FUNDAMENTALS OF SURVEY SAMPLING

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Clearly Stated Objectives

How many fish are harvested by anglers?

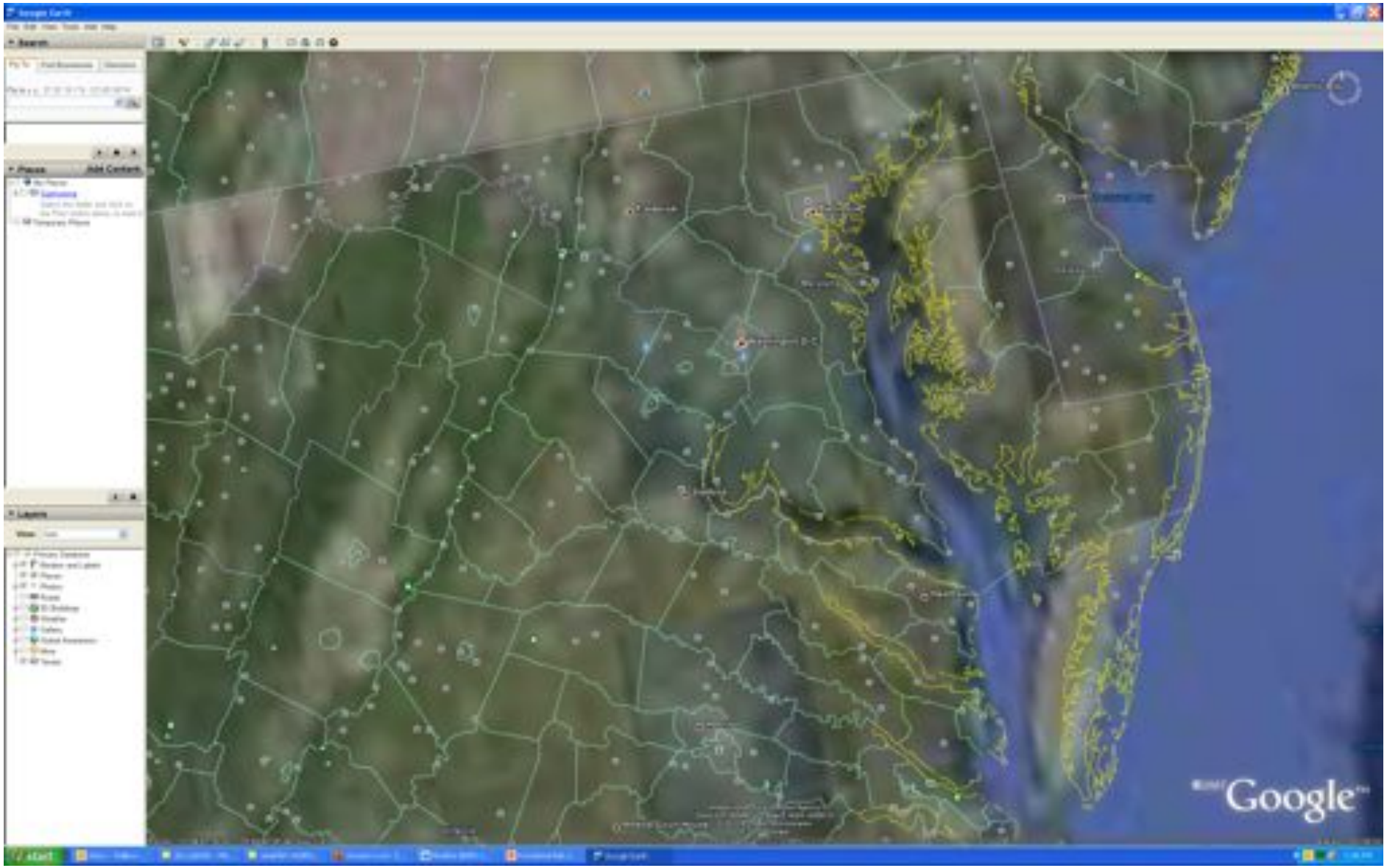
Has recreational CPUE declined?

What is the proportion of recreational Harvest compared to commercial?

WHAT IS FISH LENGTH FREQUENCY?

How quickly are the estimates needed?

Census versus Survey



Whether to sample depends of properties of the fishery

Commercial fisheries have few people catching large numbers of fish

- Own larger vessels
- Berth in larger, defined locations with services
- Report as a requirement for licensure

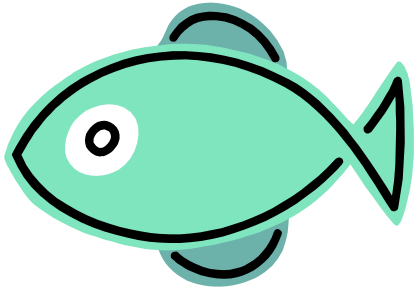
Recreational fisheries have many people catching few fish

- Variety of vessels from charter to private, shore and piers
- Enter fishery through defined and diffuse access
- Marine anglers have not historically had licenses
- Heterogeneity of skill at catching fish

How and what we sample depends on objectives

Primarily, we sample people to obtain information

Secondarily, we handle the catch and sample fish



Concept of the Sampling Frame

In many practical situations the frame is a matter of choice to the survey planner, and sometimes a critical one. [...] Some very worthwhile investigations are not undertaken at all because of the lack of an apparent frame; others, because of faulty frames, have ended in a disaster or in cloud of doubt.
—Raymond James Jessen

Concept of the Sampling Frame

An ideal sampling frame will have the following qualities:

1. All units have a logical, numerical identifier
2. All units can be found - their contact information, map location or other relevant information is present
3. The frame is organized in a logical, systematic fashion
4. The frame has additional information about the units that allow the use of more advanced sampling frames
5. Every element of the population of interest is present in the frame
6. Every element of the population is present *only once* in the frame
7. No elements from outside the population of interest are present in the frame

Wikipedia 2011

List Frame

Systematic sample from list frame

Daubenspeck T 2763 Burning Tree Ln Suffolk ----- 538-1942
W M 6001 Vineyard Ln Suffolk ----- 484-8547
Daubert B H 3982 Wyckoff Dr Virginia Beach ----- 431-2138
Daubert , Inc 3255 Henneman Dr Norfolk ----- 853-4077
Daubert James 8013 Baywood Dr Norfolk ----- 588-2628
James 3013 Pewter Rd Virginia Beach ----- 486-0367
Kevin 4017 Vaughan Town Ct Virginia Beach ----- 689-0141
Tim & Maureen 8246 Andrew Ln Norfolk ----- 480-3074
Dauda Edwin 8900 Old Ocean View Rd Norfolk ----- 228-3722
Dauer Christopher 5348 Chatham Lake Dr
Virginia Beach ----- 495-3847
Daniel 3560 Kentucky Trl Chesapeake ----- 485-5057
Matthew 3557 Chesapeake Blvd Norfolk ----- 623-0943
Pamela 3224 E Ocean View Av Norfolk ----- 962-1119
Thomas & Amy 521 Cameo Terr Chesapeake ----- 382-0732
Wesley J 5701 Constance Ct Virginia Beach ----- 490-9765
Dauge Bernadette 4832 Cliffony Dr Virginia Beach -- 495-5958
Daughdrill M J 3100 Shore Dr Virginia Beach ----- 496-1404
Oliver 1561 Willimantic Dr Virginia Beach ----- 467-5794
Daughdrille John & Cheryl 840 Old Bridge Ln
Chesapeake ----- 819-7597
Daugherty Associates Architects 248 W Bute Ste 200
Norfolk ----- 623-0051
Daugherty B H 1327 Hodges Ferry Rd Portsmouth -- 465-5410
Raymond W 8304 Booth St Norfolk ----- 587-7418
Brian 5313 Shorebird Ct Chesapeake ----- 558-0937
Brian & Kelly 2312 Shorebird Ct Chesapeake ----- 558-1248
Brian & Susann 1513 Captains Ct Virginia Beach -- 467-6318
Bruce 27266 Spivey Town Rd ----- 242-3192
Carl 115 N Main St Franklin ----- 569-1171
Christopher 1614 Sword Dancer Dr Virginia Beach - 301-6511
Dale 122 Kimberly Ln Norfolk ----- 271-4447
Dale 122 Kimberly Ln Norfolk ----- 271-8790
Darlene 20380 Garrison Dr Wind ----- 242-6636
David W & Nancy A 1625 Mill Landing Rd
Virginia Beach ----- 721-5027
Dawn 300 Dunkirk Ct Virginia Beach ----- 963-9300
Dolard N Cdr 2313 Dodd Dr Virginia Beach ----- 481-3996
Doug 3024 Glastonbury Dr Virginia Beach ----- 468-5380
Earl 6315 Adair Av Norfolk ----- 466-1792
Ethan ----- 275-9373
G W ----- 430-9052
George S 1041 Baker Rd ----- 464-5502
Guy E & Sherry 1700 Catherine Ct Virginia Beach -- 481-7916
Hunter 1725 Meredith Rd Virginia Beach ----- 460-3399
J 4224 Nightower Rd Portsmouth ----- 673-0816
J B 293 Corporate Blvd Norfolk ----- 893-9254
J S 5044 Rugby Rd Virginia Beach ----- 233-0444
James 2552 Elson Green Av Virginia Beach ----- 721-2079
James W 244 Lucille Av ----- 623-9529
Jennifer 1756 Aquamarine Dr Virginia Beach ----- 321-0389
John & Linda 313 46th St Virginia Beach ----- 962-7290
K J 710 Roosevelt Av Virginia Beach ----- 306-1205
Kimberly 2869 Augusta Cir Virginia Beach ----- 301-9484
Kimberly 3496 Thurston St Norfolk ----- 853-3534
Lakia 2621 Harlins Dr Chesapeake ----- 963-7520
Larry Melanie 628 Manor Dr Virginia Beach ----- 963-3094
Larry R 748 Waters Dr Virginia Beach ----- 495-4290
Melissa 1021 Bowling Green Tr Chesapeake ----- 410-9195
Misty ----- 233-9735
Mitch ----- 491-2350
P N 900 Le Cove Dr Virginia Beach ----- 420-6870
Phillip 4321 Two Woods Rd Virginia Beach ----- 460-7855
Raymond 901 Northwood Dr Chesapeake ----- 546-5035
Roger A 1332 Roanoke Arch Chesapeake ----- 482-1867
S Clark 311 Suburban Pkwy Norfolk ----- 531-8058
Scott 863 Park Place Dr Virginia Beach ----- 428-5111
Selden F 4420 Cambria St Virginia Beach ----- 687-6517
T R ----- 498-0416
Vicky 408 Constitution Dr Virginia Beach ----- 473-1640
Daughety Bobbie 1235 Picadilly St Norfolk ----- 853-6518
J C 4816 Manor Av Portsmouth ----- 484-1367
Joseph 2000 Pine Tree Ct Suffolk ----- 934-1146
Pamela 453 Ballahack Rd Chesapeake ----- 204-4817
Robert 1221 Renoir Ct ----- 427-9038

Area-Time Frame

Mon	Tue	Wed	Thur	Fri	Sat	Sun
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28

Jones & Pollock In Press Chapter 19 in Fisheries Techniques

Frame Coverage

Undercoverage By RDD
Anglers without phones or with non-coastal area codes

Overcoverage By RDD

Random Dialing to coastal area codes (Landline and Cell)

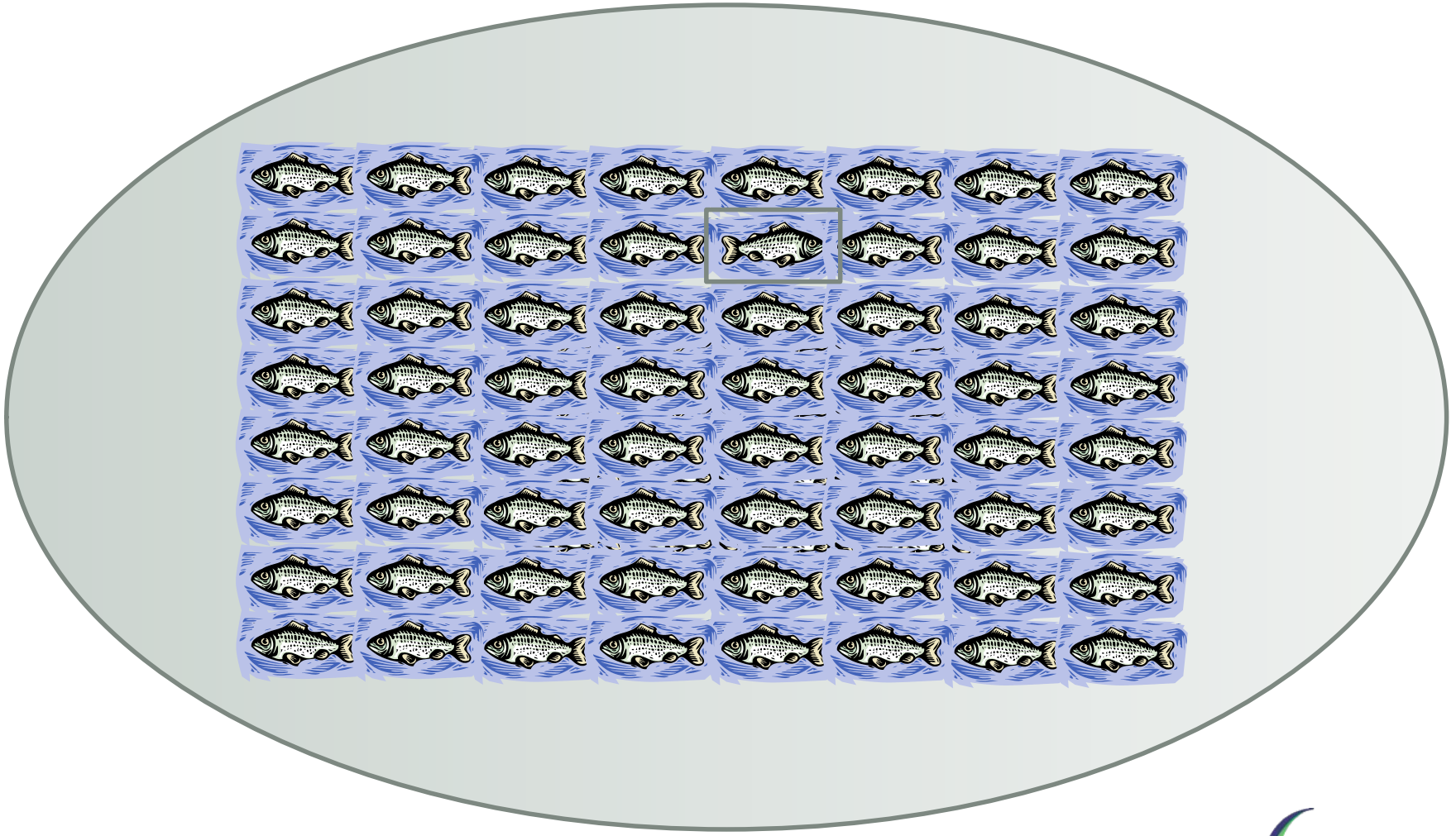
Anglers with coastal area codes (Landline and cell)

Concepts of the target population, sampling frame, and sampling unit

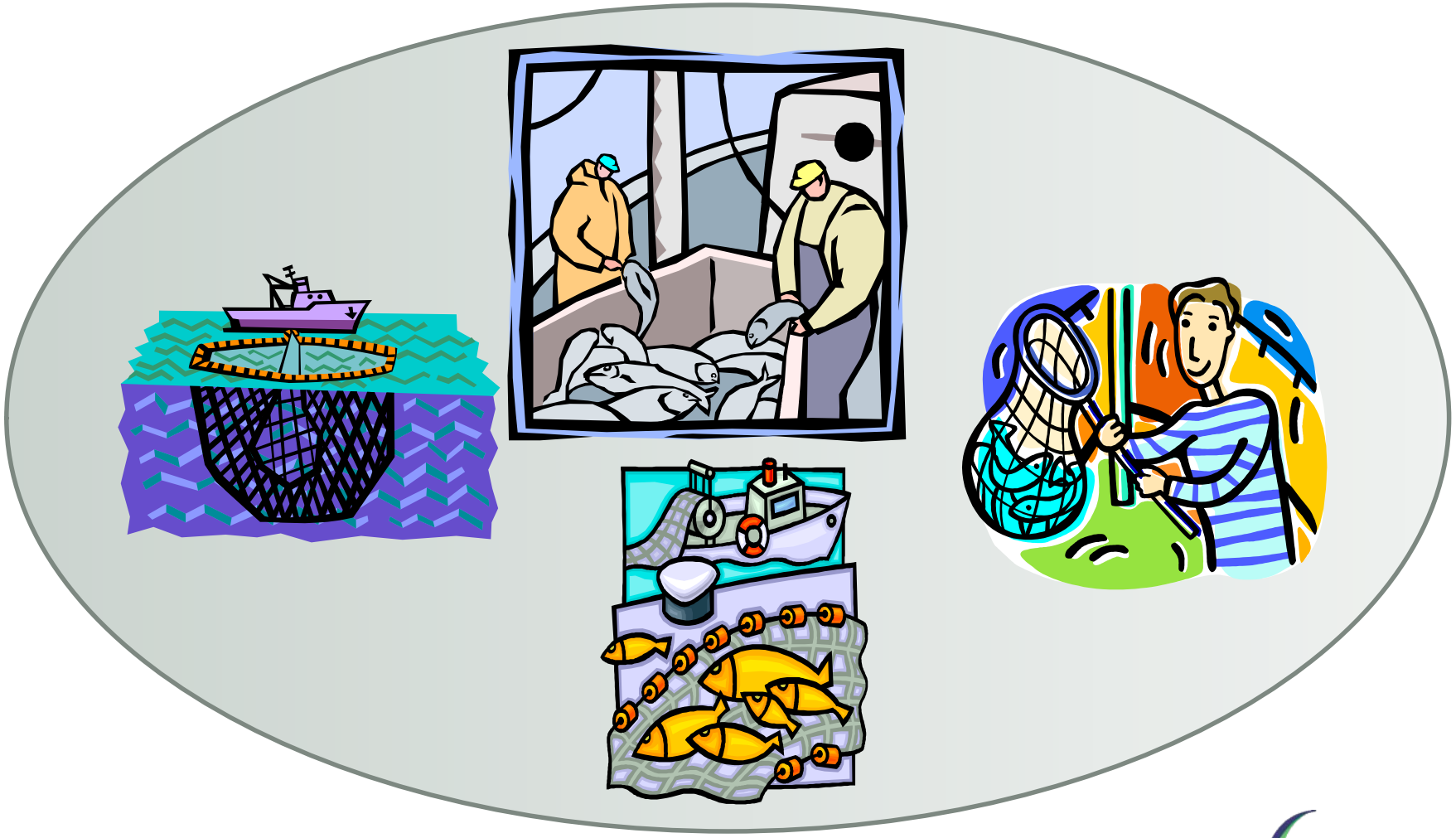
All of the anglers in the large rectangle are the *target population* that we wish to sample. However, the *sampling frame* for our survey method, e.g. a list of licensed anglers (shaded area) does not include unlicensed anglers. A better method would include all anglers. For our method, the sampling unit is the individual angler.

 = sampling unit

Concept of the Sampling Unit



Concept of the Sampling Unit



Choosing a Sampling Unit

In a design-based study, the sampling unit is chosen with a known probability

$$\sum_{i=1}^{N} \pi_i = n$$

For example, in a list of angler names we might chose every 10th name resulting in each having a one in ten chance of being contacted

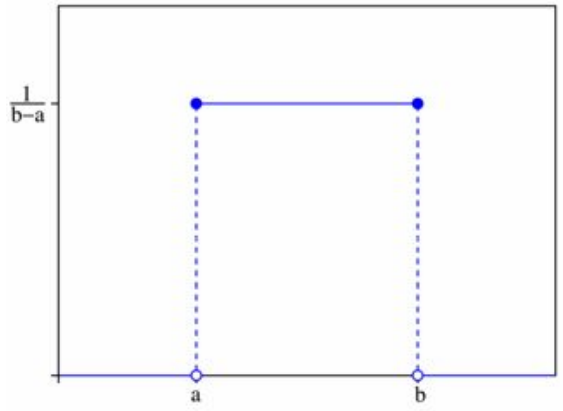
Or we can choose a sample of 15 out of 30 using a random number generator:

3	19	15	3	21	22	12	1	28	29	19	22	8	16	13	3	16	30

Choosing a Sampling Unit

In a design-based study, the sampling unit is chosen with a known probability:

Depends on the distribution
In a uniform distribution there is an equal chance



In an area-time frame, there are several ways to draw a sample:

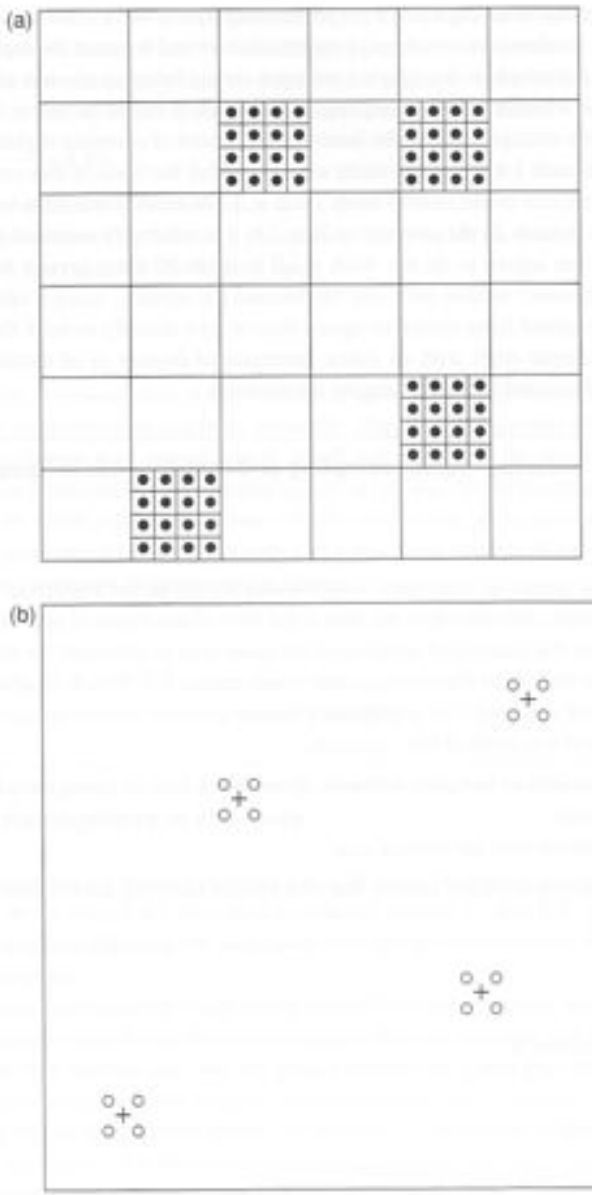


Figure 2.5 Two forms of cluster sampling: (a) cluster areas (the large squares) are chosen at random and all sample units (small squares) in each are sampled; (b) points are chosen at random (+) and samples (○) taken in a fixed pattern relative to each.

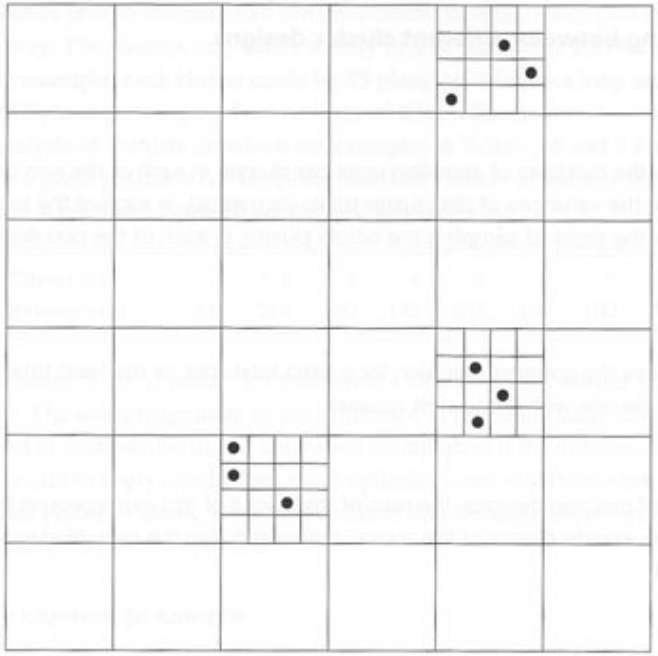


Figure 2.6 Two-stage sampling: major units (large squares) are randomly chosen and minor units (small squares) sampled at random within each.

From: Sutherland 2006 Ecological Census Techniques

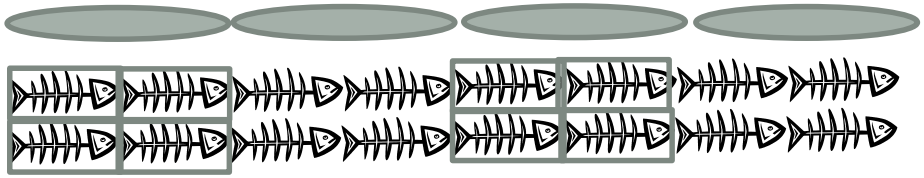
Estimation

Simple Random Sample

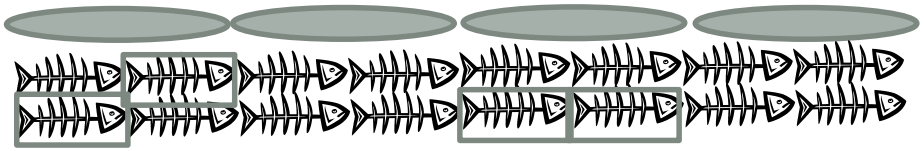
Stratified Random Sample

Systematic Random Sample

Cluster Sample



Multi-stage Sample



Estimation

Simple Random Sample

$$\bar{y} = \frac{1}{n}\sum_{i=1}^{n} y_i$$

$$s^2 = \frac{1}{n-1}\sum_{i=1}^{n}(y_i - \bar{y})^2$$

Stratified Random Sample

$$\bar{y}_h = \frac{1}{n_h}\sum_{i=1}^{n_h} y_{hi}$$

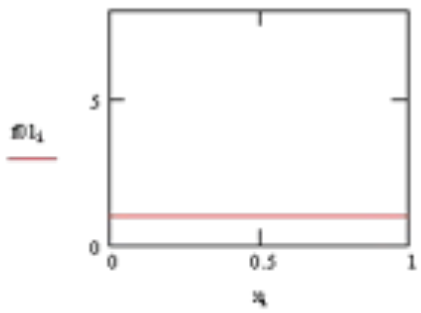
$$\overline{y_{st}} = \frac{1}{N}\sum_{h=1}^{L} N_h \overline{y_h}$$

Estimation of Population Mean

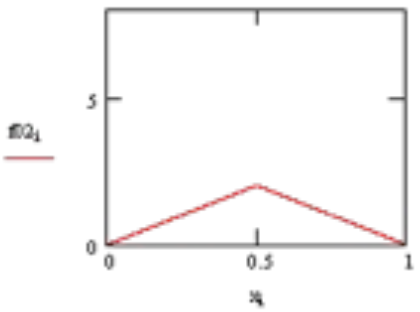
http://www.math.csusb.edu/faculty/stanton/probstat/clt.html

Estimation of Population Mean

Mean of uniform distribution: $\frac{1}{2}(a+b)$



NonNormal Distribution of X



Distribution of Xbar when sample size is 2

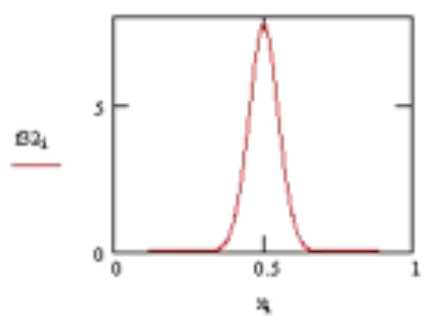
The **uniform** distribution on the left is obviously *non*-Normal. Call that the parent distribution.

To compute an average, Xbar, **two** samples are drawn, at random, from the parent distribution and averaged. Then another sample of two is drawn and another value of Xbar computed. This process is repeated, over and over, and averages of two are computed. The distribution of averages of two is shown on the left.

http://www.statisticalengineering.com/central_limit_theorem.htm

Estimation of Population Mean

Mean of uniform distribution: $\frac{1}{2}(a+b)$



Distribution of Xbar when sample size is 32

Repeatedly taking **thirty-two** from the parent distribution, and computing the averages, produces the probability density on the left.

http://www.statisticalengineering.com/central_limit_theorem.htm

Reduce Variance

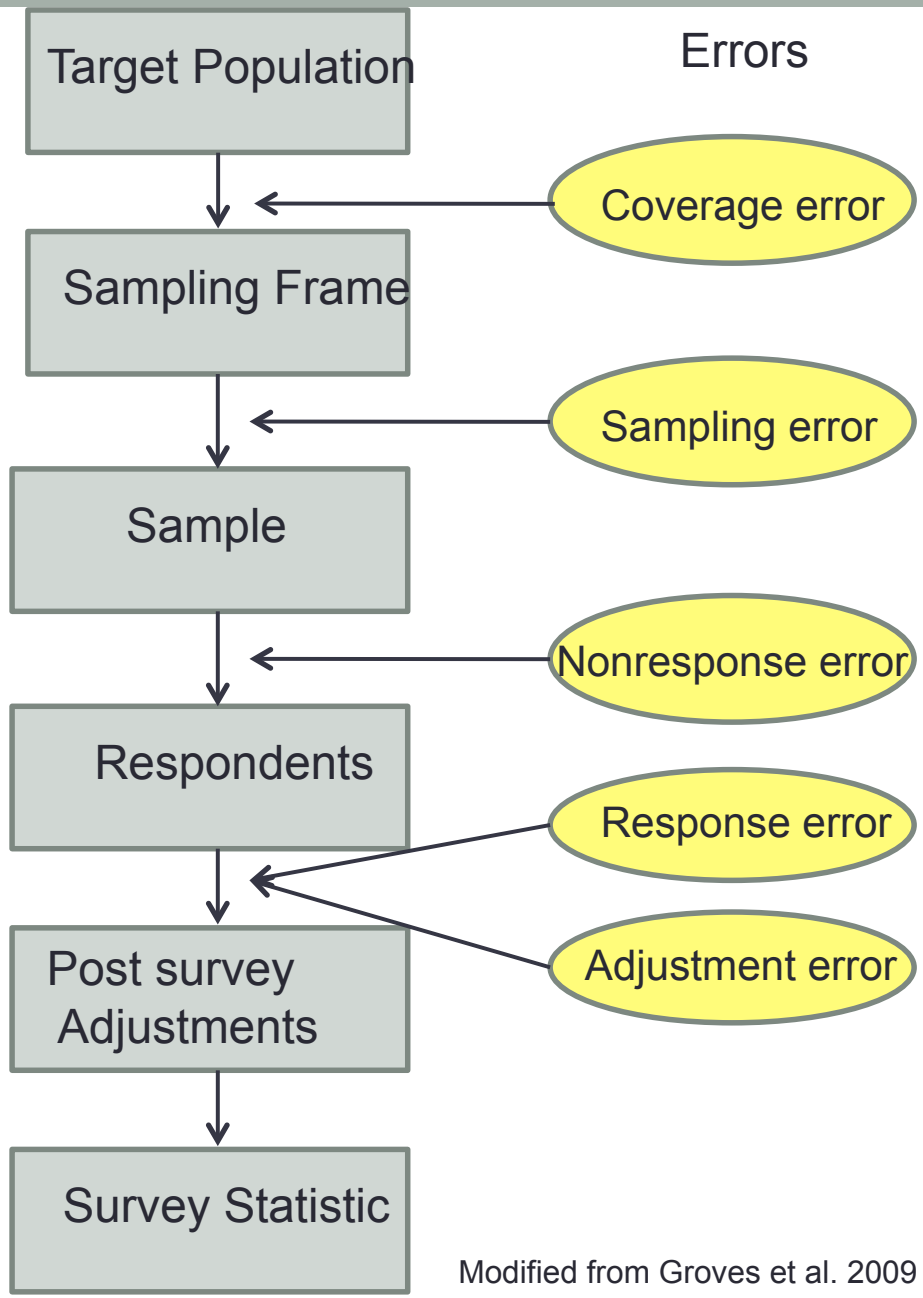
$$s^2 = \frac{1}{n-1}\sum_{i=1}^{n}(y_i - \bar{y})^2$$

- Increase sample size
- Match sampling design to population characteristics
  - Components of variability, e.g. stratify
  - Sample proportional to greatest variability, e.g. more sampling where disparities are greatest (ppx)

Survey Biases & Errors

Biases

- Non-response
- Prestige
- Recall
- Visibility



Modified from Groves et al. 2009 Survey Methodology

In Summary

- Census versus Sample
- Sampling Frames
- Survey Objectives
- Addressing potential bias