The On-line Regional Training Course on Sampling Gear Design for Onboard Fisheries Resource Survey

31 August - 4 September 2020

Fisheries resource survey design technique

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Fisheries resource survey and its purpose-1

https://gguilleraresearch.wordpress.com/2013/08/01/what-are-ecological-statisticians-talking-about/

Fisheries resource survey and its purpose-2

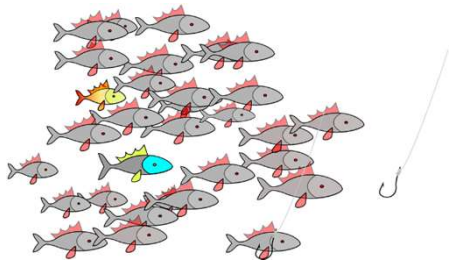
https://sites.google.com/a/uw.edu/most-cited-fisheries/how-to-cite

What are the data we want from the fisheries resources survey?

- Catch, landings and discards
  - A fundamental variable of interest
- Species and stock composition
  - Biological state of the resources
    - Stock size, production, population dynamics
- Environmental conditions
  - Relationships to catch and fishing activities
- Fishing activity (effort)
  - Fishing patterns and relation to yields
    - Fishing mortality = f(Effort),
    - Yield = f(Effort)

Survey design process

- Fishery dependent survey
- Fishery independent survey



Fishery dependent survey-1

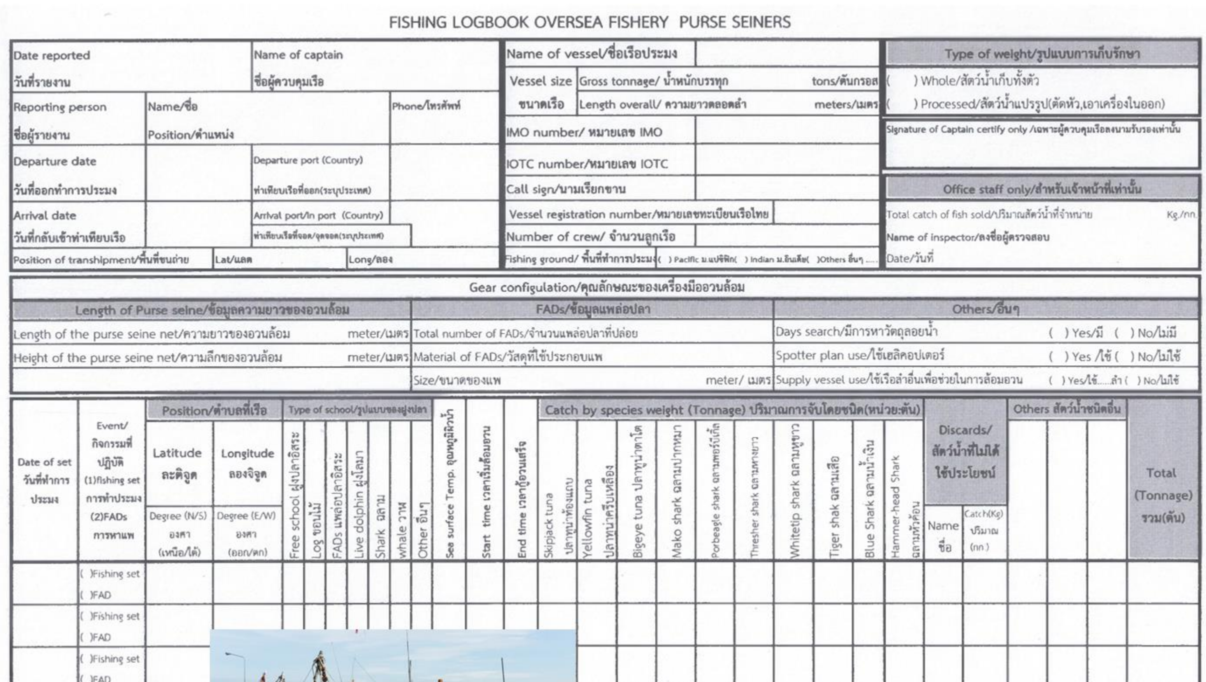
Advantages

- Provide mandatory data on catches and fishing activities in wide spatial coverage all year round
- Provide, *optional,* data on discards, fishing grounds and effort used etc.
- Provide evidence on trends in stock abundance through the quantities of catch per unit of fishing effort (e.g. per day)
- Provide information on the size and (where possible) age of individuals in the catches and, then, be further used to estimate the annual fishing mortality rate.
- Provide biological information of the catches, i.e. samples from the landing sites

Disadvantages

- Bias and repeat since samples are collected using preferential sampling because fishing fleets are commercially driven.
- Lack of environmental information and, sometimes, lack particular details such as the location of fishing grounds and species identity, in particular small scale fisheries.

Fishery dependent survey-2



FISHING LOGBOOK OVERSEA FISHERY PURSE SEINERS

Date reported วันที่รายงาน		Name of captain ชื่อผู้ควบคุมเรือ		Name of vessel/ชื่อเรือประมง	
Reporting person ชื่อผู้รายงาน	Name/ชื่อ Position/ตำแหน่ง		Phone/โทรศัพท์	Vessel size ขนาดเรือ	Gross tonnage/ น้ำหนักบรรทุก tons/ตันกรอส Length overall/ ความยาวตลอดลำ meters/เมตร
Departure date วันที่ออกทำการประมง		Departure port (Country) ท่าเทียบเรือที่ออก(ระบุประเทศ)		IMO number/ หมายเลข IMO	
				IOTC number/หมายเลข IOTC	
				Call sign/นามเรียกขาน	
Arrival date วันที่กลับเข้าท่าเทียบเรือ		Arrival port/In port (Country) ท่าเทียบเรือที่จอด/จุดจอด(ระบุประเทศ)		Vessel registration number/หมายเลขทะเบียนเรือไทย	
				Number of crew/ จำนวนลูกเรือ	
Position of transhipment/พื้นที่ขนถ่าย	Lat/แลต	Long/ลอง		Fishing ground/ พื้นที่ทำการประมง	( ) Pacific ม.แปซิฟิก ( ) Indian ม.อินเดีย ( )Others อื่นๆ .....

Type of weight/รูปแบบการเก็บรักษา
( ) Whole/สัตว์น้ำเก็บทั้งตัว
( ) Processed/สัตว์น้ำแปรรูป(ตัดหัว,เอาเครื่องในออก)
Signature of Captain certify only /เฉพาะผู้ควบคุมเรือลงนามรับรองเท่านั้น

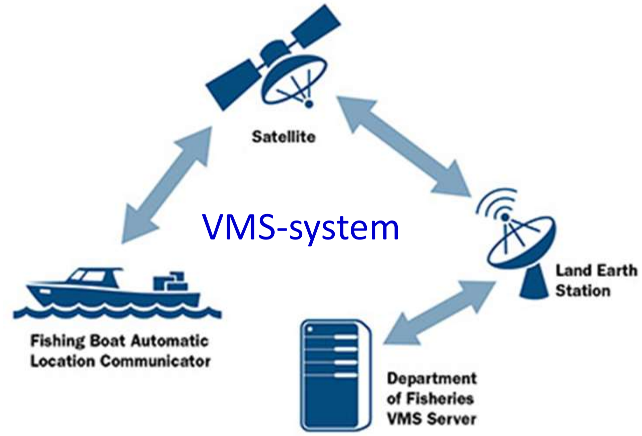
Office staff only/สำหรับเจ้าหน้าที่เท่านั้น
Total catch of fish sold/ปริมาณสัตว์น้ำที่จำหน่าย Kg./กก.
Name of inspector/ลงชื่อผู้ตรวจสอบ
Date/วันที่

Gear configulation/คุณลักษณะของเครื่องมืออวนล้อม

Length of Purse seine/ข้อมูลความยาวของอวนล้อม	FADs/ข้อมูลแพล่อปลา	Others/อื่นๆ
Length of the purse seine net/ความยาวของอวนล้อม meter/เมตร	Total number of FADs/จำนวนแพล่อปลาที่ปล่อย	Days search/มีการหาวัตถุลอยน้ำ ( ) Yes/มี ( ) No/ไม่มี
Height of the purse seine net/ความลึกของอวนล้อม meter/เมตร	Material of FADs/วัสดุที่ใช้ประกอบแพ	Spotter plan use/ใช้เฮลิคอปเตอร์ ( ) Yes /ใช้ ( ) No/ไม่ใช้
	Size/ขนาดของแพ meter/ เมตร	Supply vessel use/ใช้เรือลำอื่นเพื่อช่วยในการล้อมอวน ( ) Yes/ใช้.....ลำ ( ) No/ไม่ใช้

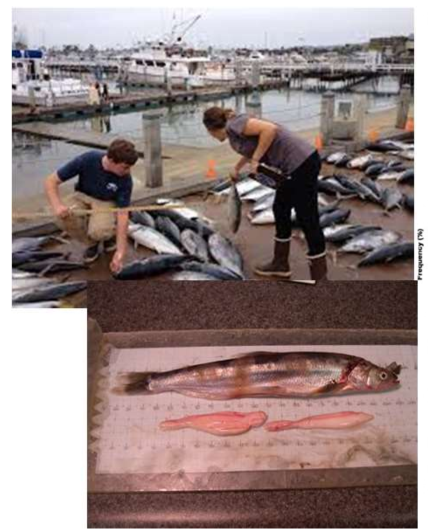
Date of set วันที่ทำการประมง	Event/ กิจกรรมที่ปฏิบัติ (1)fishing set การทำประมง (2)FADs การหาแพ	Position/ตำบลที่เรือ: Latitude ละติจูด Degree (N/S) องศา (เหนือ/ใต้)	Longitude ลองจิจูด Degree (E/W) องศา (ออก/ตก)	Type of school/รูปแบบของฝูงปลา: Free school ฝูงปลาอิสระ	Log ขอนไม้	FADs แพล่อปลาอิสระ	Live dolphin ฝูงโลมา	Shark ฉลาม	whale วาฬ	Other อื่นๆ	Sea surface Temp. อุณหภูมิผิวน้ำ	Start time เวลาเริ่มล้อมอวน	End time เวลากู้อวนเสร็จ	Catch by species weight (Tonnage) ปริมาณการจับโดยชนิด(หน่วย:ตัน): Skipjack tuna ปลาทูน่าท้องแถบ	Yellowfin tuna ปลาทูน่าครีบเหลือง	Bigeye tuna ปลาทูน่าตาโต	Mako shark ฉลามปากหมา	Porbeagle shark ฉลามพอร์บีเกิ้ล	Thresher shark ฉลามหางยาว	Whitetip shark ฉลามหูขาว	Tiger shak ฉลามเสือ	Blue Shark ฉลามน้ำเงิน	Hammer-head Shark ฉลามหัวค้อน	Discards/ สัตว์น้ำที่ไม่ได้ใช้ประโยชน์: Name ชื่อ	Catch(Kg) ปริมาณ (กก.)	Others สัตว์น้ำชนิดอื่น			Total (Tonnage) รวม(ตัน)
	( )Fishing set ( )FAD																												
	( )Fishing set ( )FAD																												
	( )Fishing set ( )FAD																												

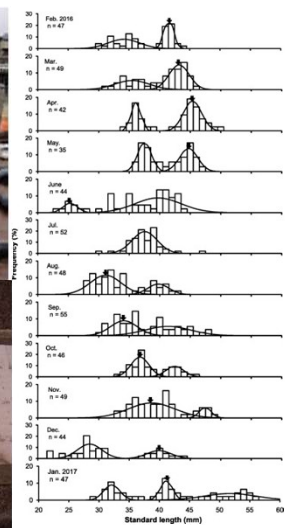
Fishing logbook



VMS-system

Field-samplings





Fishery dependent survey-3

Data collection and utilization

Data	How to collect?	What is it used for?
Landings (or catches)	Logbooks, samplings at landing sites	• Information in statuses of fisheries and fish stocks. • Further used assessment for stock assessment and fishery management
Discards	Logbooks, observer programs, samplings at landing sites	• Information in the removals, that not being utilized, both targets and bycatches
Efforts	Satellite monitoring (VMS), logbooks (fishing duration)	• Fishing capacity and efficiency (catch per unit effort, CPUE). • Further used assessment for stock assessment and fishery management
Biological data – e.g. lengths, weight and age frequency data	samplings at landing sites and further work in the laboratory	• Cohorts information, through length-, weight-. and age frequency distributions, which further used assessment for stock assessment and fishery management. • Biological information, e.g. growth and feedings, of the target species

Mackinson 2017

Fishery independent survey-1

Advantages

- Provide high quality data because sampling and collection are scientifically designed and standardized.
- Provide information on oceanography, environment and ecosystem
- Provide data and information on any particular interests, e.g. planktons and fish larvae, according to specific research questions.
- Can set the fixed stations and/or fixed-transect surveys for data collection

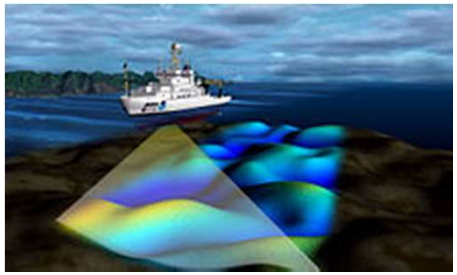
Disadvantages

- Expensive and carried out over relatively short periods of time
- Limited amount of data can be collected.
- Limited coverage in space and time, i.e. seasonality and the number of years of available data

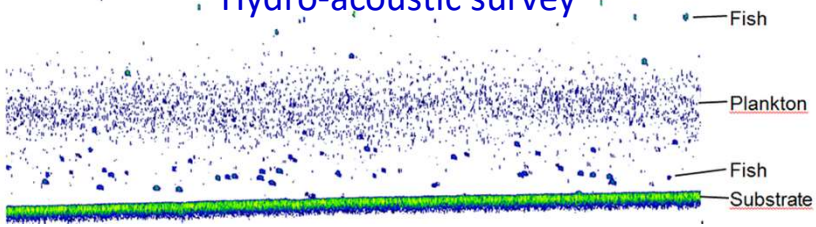
Fishery independent survey-2

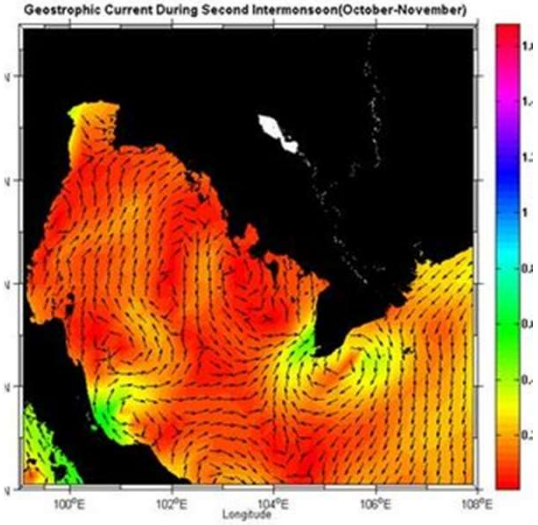


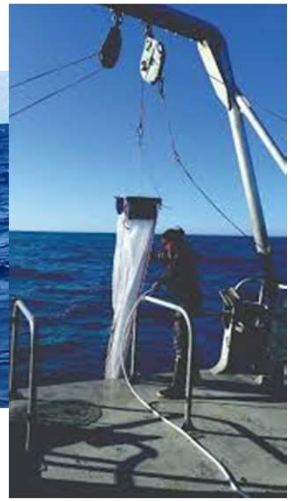
Scientific trawl survey



Hydro-acoustic survey







Oceanographic and environmental survey

Ecosystem survey

Fishery independent survey-3

Data collection and utilization

Data	How to collect?	What is it used for?
Catches and abundances	• Swept area method (trawl) • Hydro-acoustic method • Underwater cameras	• Density index, catchability, population composition, distribution. • Used in tuning stock assessment models.
Biological data – e.g. lengths, weight and age frequency data / Age & growth / Feedings	Survey catch sampling followed by lab analyses	• Changes in the size and age composition of the population, proportion mature, growth rates. All used in stock assessments.
Plankton & Larval and egg counts	Various nets and samplers	• Diversity and distribution • Abundance and its variation
Environmental & Oceanographic data	Various physical and chemical sensors, water samplers Grabs and cores for sediments.	• Relating patterns to environmental conditions. From population biology to ecological understanding necessary to make predictive models.

Mackinson 2017

Data collection methods for fishery dependent

Data collection method	Output	Pros (+) and cons (-)
Logbooks	Catch and effort data for individual fishermen/boats	(+) detailed trip information (-) relies on fisher's willingness to complete detailed records
Surveys at landing sites	Catch, effort and biological data for sample of fishermen/boats	(+) direct sampling by observers gives high quality data (-) Expensive and limited in coverage
Household surveys	Household level catch and effort data	(+) Captures subsistence fishing that bypasses landing sites and markets
Market surveys	Total landings	
Voluntary reporting	Catches, effort, CPUE, species and size information	(+) Potentially easy to collect in large quantities (-) Relies on individual motivation, biased towards avid anglers and high catches, low uptake and continuity
Automatic recording (e.g. by cameras or VMS)	Fishing effort, catch, bycatch	(+) Can partially replace direct observation by people, cost effective (-) Still requires visual analysis of recordings

Lorenzen et al., 2016

Data collection methods for fishery independent

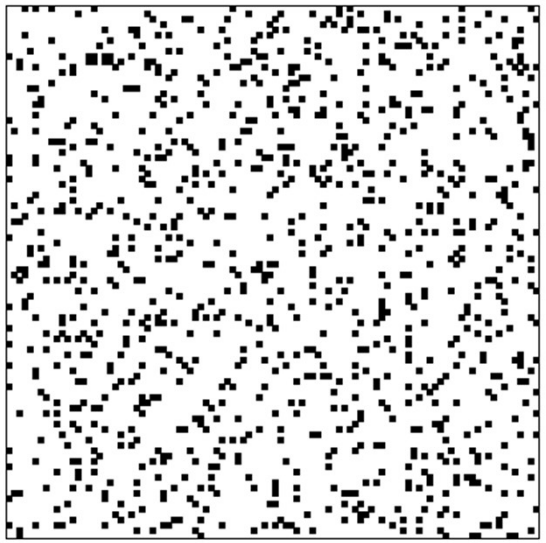
Data collection method	Output	Pros (+) and cons (-)
Standard sampling	Relative abundance, population structure	(+) Rapid sampling with gear of known selectivity and to a scientific design (-) Provides only relative abundance estimates
Depletion sampling	Abundance (absolute), population structure	(+) Provides absolute abundance estimates immediately (-) Requires intensive sampling
Mark-recapture studies	Abundance (absolute), growth, mortality components	(+) Provides estimates of absolute abundance, growth and mortality components, movement (-) Requires sampling over extended period
Hydro-acoustics	Biomass, size structure, distribution	
Remote sensing	Habitat characteristics, fishing effort	
Environmental DNA (eDNA)	Indirect estimate of biomass index	(+) Rapid in the field, suitable for habitats that are difficult to sample (-) Provides only rough estimate of biomass

Lorenzen et al., 2016

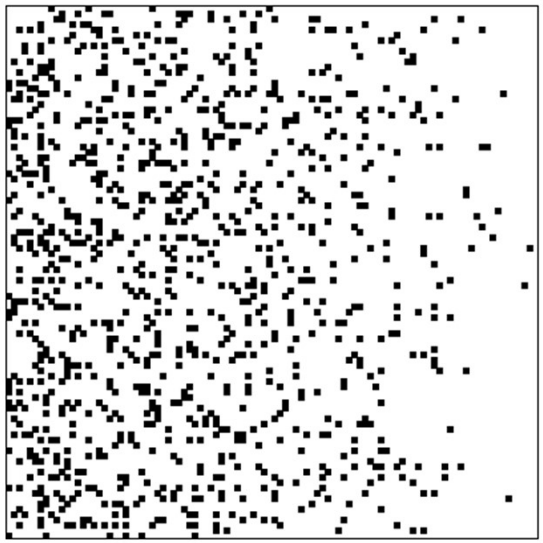
https://www.youtube.com/watch?v=9D5uJm9S79o

General population distributions of fisheries resources

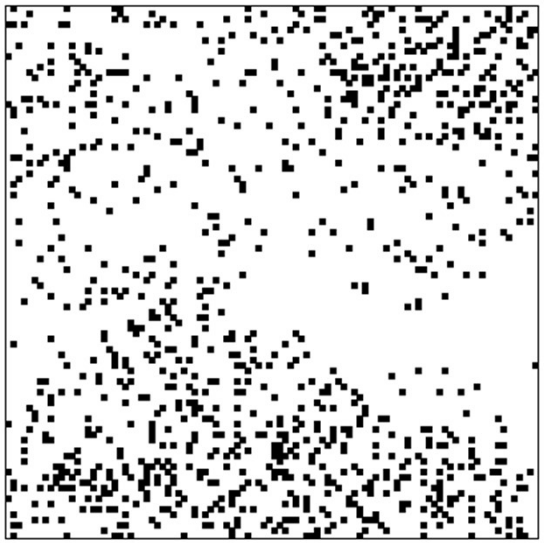
Random (homogenous)



Gradient

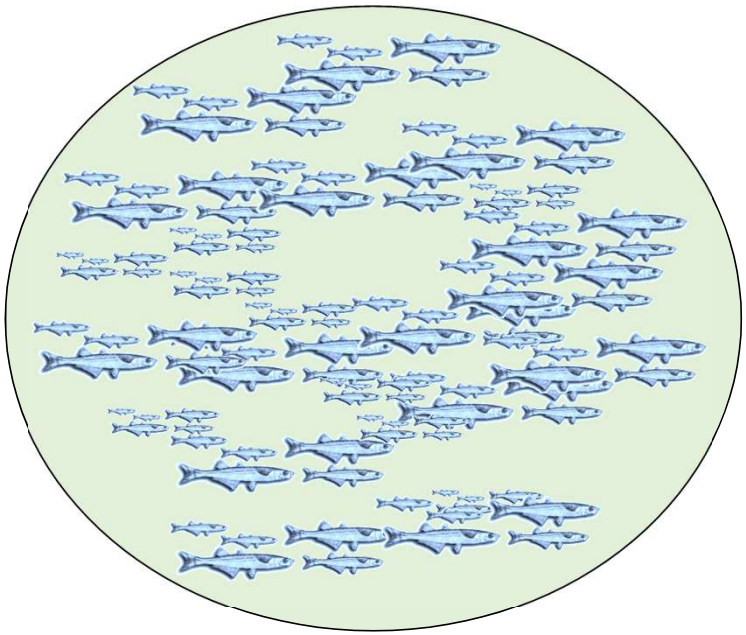


Patchy (heterogeneous)



Fishvice: fishvice.hafro.is

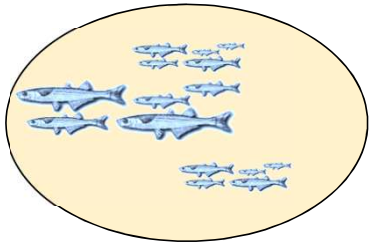
Population VS samples



A population is "*all items with the characteristic one wishes to understand*"

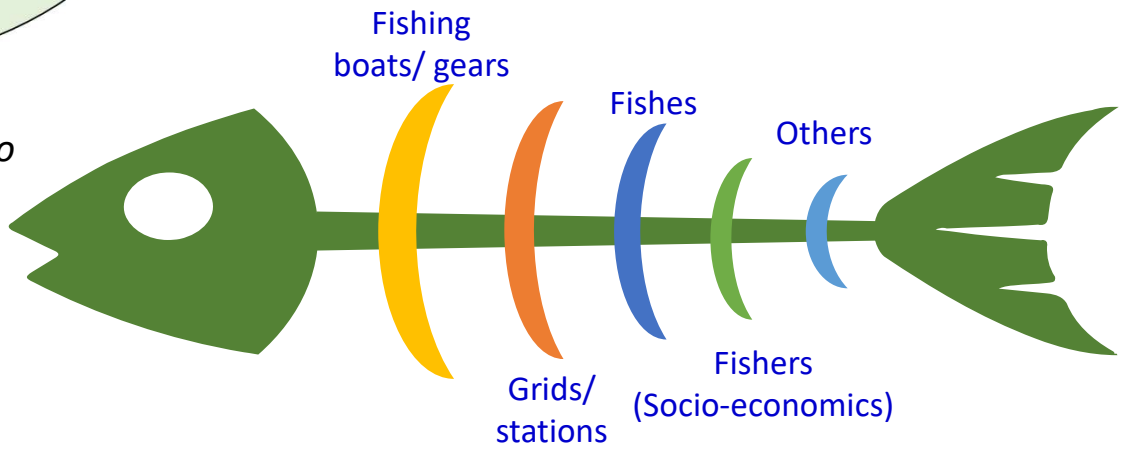
Sampling

Inference



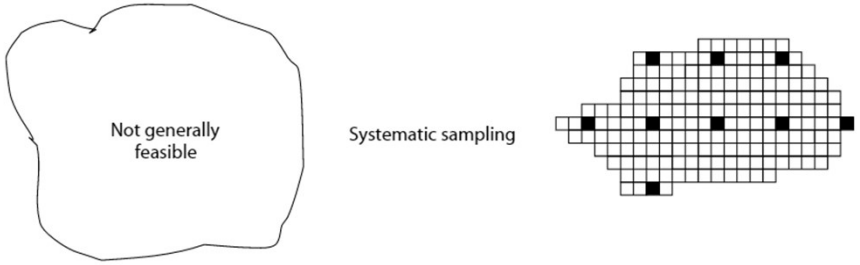
A sample is "*a smaller (but hopefully representative) collection of units from a population used to determine truths about that population*"

Populations

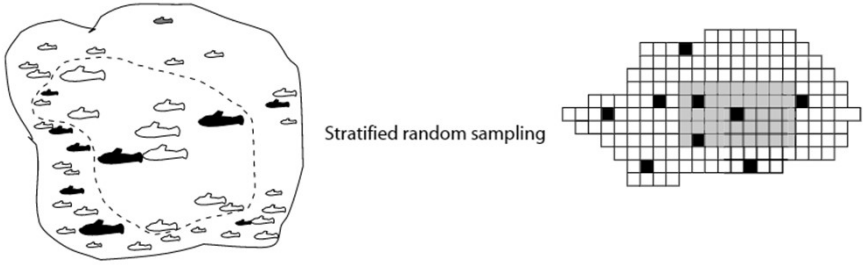


Typical sampling techniques in fisheries resource survey-1

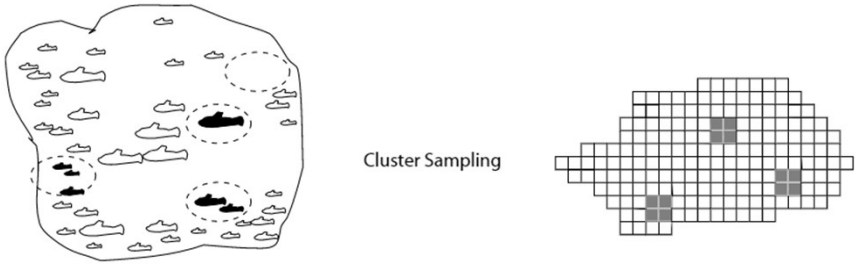
distribution homogeneous or uniform: variance ≤ mean



distribution heterogeneous without periodicity or due to unknown factors



distribution contagious, patched with known external factors, e.g. depth: variance > mean

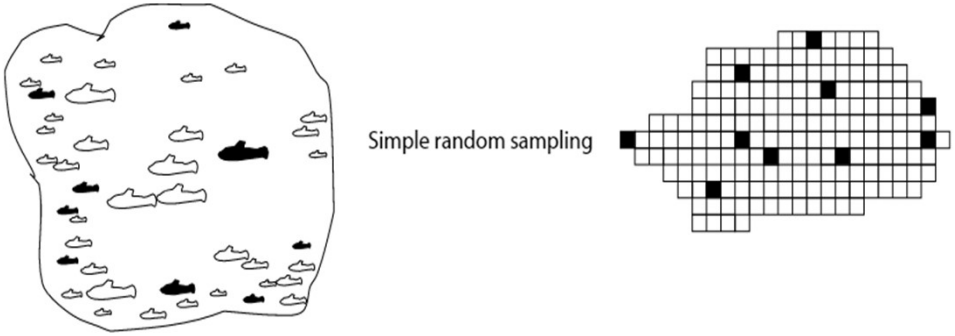


within a cluster should ideally heterogeneous, but homogeneity between clusters.

Typical sampling techniques in fisheries resource survey-2

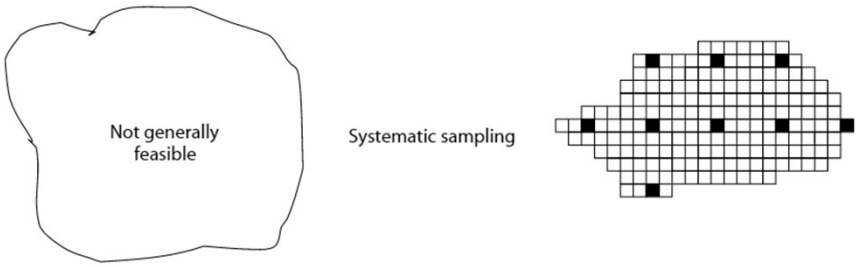
Simple Random Sampling

- Apply when population is small, homogeneous & readily available
- Each element has an equal probability of selection.
- It provides for greatest number of possible samples.
- This is done by assigning a number to each unit in the sampling frame.
- Estimates are easy to calculate.
- NOT Convenient sampling



Systematic Sampling

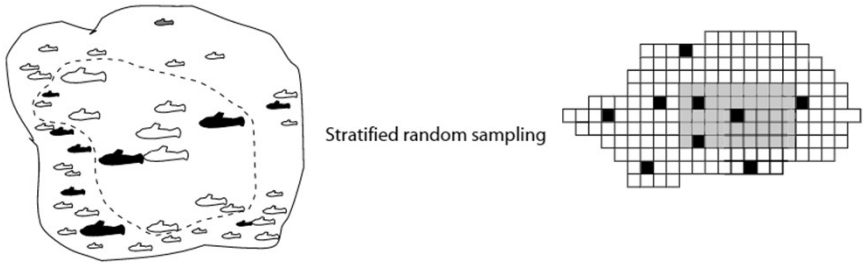
- Rely on arranging the target population according to ordering scheme and then selecting elements at regular intervals through that ordered list.
- Random start and then proceeds with the selection of every kth element from then onwards
- Sample evenly spread over entire reference population
- Sample may be biased if hidden periodicity in population coincides with that of selection.



Typical sampling techniques in fisheries resource survey-3

Stratified Sampling

- Population embraces a number of distinct categories, the frame can be organized into separate "strata." .
- Each stratum is then sampled as an independent sub-population, out of which individual elements can be randomly selected.
- Every unit in a stratum has same chance of being selected.
- Using same sampling fraction for all strata ensures proportionate representation in the sample.



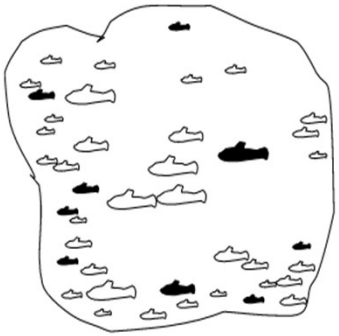
Cluster Sampling

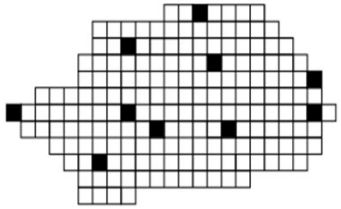
- Cluster sampling is an example of 'two-stage sampling'
- First stage a sample of areas is chosen; Second stage a sample of respondents within those areas is selected.
- All units from the selected clusters are studied.
- Although strata and clusters are both non-overlapping subsets of the population, they are different.
- With stratified sampling, the best survey results occur when elements within strata are internally homogeneous. However, with cluster sampling, the best results occur when elements within clusters are internally heterogeneous

Estimations of mean and variance-1

Simple random sampling

- Sample's total value $y_{\cdot} = \sum_{i=1}^{n} y_i$
- Sample's mean $\bar{y} = \frac{1}{n}\sum_{i=1}^{n} y_i$ (assuming equal population mean$(\bar{Y})$)
- Sample's variance $s^2 = \frac{1}{n-1}\sum_{i=1}^{n}(y_i - \bar{y})^2$
- Variance of sample's mean $\mathrm{v}(\bar{y}) = \left(\frac{N-n}{N}\right)\frac{s^2}{n}$
- Population's total value $\hat{Y}_{\cdot\cdot} = N\bar{y}$
- Variance of population's total value $\mathrm{V}\left(\hat{Y}_{\cdot\cdot}\right) = N^2(1-f)\frac{s^2}{n}$ when $f = \frac{n}{N}$

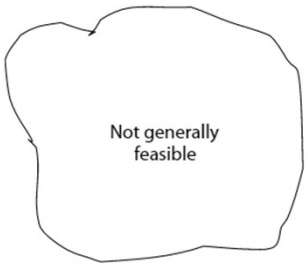




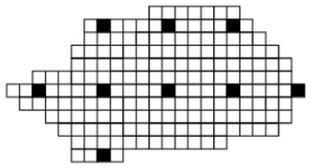
Estimations of mean and variance-2

Systematic random sampling (sampling every kth unit, until achieve n units, then N = kn)

- Sample's total value $y_{i.} = \sum_{j=1}^{n} y_{ij}$
- Sample's mean $\overline{y_{sy}} = \bar{Y} = \frac{1}{kn}\sum_{i=1}^{k}\sum_{j=1}^{n} y_{ij}$ (proxy of Population's mean ($\bar{Y}$))
- Sample's variance $s_{sy}^2 = \frac{1}{k(n-1)}\sum_{i=1}^{k}\sum_{j=1}^{n}\left(y_{ij} - \overline{y_{i.}}\right)^2$
- Variance of sample's mean $\overline{y_{sy}}$: $v\left(\overline{y_{sy}}\right) = \left(\frac{N-n}{N}\right)\frac{s^2}{n}$ when $s^2 = \frac{1}{n-1}\left(y_{ij} - \overline{y_{sy}}\right)^2$
- Population's total value $\widehat{Y_{sy}} = N\overline{y_{sy}}$
- Variance of population's total value $\mathrm{V}\left(\hat{Y}\right) = N^2 v\left(\overline{y_{sy}}\right)$



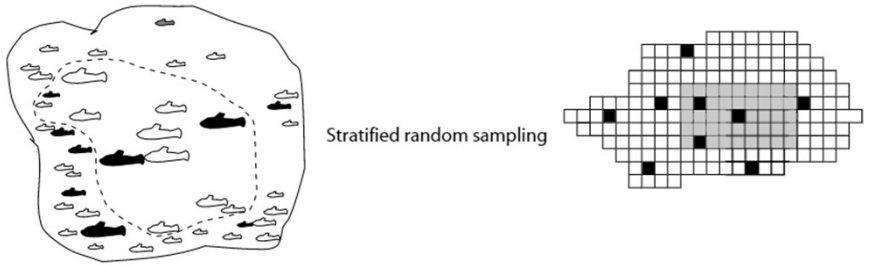
Systematic sampling



Estimations of mean and variance-3

Stratified random sampling (if there are *L* strata, i.e. strata, *h* = 1 to L)

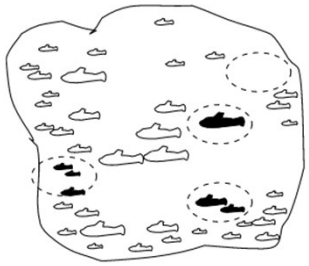
- Sample's total of stratum "*h*" $y_h = \sum_{i=1}^{n_h} y_{h_i}$
- Sample's mean of stratum "*h*" $\overline{y_h} = \frac{y_h}{n_h}$
- Sample's variance of stratum "*h*" $s_h^2 = \frac{1}{n_h - 1} \sum_{i=1}^{n_h} \left(y_{h_i} - \overline{y_h}\right)^2$
- Population's mean $\bar{Y} = \overline{y_{st}} = \sum_{h=1}^{L} W_h \overline{y_h}$ when $W_h = \frac{N_h}{N}$
- Variance of population's mean $\mathrm{v}(\overline{y_{st}}) = \sum_{h=1}^{L} (1 - f_h) \frac{s_h^2}{n_h}$ when $f = \frac{n_h}{N}$
- Population's total value $\widehat{Y_{st}} = N y_h$
- Variance of Population's total value $V\left(\widehat{Y_{st}}\right) = N^2 \mathrm{v}(\overline{y_{st}})$



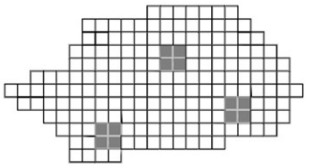
Estimations of mean and variance-4

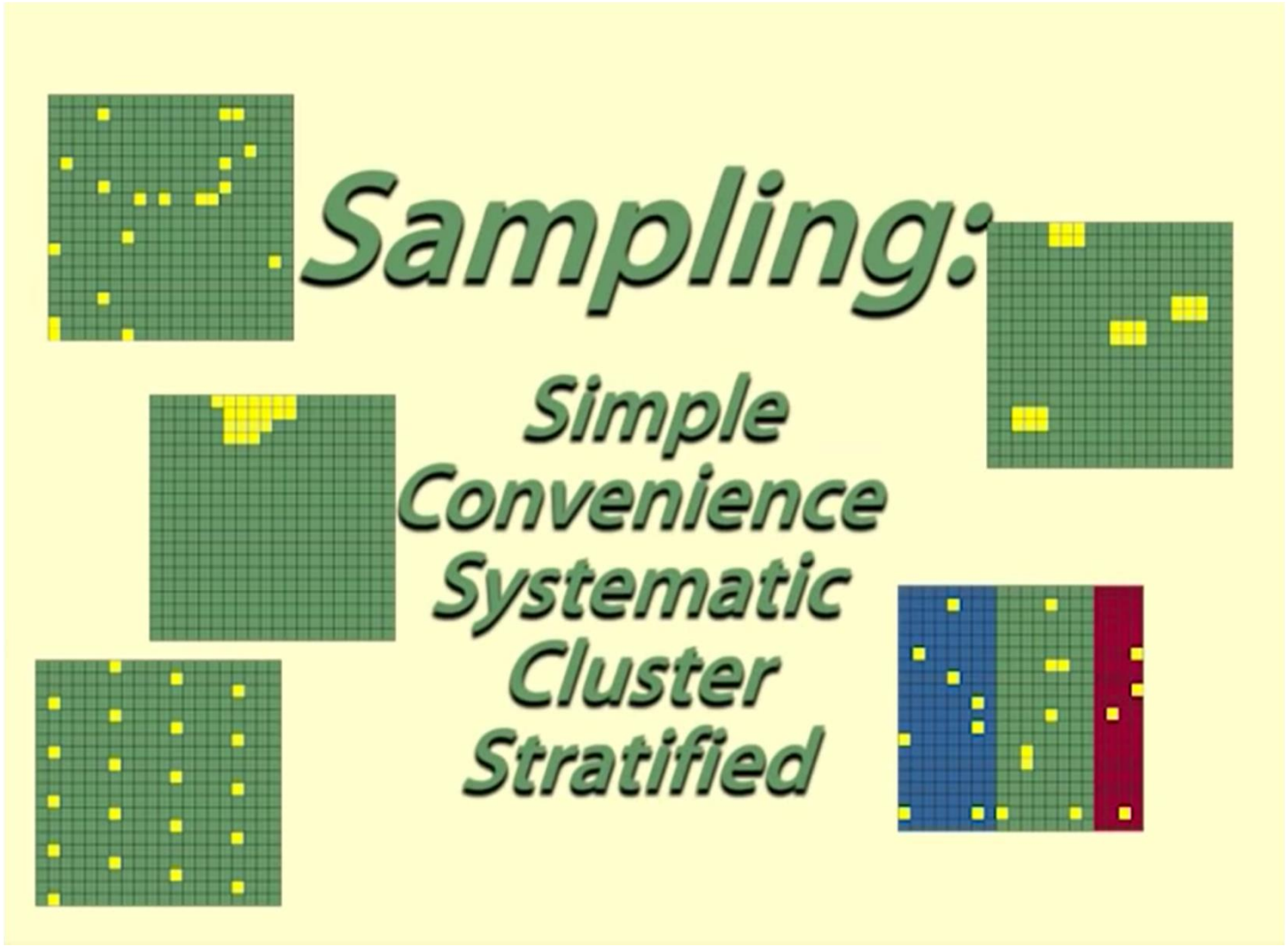
Cluster sampling (If there are *N (n)* clusters, each cluster contains *M* units)

- Sample's total value $y_{..} = \sum_{i=1}^{n}\sum_{j=1}^{M} y_{ij}$ Sample's mean $\overline{y}_{..} = \frac{y_{..}}{nM}$
- Total value of cluster ith $y_{i.} = \sum_{j=1}^{M} y_{ij}$ Mean of cluster ith $\overline{y_{i.}} = \frac{y_{i.}}{M}$
- Cluster mean ค่าเฉลี่ยต่อกลุ่มตัวอย่าง $\overline{y} = \frac{y_{..}}{n}$ Mean of cluster mean $\overline{\overline{y_{n.}}} = \frac{1}{n}\sum_{i=1}^{n}\overline{y_{i.}}$
- Population's total value $\widehat{Y}_{..} = N\overline{y} = N\frac{1}{n}\sum_{i=1}^{n} y_{i.}$
- Variance of population's total value $\widehat{Y}_{..}$: $\mathrm{v}(\widehat{Y}_{..}) = N^2\left(\frac{N-n}{N}\right)\frac{s_{Ib}^2}{n}$ when $s_{Ib}^2 = M^2 s_b^2$ และ $s_b^2 = \frac{1}{n-1}\sum_{i=1}^{n}(\overline{y_{i.}} - \overline{\overline{y_{n.}}})^2$
- Population's mean $\widehat{\overline{Y}}_{..} = \overline{\overline{y_{n.}}}$
- Variance of population mean $v(\overline{\overline{y_{n.}}}) = \left(\frac{N-n}{N}\right)\frac{s_b^2}{n}$



Cluster Sampling





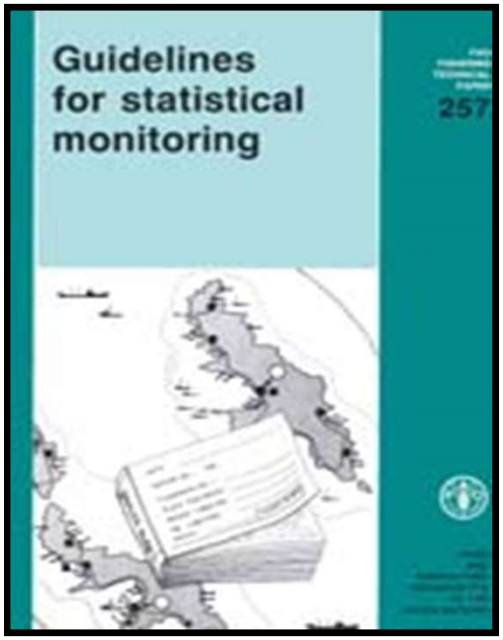
https://www.youtube.com/watch?v=be9e-Q-jC-0

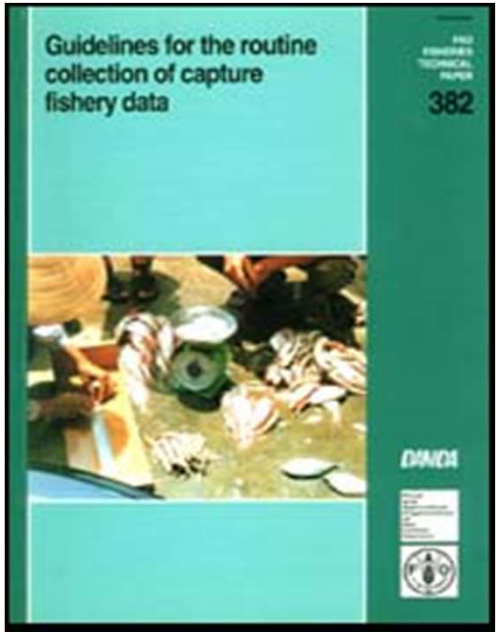
Final Remarks

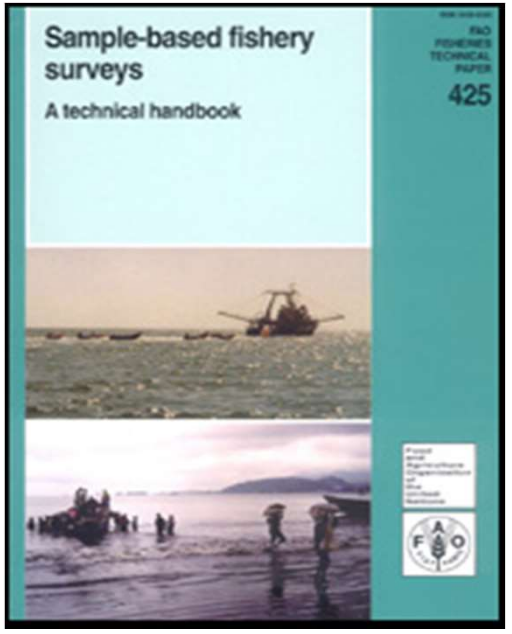
Survey objectives → Discussed

Statistical units → Frame

Variation in the population → stratification







THANK YOU

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