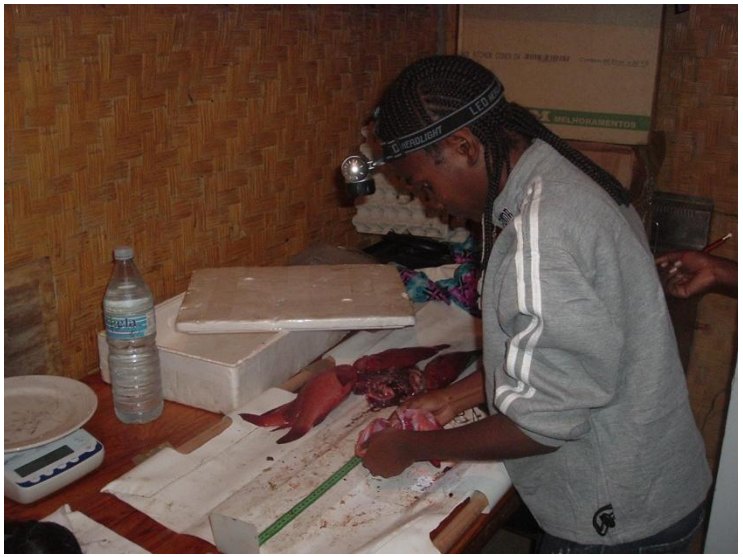
Field Techniques
ICH 3 Lecture 1

1. Provide you with the skills to design a basic fish life history experiment
2. Provide insight on how to remove bias from scientific studies



Course Assignment - Glen Melville dam/ Due Monday 28th May

Design a reproductive study on African sharptooth catfish *Clarias gariepinus* for Glen Melville dam (venue for the field trip).

Format:

- The key questions drive this experiment and how their requirements affect your sampling design.
- A sketch of Glen Melville dam showing the main habitats that may influence your study.
- The location of your sampling sites and a justification for choosing these.
- What gear you will use to sample and where you will employ it
- Sampling dates and a justification for choosing these.
- Sample size for each of the key questions
- Your field data sheets showing what information you will collect

Course Assignment - Glen Melville dam/ Due Monday 28th May

Design a feeding study on African sharptooth catfish *Clarias gariepinus* for Glen Melville dam (venue for the field trip).

- **Evaluation:** Grasp of the relevant research issues and key elements to developing a sampling protocol.
    1. Understanding of how the interaction between the target species and the habitats in the research site influence the study (20%).
    2. Choosing sampling sites that are representative of the research area (15%).
    3. Identifying sampling gears to limit bias from selectivity (15%).
    4. Maintaining statistical integrity, biological realism and logistic feasibility in the choice of sampling dates and sample size (20%).
    5. Development of field data sheets (15%).
    6. Presentation, layout, grammar, spelling & referencing (15%).

Field techniques 301 Lecture Schedule May 2012

Day	Lecture
Mon 21st	Intro and sampling strategy
Tue 22nd	Sampling gear
Wed 23rd	Public holiday – work on course assignment
Thu 24th	Guidelines for reproductive biology Field Trip to Glen Melville Dam
Fri 25th	Age, growth and dietary studies

Further reading

Murphy, B. R., and D. W. Willis, editors. 1996. Fisheries techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.

Backiel, T. and R.L. Welcomme (eds), Guidelines for sampling fish in inland waters. EIFAC 1980 Tech.Pap., (33):176 p. The full text is available at www.fao.org/DOCREP/003/AA044E/AA044E00.htm#TOC

FAO. Fish capture methods in vegetated areas. Chapter 12: In: FAO. Interactions between fish and aquatic macrophytes in inland waters, a review. Available from the FAO document repository. (www.fao.org/DOCREP/006/X7580E/X7580E00.HTM)

King, M. 1995. Fisheries biology, assessment and management. Fishing News Books, Blackwell Science Ltd. Oxford. 341 pp.

Sampling strategies

- **Population and sample**
  - The entire collection of possible measurements - **population.** e.g all male bass in Settlers dam.
  - Some populations may be small enough for a measurement of all members in the population e.g. the height of men that have travelled to the moon.
  - Others are too big - **sample**.
- **Planning the research**
  - Unrealistic to assume unlimited time, manpower and budgets.
  - Populations must be sampled in such a way that the best possible scientific information that can be obtained within the given constraints of time and budget.
  - Requires a clear understanding and description of the research and the definition of **research objectives and key questions.**

Objective: Determine the life-history of species-X in area Y.

- **Key questions**:

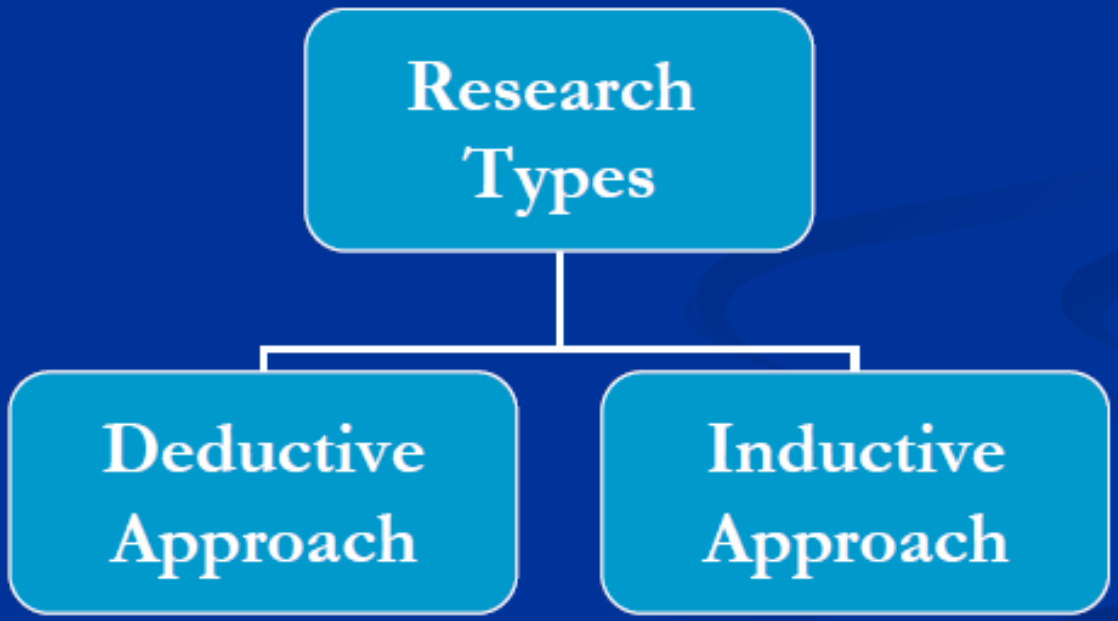
Reproductive biology
- When is the spawning season?
- What is the size/age at maturity?
- What is the fecundity?
- What is the spawning behavior?

Age, growth and population dynamics
- How fast does the fish grow?
- What is the population age structure?
- What is the rate of mortality?

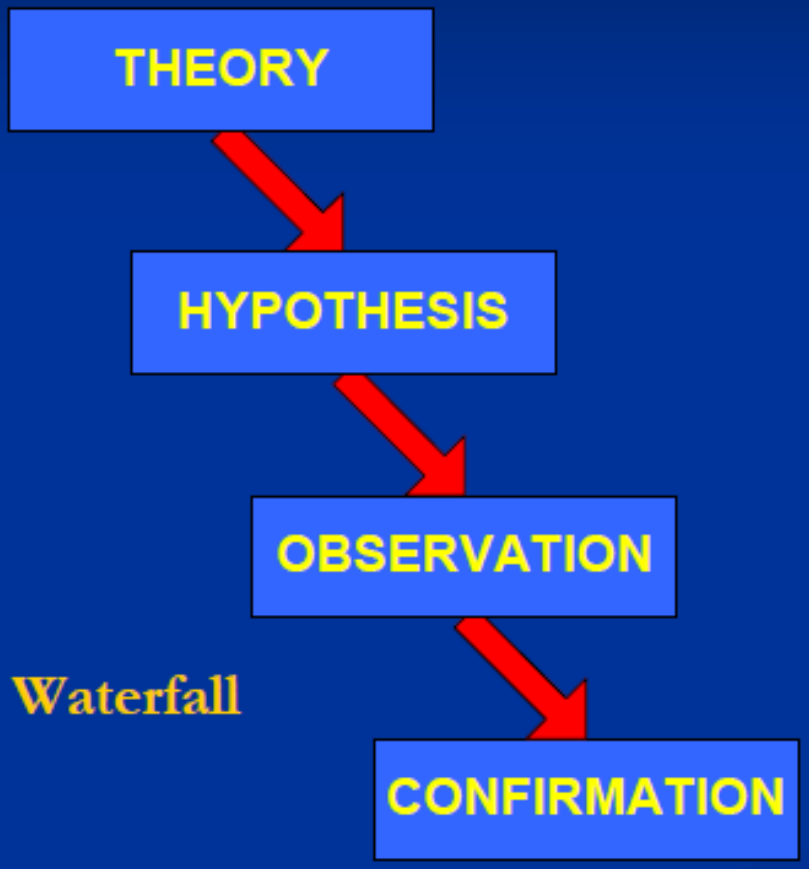
Diet
- What are the main prey items?
- Does diet change with size?
- Does diet change seasonally?

Research Methods

In research, we often refer to the two broad methods of reasoning as the ***deductive*** and ***inductive*** approaches.



Deductive Research Approach

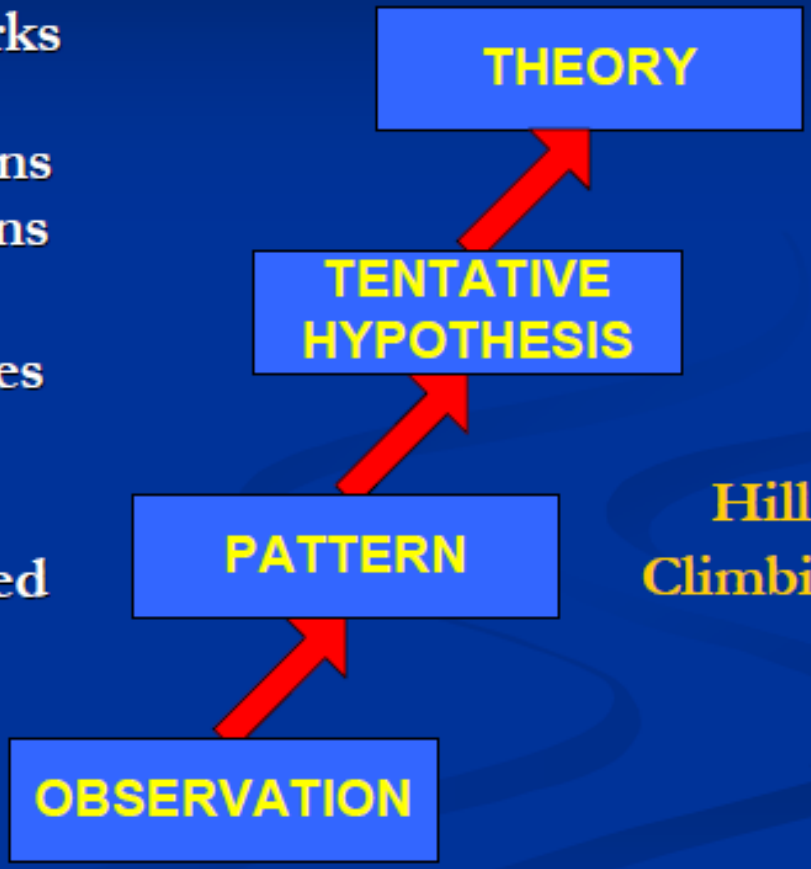


Waterfall

- Deductive reasoning works from the more general to the more specific.
- Sometimes this is informally called a "top-down" approach.
- Conclusion follows logically from premises (available facts)

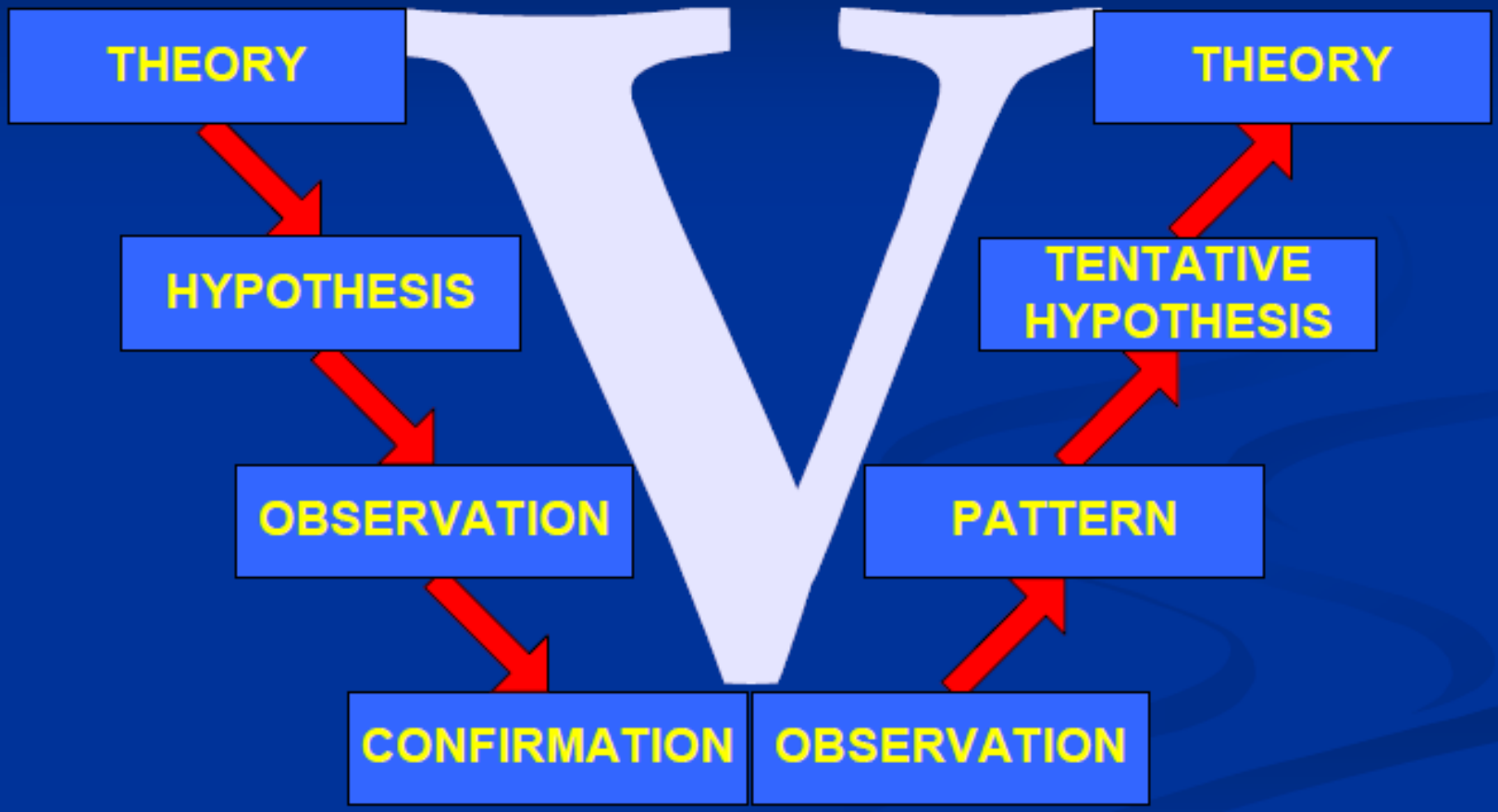
Inductive Research Approach

- Inductive reasoning works the other way, moving from specific observations to broader generalizations and theories.
- Informally, we sometimes call this a "bottom up" approach
- Conclusion is likely based on premises.
- Involves a degree of uncertainty



Hill Climbing

Deductive Vs. Inductive



Statistics and smart experimental design

- **Most of out science is deductive**

We need hypothesis testing - statistical analysis is unavoidable.

- **Of primary importance is the question:**
  - Is your sample representative of the population and is your measurement un-biased?
  - un-biased if replicate estimates deviate from the true value (that obtained if the whole population was measured) in a random manner only.
  - biased if it deviates from the true value in a systematic manner.
- **Sampling Design**
  - This is generally a compromise between obtaining the best possible scientific information given constraints of time and budget.

Accuracy and precision

Accuracy – lack of bias

- Affected by sampling design
- an estimate is accurate if on average it gives the right answer.

Precision:

- Affected by sample size.
- An estimate is precise if it does not vary much from sample to sample; it is imprecise if it varies considerably from sample to sample.

Low accuracy and high precision

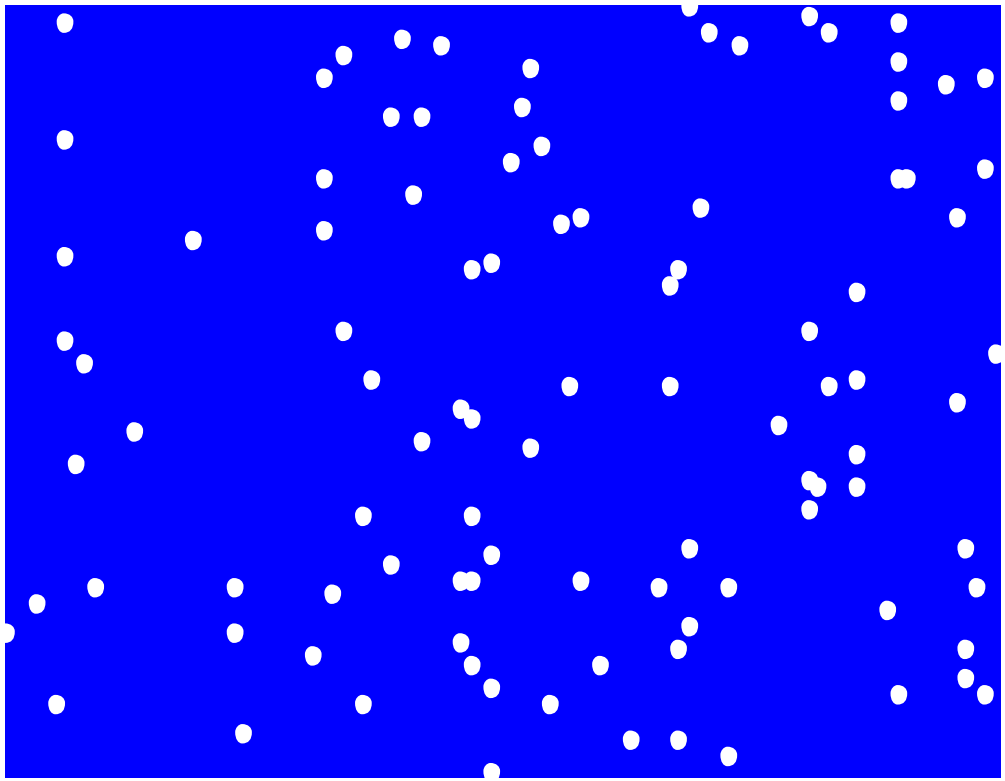
- Eg. Reading otoliths – same age estimate on all three readings, but because the reader begins assigning the first annuli on the second growth ring the accuracy of the results are questionable despite a high precision.

- Bias is not random - either +ve or -ve.
- Reduce bias by choosing a sample in an impartial way.

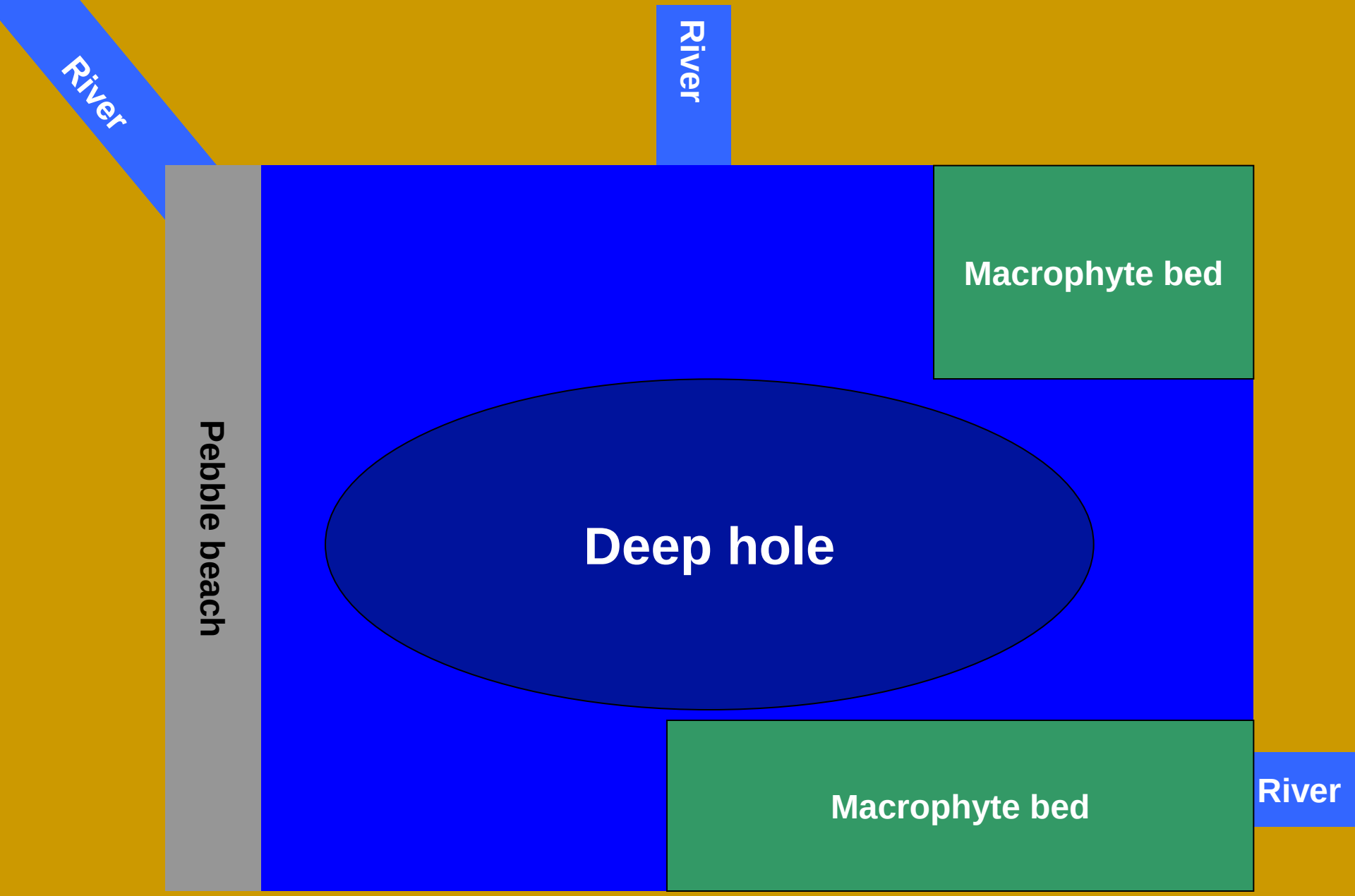
Sampling – there are many types

Simple Random Sample

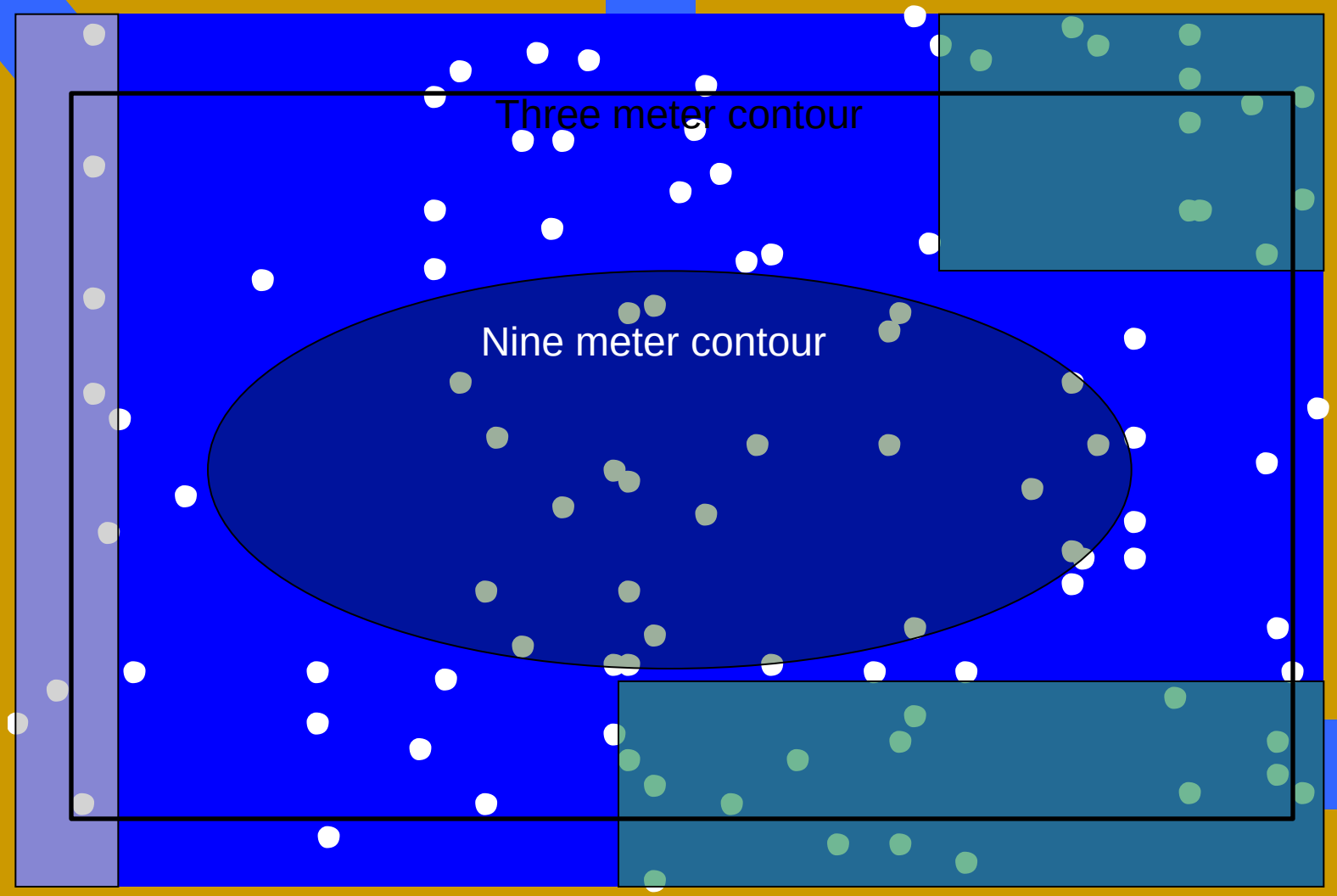
- *Without* replacement,
- Each member of the population has an equal chance of being in the sample.
- Quite complicated to achieve.



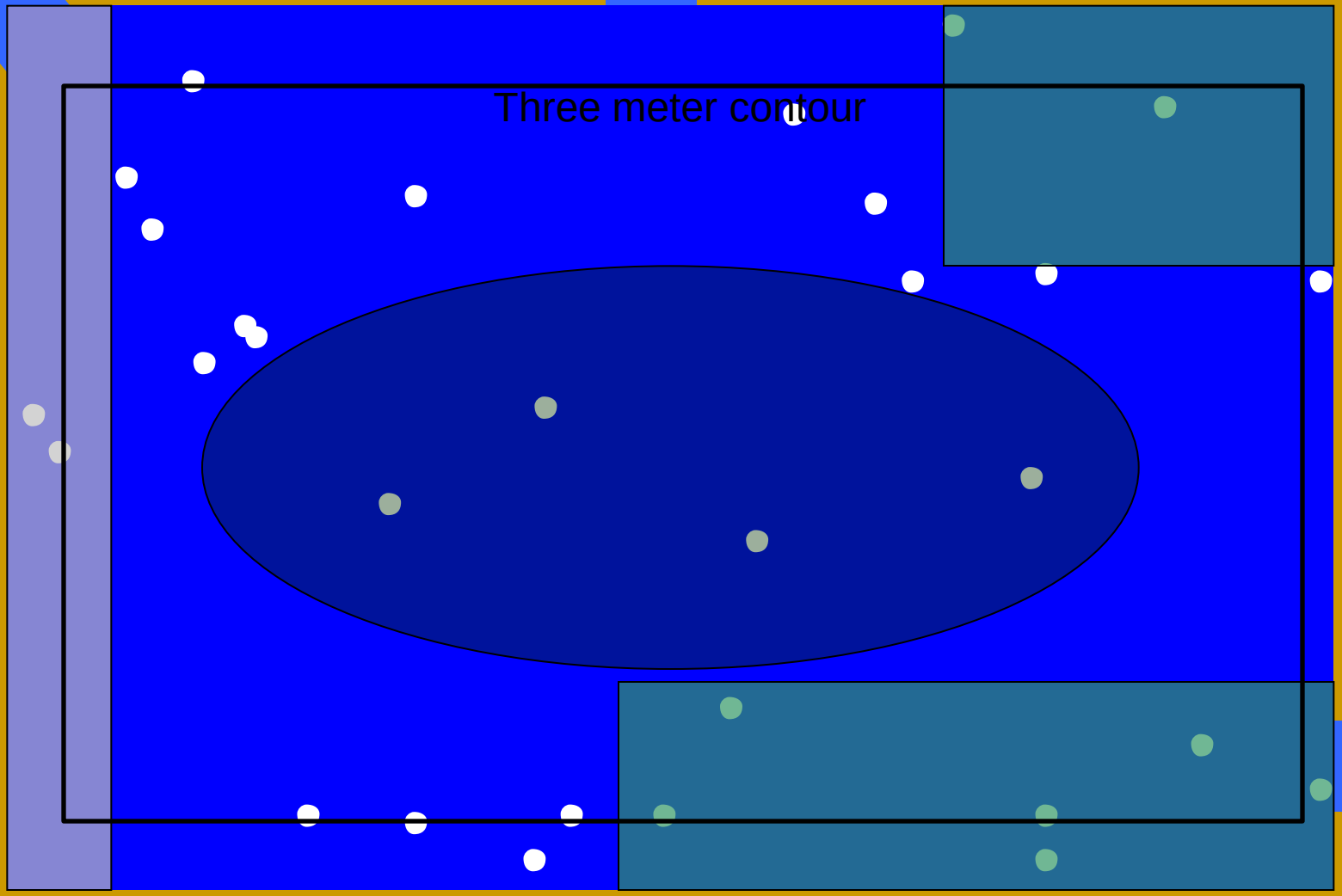
BUT WHAT IF YOUR WATER BODY LOOKS LIKE THIS?



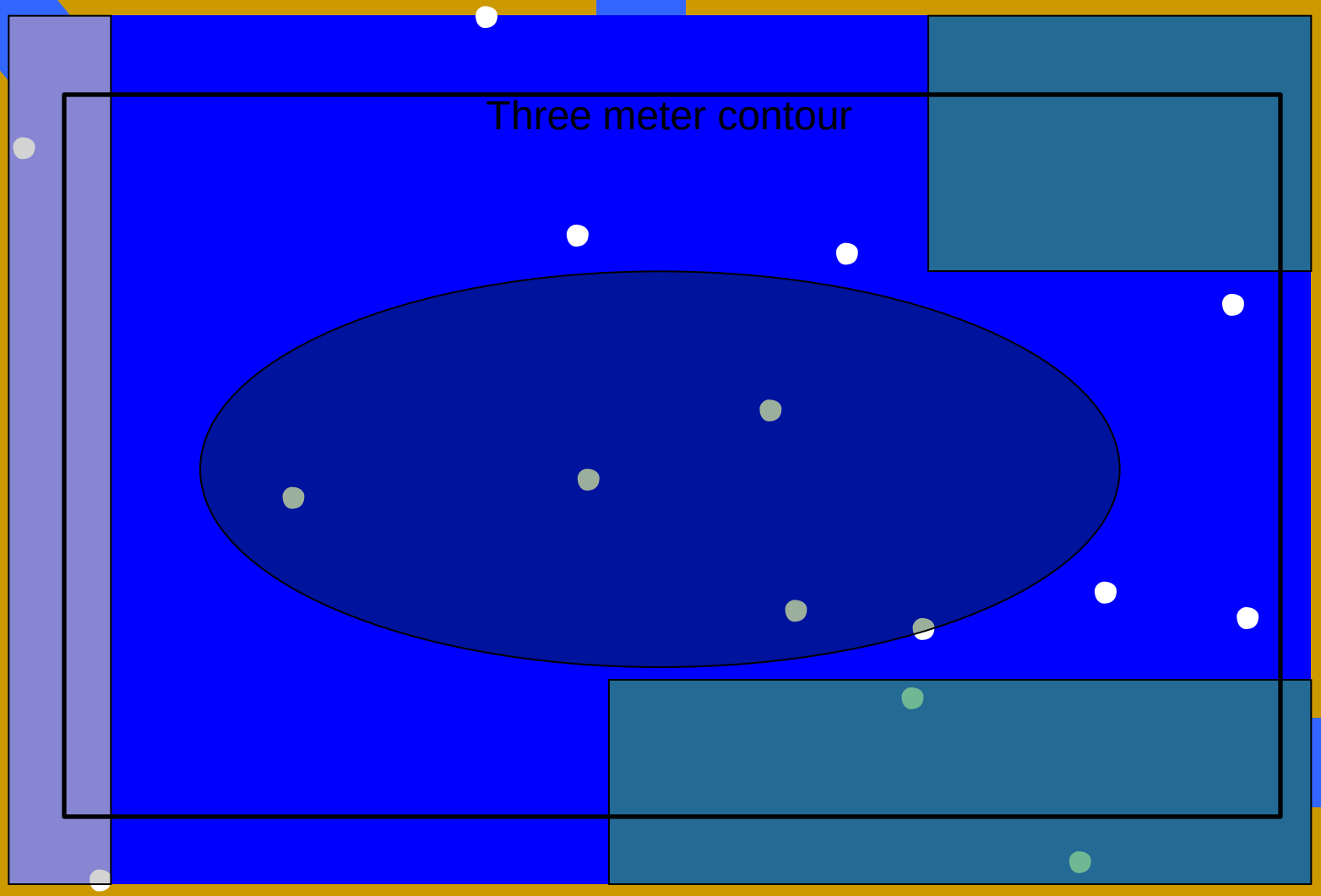
100 Random samples



30 random samples



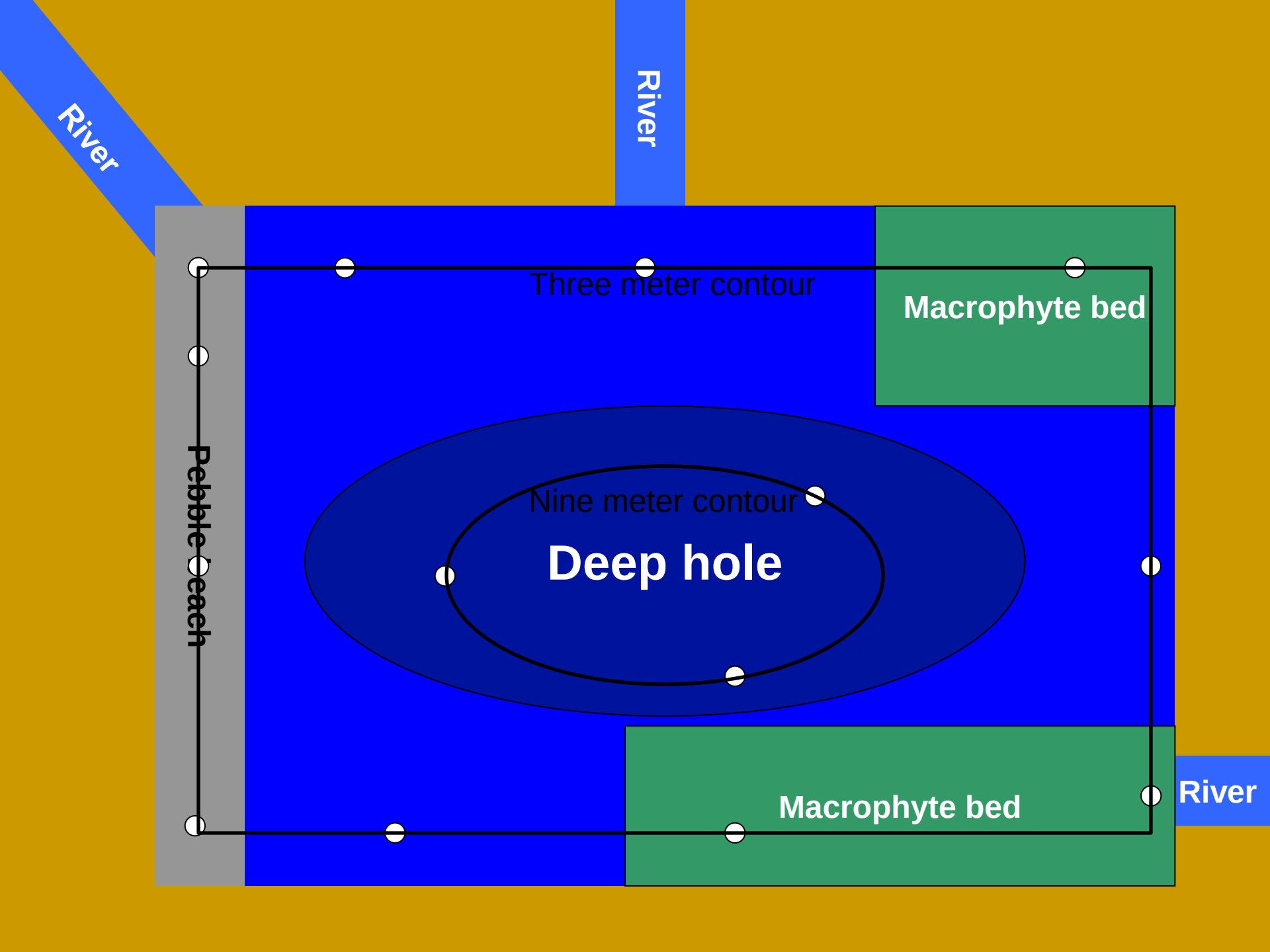
15 random samples



- *Stratified random sample*
- The next simplest probability sample is a **stratified random sample**.
- The population is split up non-overlapping subpopulations – strata
- Samples are drawn from each stratum.

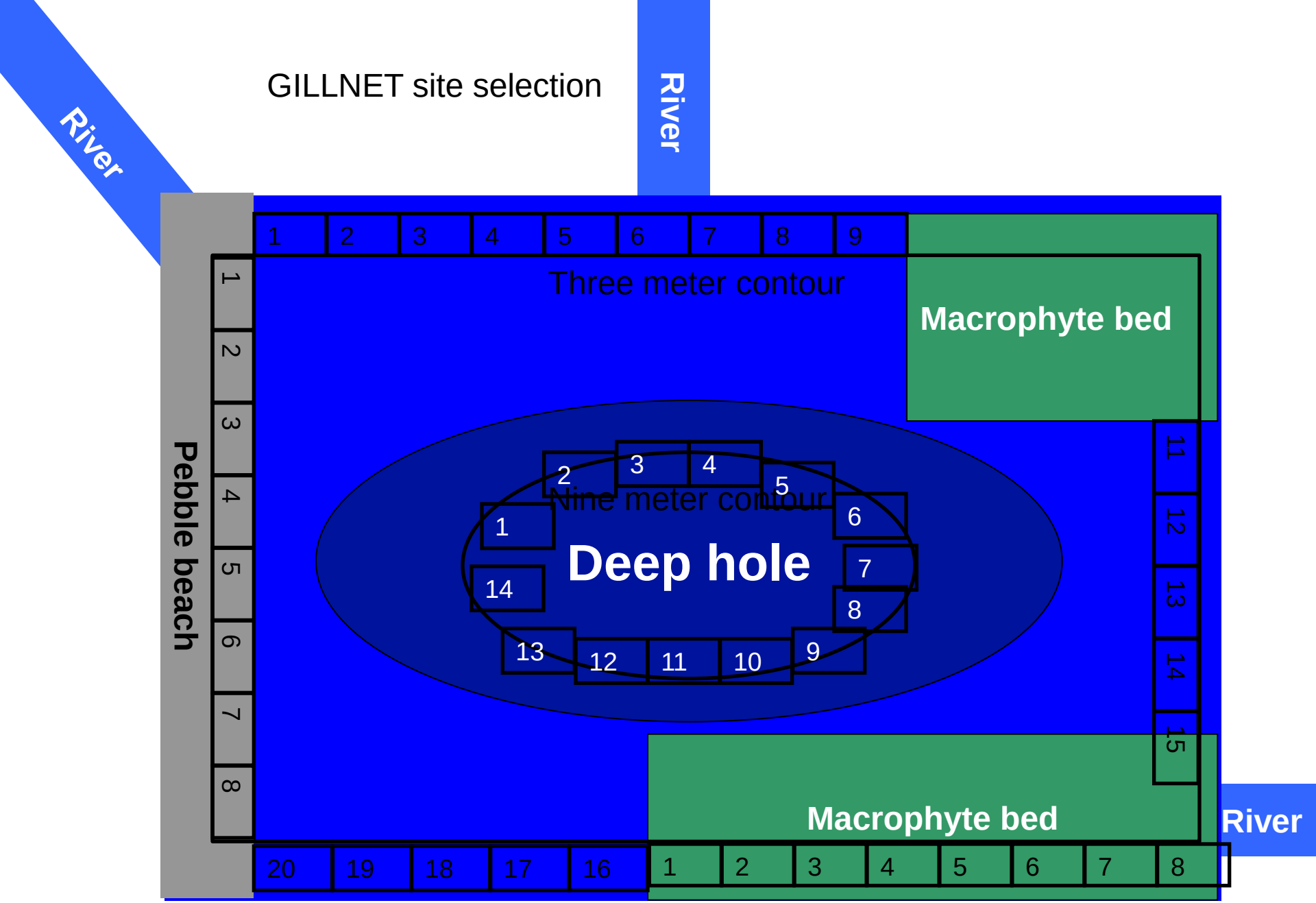
- Reasons:
  - The parameters for the individual subpopulations are of interest;
  - More precise estimates of the population parameter can be made by combining estimates from the subpopulations.

- *Irregular stratified random sampling*
  - Sampling strata may naturally be of different sizes or have more variable habitats.
  - Sample more variable strata more intensely.


River
River
Three meter contour
Macrophyte bed
Pebble beach
Nine meter contour
Deep hole
Macrophyte bed
River

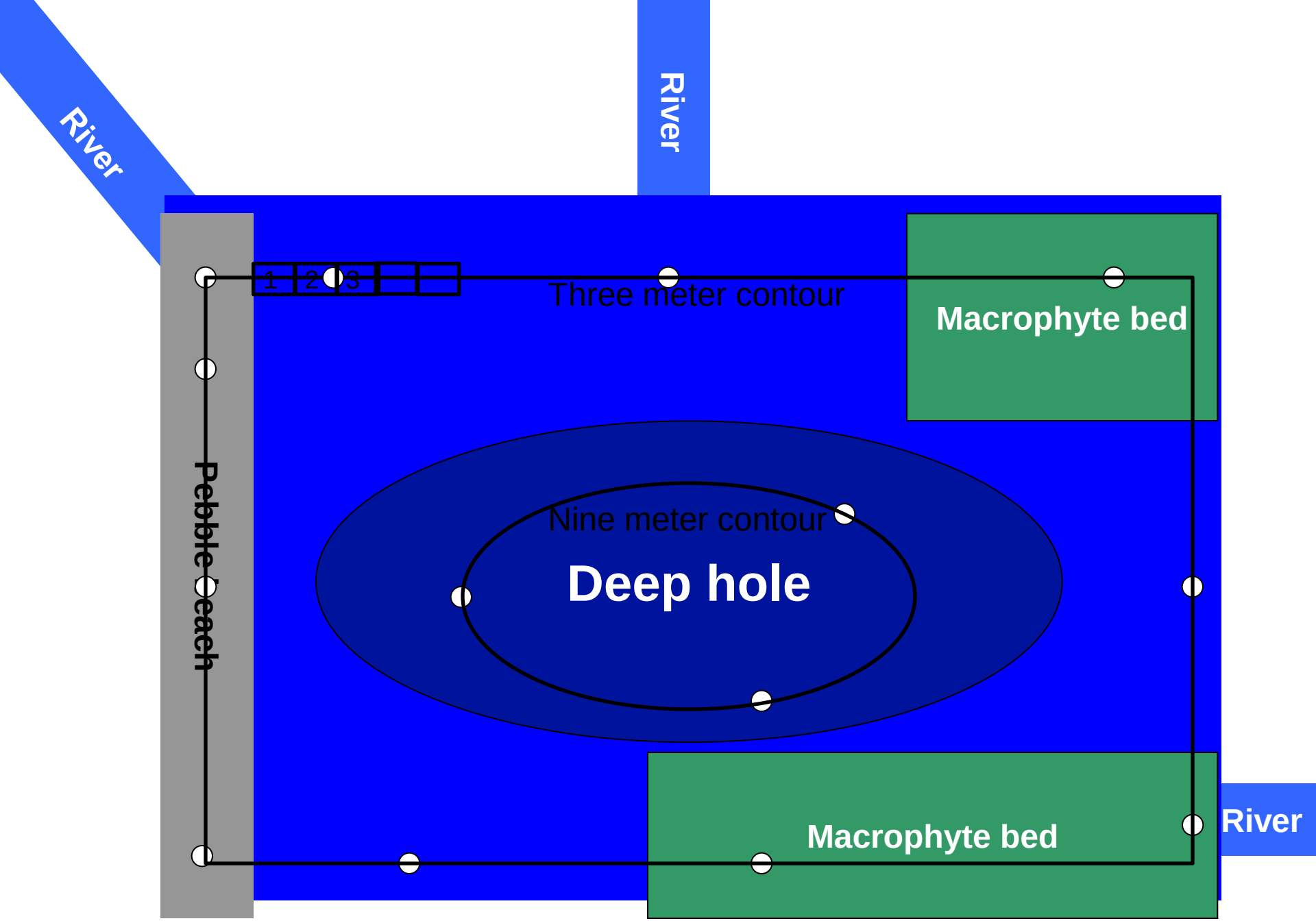
How do you achieve random sampling?????

- Determine what gear you will be using and then determine the area that the gear covers. Eg. 50m gillnet (50 m on a single contour)
- Stratify you sampling sites to sample in all of your habitats
- Divide the habitats suitable for the gear into appropriately sized blocks


GILLNET site selection
River
River
Pebble beach
1 2 3 4 5 6 7 8 9
Three meter contour
Macrophyte bed
1 2 3 4 5 6 7 8
11 12 13 14 15
2 3 4 5
Nine meter contour
1
6
Deep hole
7
14
8
13 12 11 10 9
Macrophyte bed
River
20 19 18 17 16
1 2 3 4 5 6 7 8

- Label the blocks
- Give each of the blocks a number
- Construct a random number table with those numbers

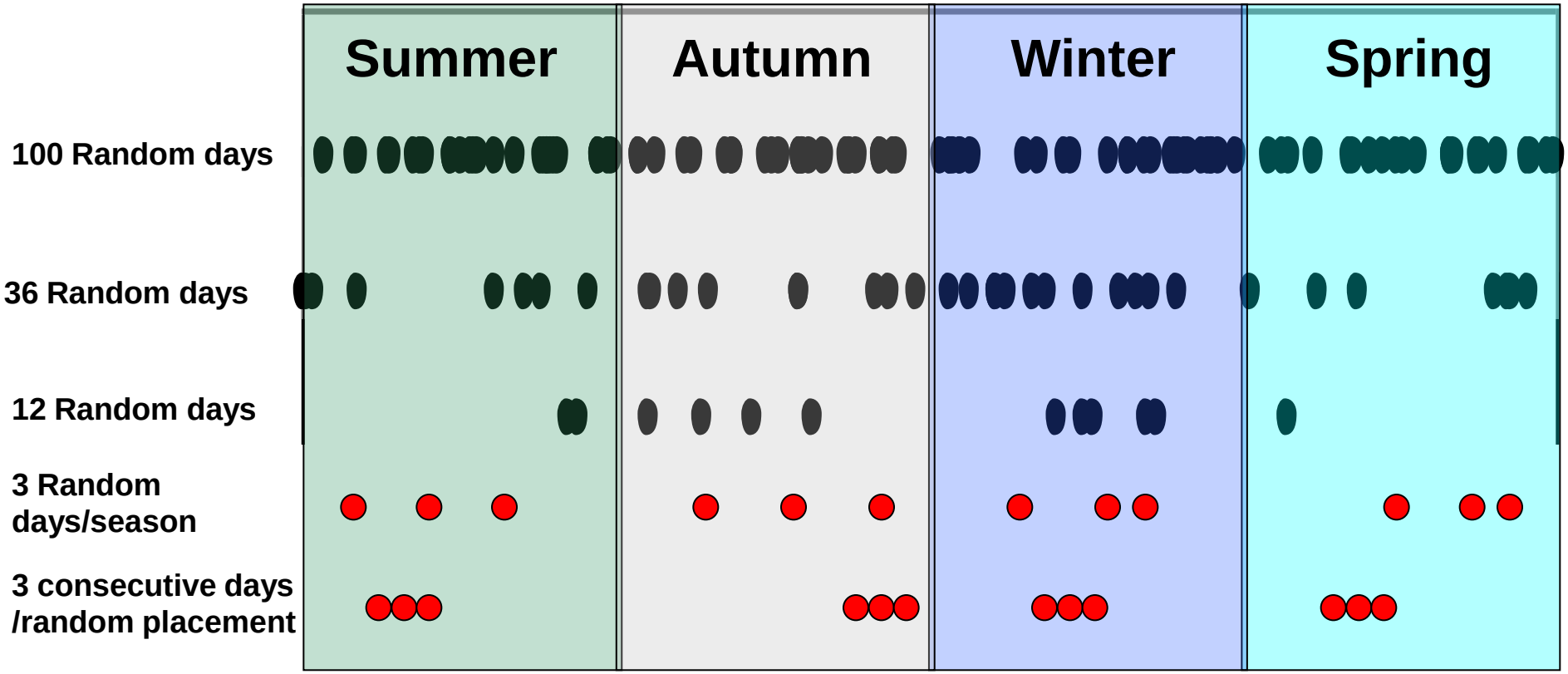
24	25	14	9	16	22	9	8	20	21	2
16	28	16	18	13	23	2	7	24	1	24
14	8	8	19	11	10	1	2	25	26	9
22	21	16	1	21	20	24	15	12	1	23
14	22	19	6	11	20	1	6	21	8	24
25	18	5	25	21	12	12	24	10	16	12
20	14	23	24	9	9	8	18	27	16	13
1	26	24	9	23	17	21	20	12	17	13
3	13	11	9	15	10	23	28	16	24	28
14	26	28	23	7	9	20	6	15	28	22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


River
River
1
2
3
Three meter contour
Macrophyte bed
Pebble beach
Nine meter contour
Deep hole
Macrophyte bed
River

Systematic sampling

- Generally done for reasons of convenience.
  - On a trawler - every 10th crate of fish.
  - Every 5th fish may be selected for measurement or
  - Every 3rd boat.
  - Sample every month.
  - Systematic *sample with a random start*.
  - When won't this work???

Random & systematic sampling dates



- Other considerations
- Tide, moon phase, flooding
- Monthly patterns i.e. one 3-day sampling period randomised in the month.

Others

- *Cluster sample*
  - For convenience, not for better precision.
  - Rather than sample individual population members at random, groups of members are randomly sampled.
  - Applies to taking a random crate of fish from a commercial catch.

- *Adaptive sampling*
  - Adaptive sampling is when a random or systematic system is overruled by circumstances.
  - eg. if all the vessels with observers on board are in the northern fishing grounds it may be appropriate to place an observer on a vessel that is headed south.

- *2-stage sampling*
- We take a random sample of fish from a pond with a beach seine and then we measure a random sample of all fish.

How to choose a sampling protocol

- Truly random sampling is rarely possible.
- Stratified and/or systematic sampling are normally the most feasible methods.

- Researchers often follow a pattern that introduces bias
  - sampling in the morning or only in daylight.
  - Thought is required to ensure that such bias is avoided.
  - Examples?

Sample size

- **Estimation of sample size - check Tony Booths previous statistics lectures for power analysis.**

- Too large - waste of resources

- Too small - diminishes the utility of the results

Sample size

- Sampling theory provides a framework to solve these problems.
- Check example in lecture notes.

The principal steps:

- What is expected of the sample CV of 20% with a 95% confidence limit.
- Some equation that connects *n* with the desired precision of the sample must be found.
- Use your initial or pilot studies to determine desired sample size.
- Remember that once you have started sampling, you need to confirm that you are achieving the desired level of accuracy.
- If necessary, adjust the survey accordingly.