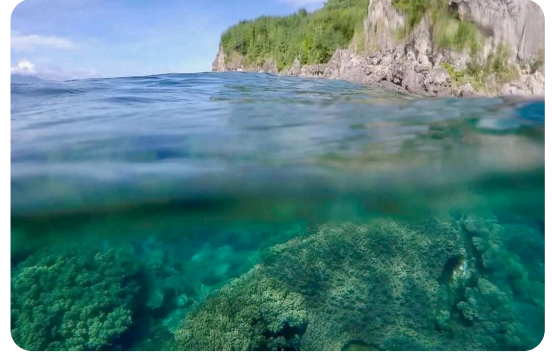




Protected or not?

Lesson plan: compare fish biomass and fished species in reserves and on open reefs, check the pattern at every depth, and discover that enforcement drives it



Ages	14 to 18 (grades 9 to 12)
Time	60 to 75 minutes
Group	Pairs, one computer per pair
Where	Computer room or laptops
You need	The slides, the clean fish file and the Sites table (or the workbook), one worksheet per pair

What students learn

- How to choose a measure that fits the question, and why biomass is so widely used.
- How to compare groups with means and medians, and why skewed data needs both.
- How to join two tables with a lookup.
- That well-enforced reserves hold far more fish, and weakly enforced ones barely differ from open reefs.

Before the lesson

1. Share **fish-surveys-clean.csv** and **sites.csv**, or the workbook, which has both.
2. Print one **worksheet** per pair.

The lesson

- 1 The question **8 minutes, slides 1 to 3**. Students predict and choose a measure.
- 2 Analysis **20 minutes, slide 4**. Pairs calculate means and medians and draw a chart.
- 3 Reveal **10 minutes, slides 5 to 7**. Biomass, fished groups and the depth check.
- 4 Enforcement **15 minutes, slides 8 to 10**. Pairs add enforcement with a lookup and compare. Discuss why enforcement matters most.
- 5 Wrap up **7 minutes, slides 11 and 12**. Sample size, and one or two questions.

Answers and what to listen for

Expected results (S217 removed), reserves and open reefs: biomass 23.1 and 8.7 kg (medians 12.2 and 4.6); total fish 771.8 and 706.5; parrotfish 5.9 and 2.2; groupers 7.4 and 2.8; snappers 17.5 and 7.8; large fish 4.8 and 2.1. Biomass by depth: shallow 14.5 and 4.1, medium 25.6 and 8.3, deep 29.7 and 13.8 kg.

By enforcement: biomass Strong 30.8, Moderate 20.5, Weak 12.3, open reefs 8.7 kg; large fish 6.5, 4.3, 2.5 and 2.1. Total fish differs least, because it is dominated by small fish nobody catches. Leaving S217 in inflates every average.

Making it easier or harder

- **Less confident groups:** compare biomass only, and give them the enforcement column ready-made.
- **Older groups:** run `=T.TEST()` on biomass, and discuss why a log transform suits skewed data.
- **Link:** the Fish, fishers and no-take zones module, especially the Apo Island story and the NEOLI features.

Curriculum links

- **Maths and statistics:** averages, skew, comparing distributions, lookups, hypothesis testing.
- **Science:** ecology, human impact, conservation.
- **Philippine senior high school:** General Mathematics and research skills.
- **IB and GCSE:** data analysis and evaluation.

The teacher reading has the science behind every slide, with links to the sources.

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