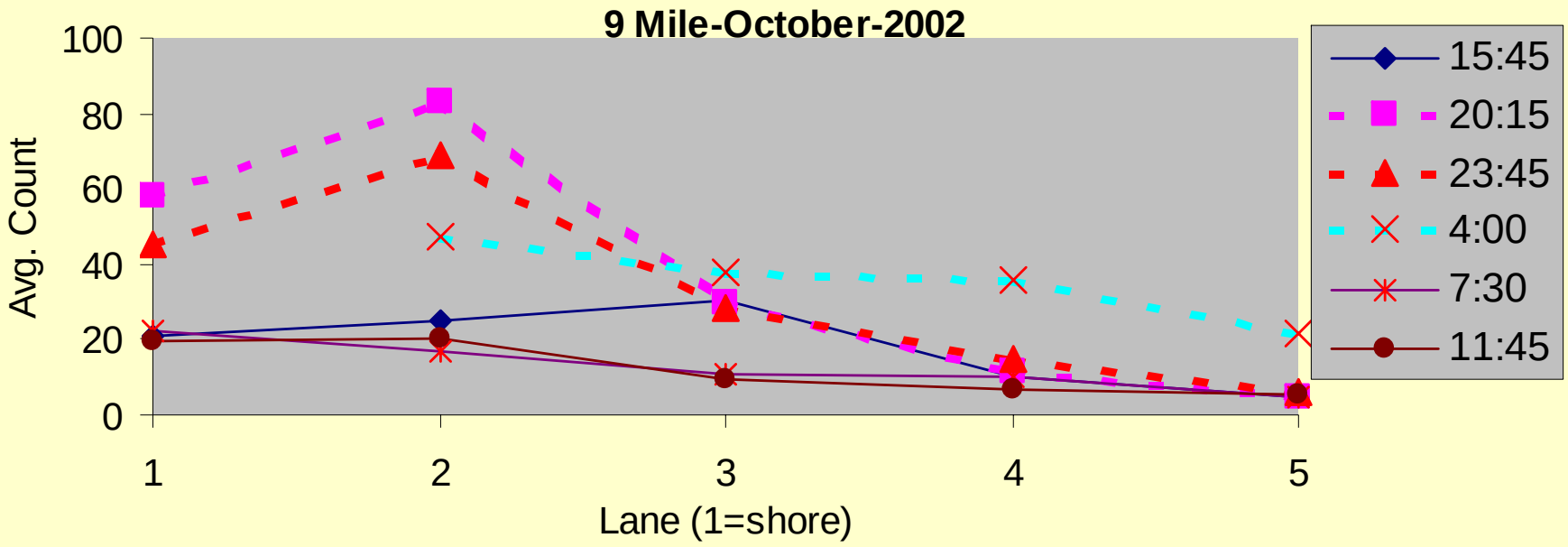

9 Mile - October - 2002
q=0.39, Den =1.5/100 m2, N = 52,000
300
250
200
150
100
50
0
12:00
18:00
0:00
6:00
12:00
18:00
Time of Day


3.5 Mile-October-2002
Avg. Count
100
80
60
40
20
0
1
2
3
4
5
Lane (1=shore)
11:45
15:30
20:30
23:30
3:30
7:45

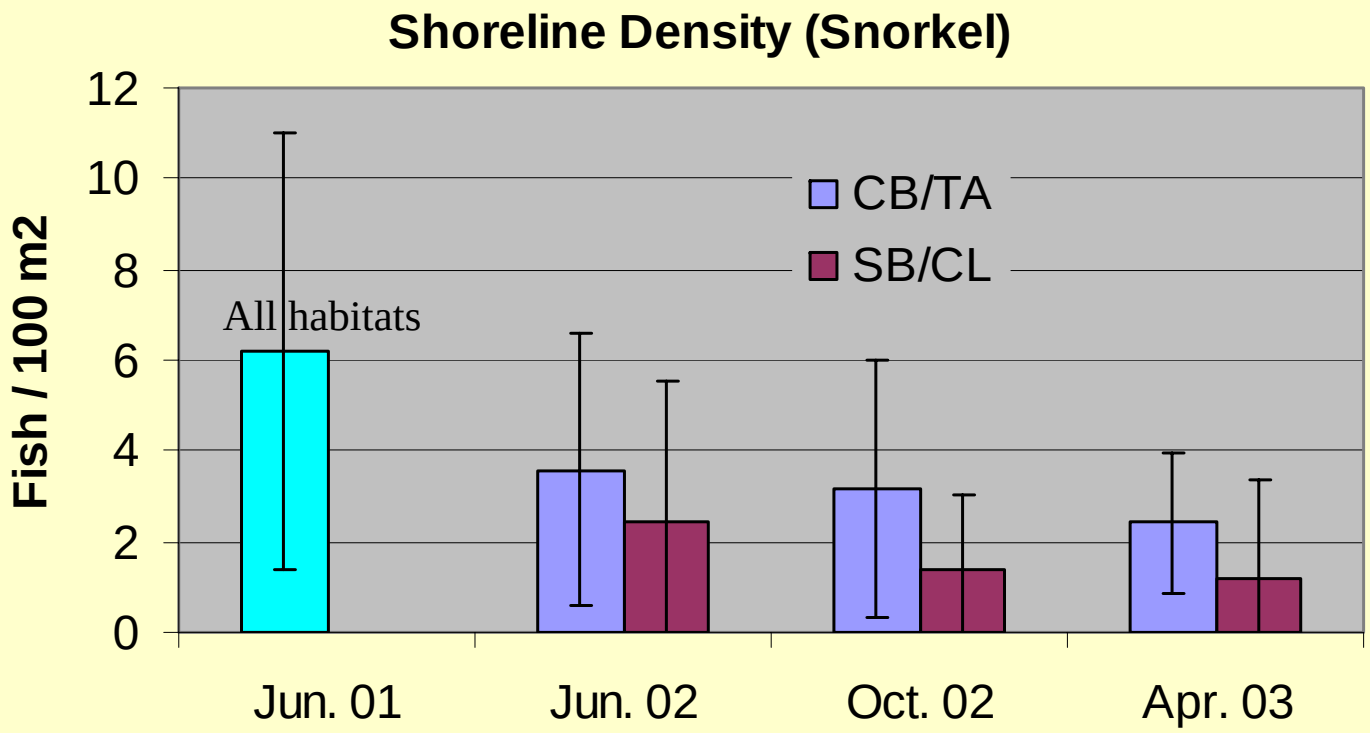

3.5 Mile - April - 2003
Avg. Count
80
60
40
20
0
1
2
3
4
5
6
Lane (1=shore)
14:00
22:00
5:15
9:00


8 Mile-October-2002
Avg. Count
200
150
100
50
0
2
3
4
5
6
Lane (2=near shore)
15:45
20:00
23:45
3:45
8:00
11:45

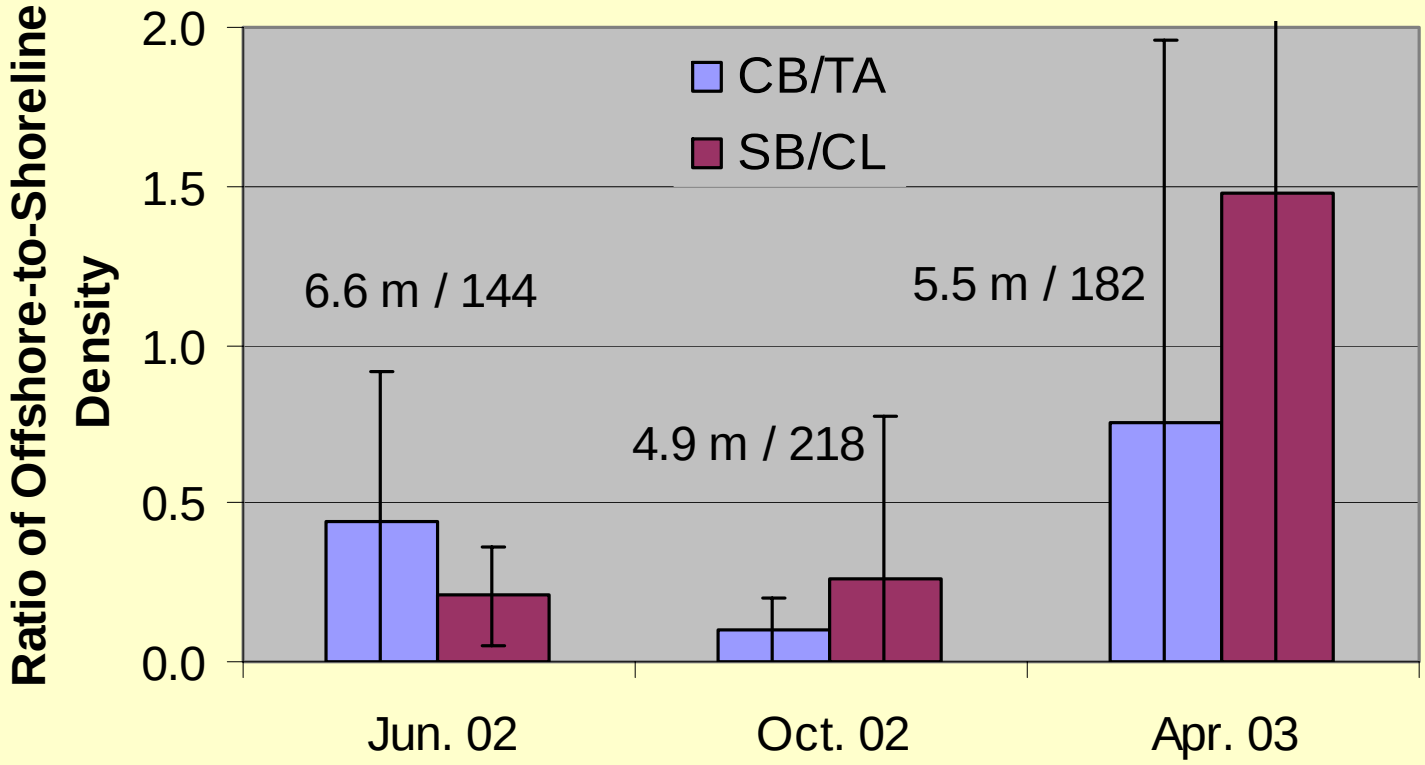

8 Mile - April - 2003
Avg. Count
160
120
80
40
0
2
3
4
5
6
Lane (2=near shore)
12:00
16:00
20:30
0:45
4:30
9:30
14:30
20:45
4:30
Sunday
Monday
Tuesday


9 Mile-October-2002
Avg. Count
100
80
60
40
20
0
1
2
3
4
5
Lane (1=shore)
15:45
20:15
23:45
4:00
7:30
11:45

Shoreline Densities

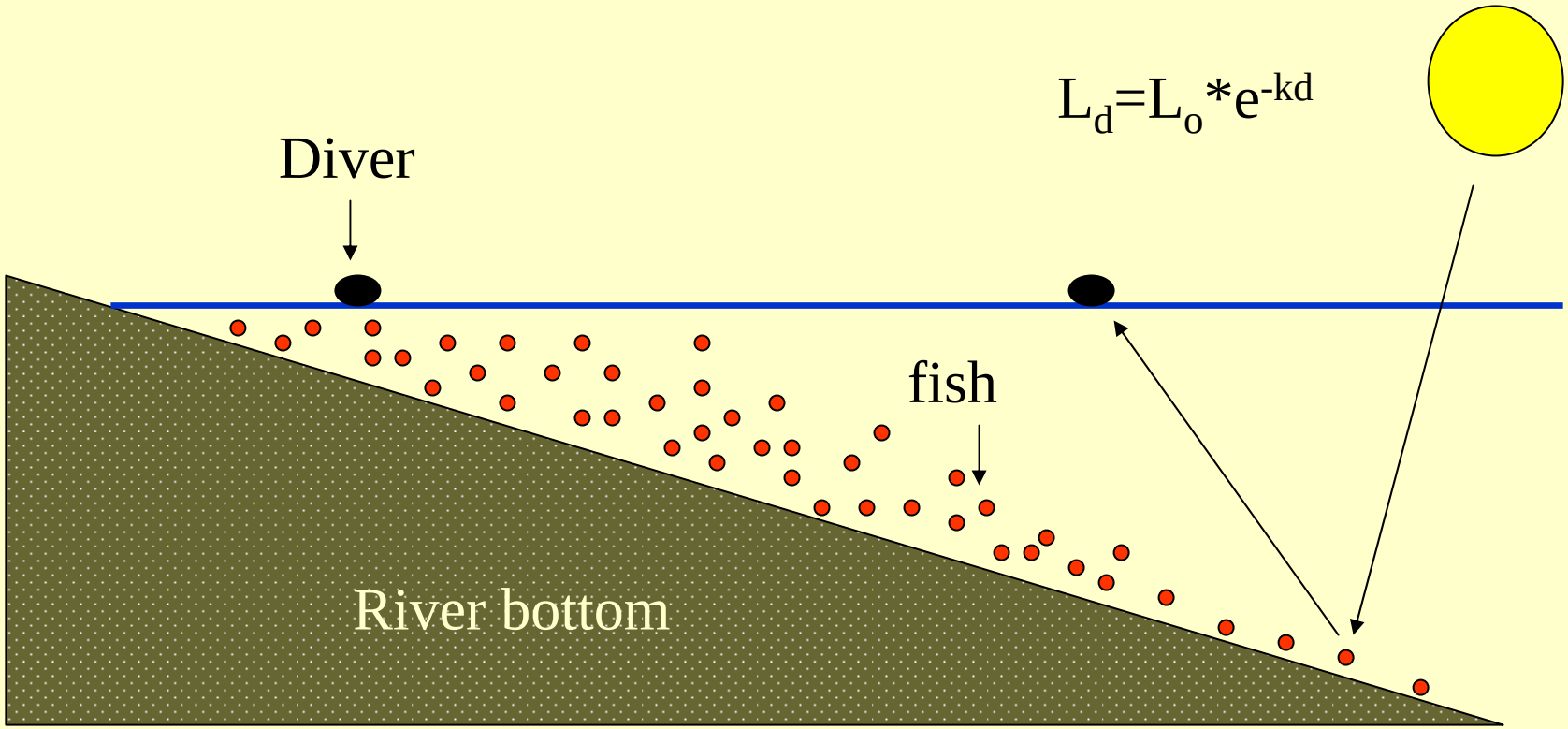


Transect Survey Results

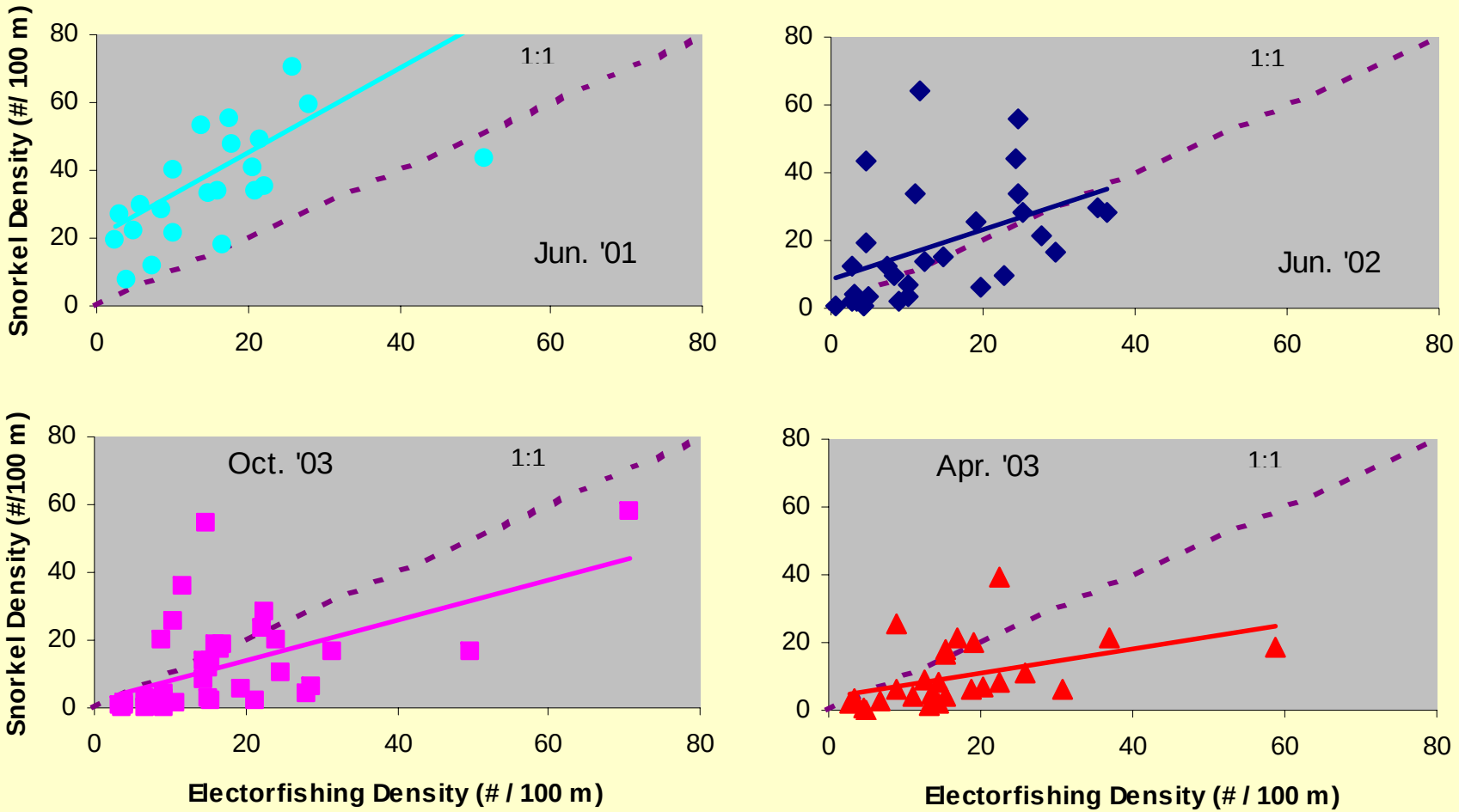


	Density of Fish (#/100m2)			Number of Fish		
	Jun. 02	Oct. 02	Apr. 03	Jun. 02	Oct. 02	Apr. 03
	Shoreline					
CB/TA/DF	3.74	3.19	2.42	8,000	5,200	4,348
SB/CL	2.19	1.39	1.19	3,500	1,700	1,600
Total	2.97	2.29	1.80	11,500	6,800	5,900
	Offshore-Onshore					
CB/TA/DF	0.44	0.10	0.75			
SB/CL	0.21	0.26	1.48			
	Offshore					
CB/TA/DF	1.67	0.33	1.80	29	5,800	32,000
SB/CL	0.45	0.37	1.76	6,200	5,200	24,700
Total	1.06	0.35	1.78	35,300	11,000	56,700
		Observed Population		46,800	17,800	62,600
		q (avg. day vs. peak night)		0.47	0.38	0.79
		Total Population		**100,000**	**47,000**	**79,000**

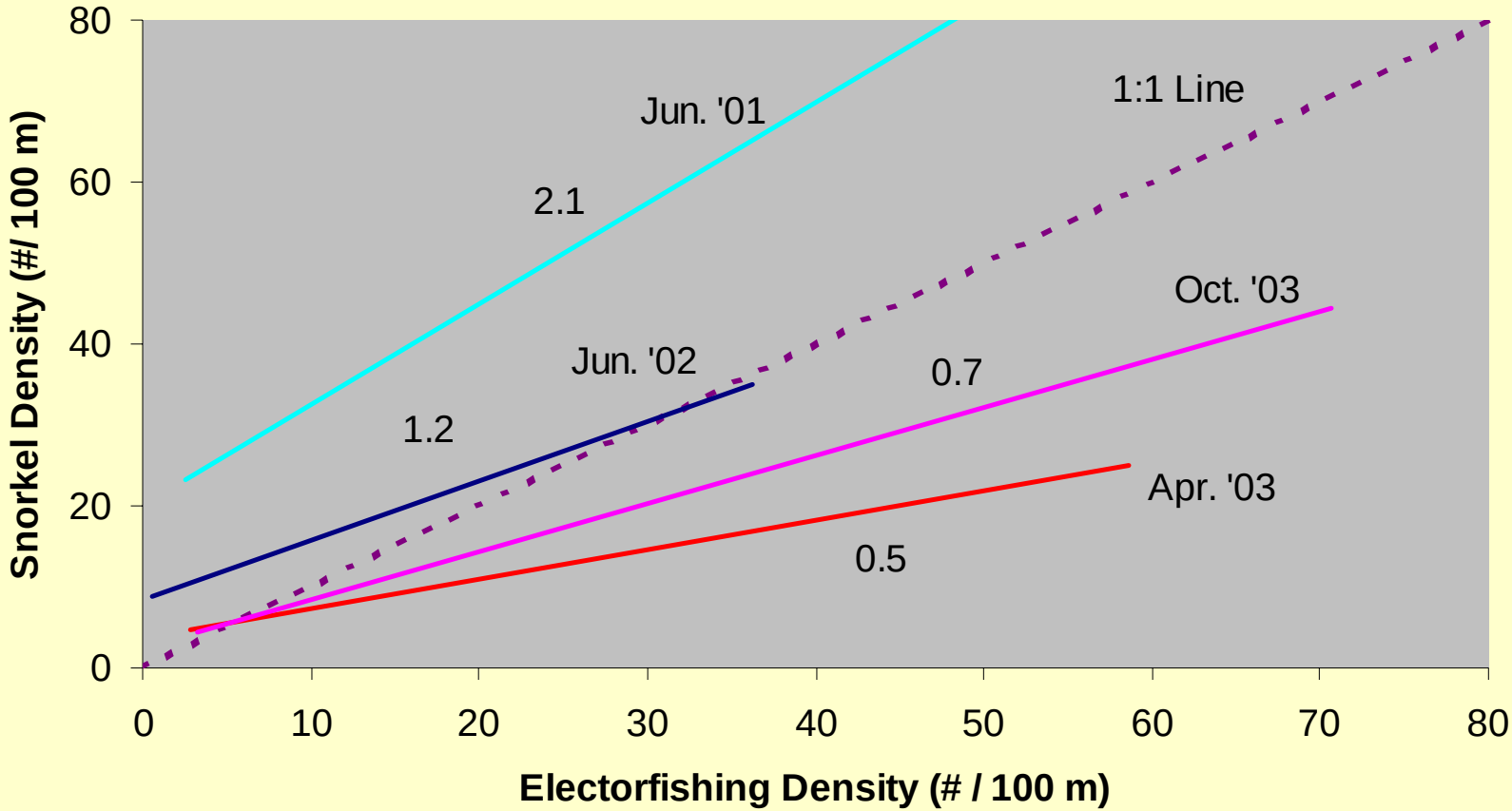
Mechanism to Explain Reduced Offshore-Shoreline Ratio in Oct. Sample



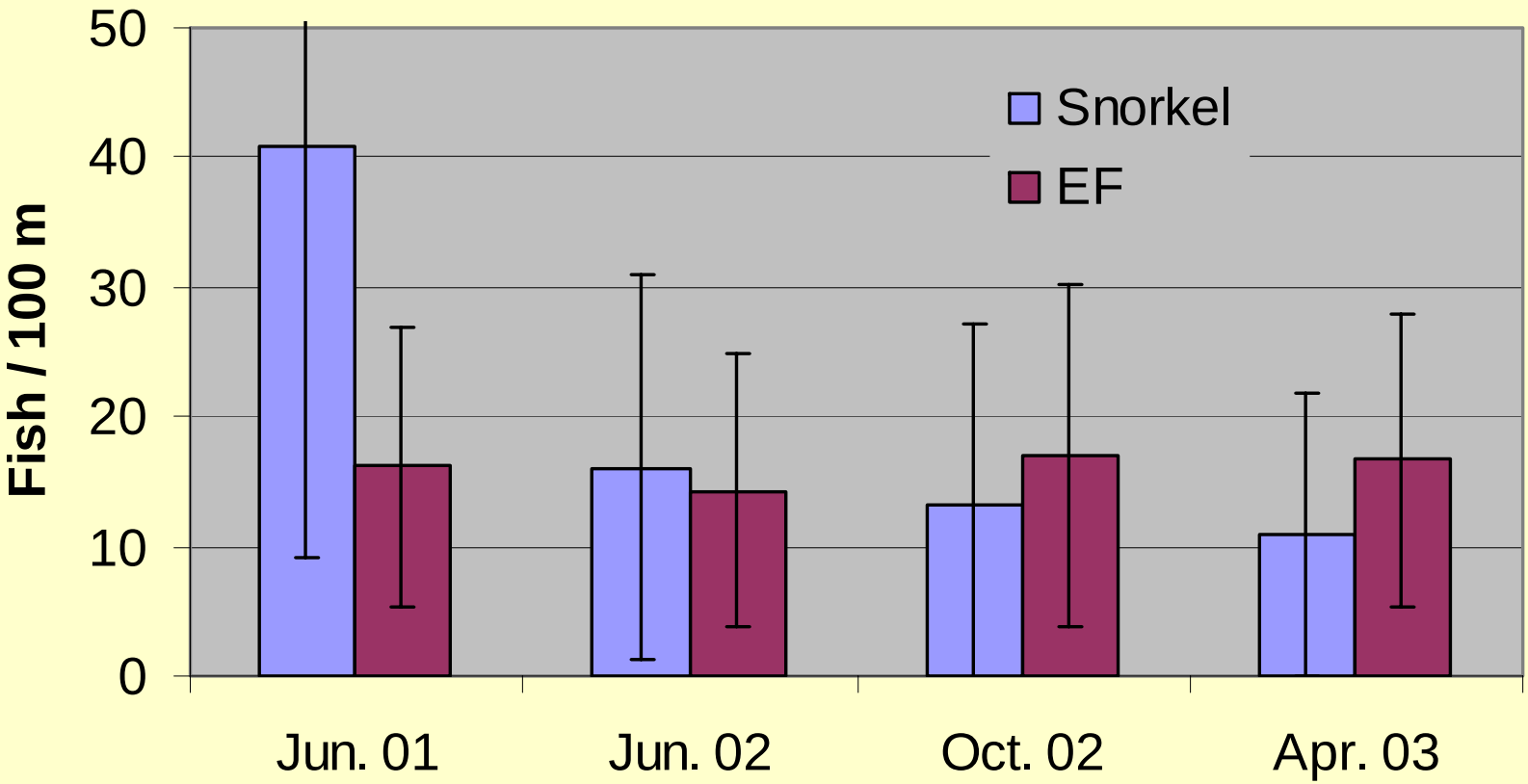
Snorkel – Electrofishing Shoreline Density Comparison



Snorkel – Electrofishing Shoreline Density Comparison



Comparison of Snorkel vs. EF Densities



Conclusions

- Potential Causes for EF vs. Snorkel Trend discrepancy
  - There is no discrepancy if sampling variance is considered
  - No population trend from ’01-’03, EF is OK and snorkel has some unknown bias
  - -’ve population trend from ’01-’03, Snorkel is OK and EF is hyperstable.

- Magnitude in trend from diel sites matches trend seen in shoreline sites (1.5↓ Jun. ’02-Apr. ’03 at 8 Mile Bar)

- Possible mechanisms for hyperstability:
  - Dipper saturation (can count fish faster than they can be dipped)
  - EF sampling highest density of fish (nightime, high flow, shoreline) where density changes over time would likely be smallest

- Biological evidence of a recent population decline
  - 2000 LSSF and low flows since then compared to late ’90s = less food base
  - PSD and condition factor were below the declining trend after 2001+
  - Many dead/sick fish observed during ’01 snorkel survey