THE CASE OF THE INVADED REEF

Part 2

How are human activities affecting coral reefs in Kāneʻohe Bay and what can we do to *hōʻihi* (respect) the bay and promote sustainability?

HAWAIʻI DOE STANDARD BENCHMARKS

Science 1: The Scientific Process: SCIENTIFIC INVESTIGATION
Scientific Inquiry

- **SC.7.1.1** Design and safely conduct a scientific investigation to answer a question or test a hypothesis.
- **SC.7.1.2** Explain the importance of replicable trials.

Science 3: Life and Environmental Sciences: ORGANISMS AND THE ENVIRONMENT
Interdependence

- **SC.7.3.3** Explain how biotic and abiotic factors affect the carrying capacity and sustainability of an ecosystem.

Math 11: Data Analysis, Statistics, and Probability: FLUENCY WITH DATA
Data Collection and Representation

- **MA.7.11.1** Design a study, collect data, and select the appropriate representation (line graph, bar graph, circle graph, histogram, stem and leaf plot, box and whisker plot) to display the data.

Language Arts 4: Writing: CONVENTIONS AND SKILLS
Citing Sources

- **LA 7.4.5** Cite various grade-appropriate sources using a consistent format when reporting information.

Language Arts 5: Writing: RHETORIC
Meaning

- **LA.7.5.1** Connect selected details, examples, reasons, and/or facts to the insight, message, or thesis in a meaningful way.

Language Arts 6: Oral Communication: CONVENTIONS AND SKILLS
Discussion and Presentation

- **LA.7.6.2** Give short prepared oral presentations incorporating information from research to inform and persuade.

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Plan for meaningful learner outcomes that foster the relationship and interaction among people, time, space, places, and natural elements around them to enhance one's ability to maintain a "local" disposition with global understandings.

- Be keen observers of their natural environment.
- Honor and respect personal and community resources.
- Preserve, protect and sustain a healthy environment.

ACTIVITY AT A GLANCE

Students collect evidence in a field study at Moku o Loʻe (Coconut Island) to complete the investigations they began in Lesson 5. As a culminating activity, students write a persuasive paper applying what they've learned in the unit to take a stance on what is affecting the future health of Kāneʻohe Bay and what can be done to *hōʻihi* (respect) this magnificent natural resource. They work in teams to creatively express ways to share what they have learned with others in the community.

Materials

Provided in Lesson 5:

- ✓ Crime Scene Report (includes map of Kāneʻohe Bay)
- ✓ Learning Log - 6
- ✓ PowerPoint presentation, *The Case of the Invaded Reef*
- ✓ Evidence Data sheets 1 and 2

Provided in this Lesson:

- ✓ Learning Log - 7
- ✓ Data Display sheets
- ✓ Help Using Excel sheet
- ✓ group- and self-assessment forms

Provided with this Unit:

- ✓ Additional student readings (provided in Unit Resources)
- ✓ Culminating Project Rubrics and Student Assessment Overview (in Unit Introduction)
- ✓ *oli* (chants) (Provided in Appendix and on CD)

Needed:

- ✓ craft materials, musical instruments, camera (depending on students' projects)

Assessment

Students:

- Display the data that they collected in tables and appropriate graphs.
- Complete Learning Logs - 6 and 7 with written conclusions from their investigation, including adjustments based on evidence, and the importance of replicable trials.
- Complete a culminating paper that answers the unit essential question.
- Work with their teammates to present their unit project to others in the school or community.
- Complete a self-assessment of their work with their team.

General Learner Outcomes

GLO 2: Community Contributor

The understanding that it is essential for human beings to work together

- Cooperate with and help and encourage others in group situations.

GLO 5: Effective Communicator

The ability to communicate effectively

- Communicate effectively and clearly through speaking, using appropriate forms, conventions, and styles to convey ideas and information.

Key Concepts

- The invasion of *limu* on the coral reefs is due to biotic factors including overfishing and introduction of non-native *limu*, and abiotic run-off of pollutants from surrounding communities.
- *Ma ka hana ka ʻike*.
  By doing one learns.
- There are different ways to display our data so that we can interpret our findings, draw conclusions, and show how the conclusions are linked to the data.
- We can promote sustainability by sharing what we have learned with others, and by actions such as fishing responsibly, preventing the spread of alien *limu*, and preventing pollution.

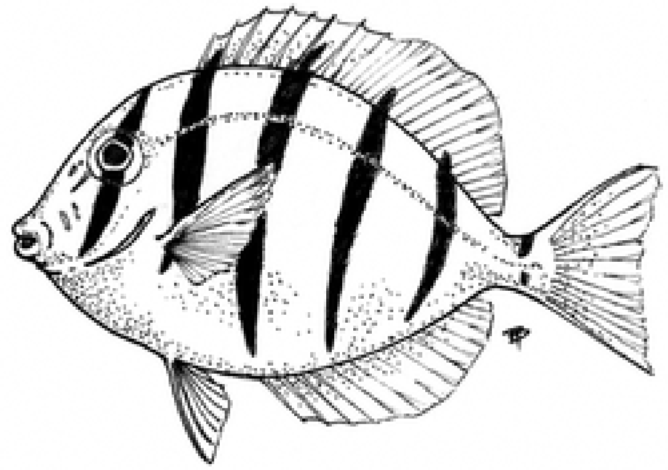
Time

3 – 4 class periods plus field trip and community presentation

Skills

observing, measuring, analyzing, interpreting data, chart and graph creation, writing, collaboration, oral communication, creativity

Advance Preparation



- ☐ See the Field Site Appendix at the back of this guide for information on setting up a field trip to Moku o Loʻe (Coconut Island). Let the staff know that your students are gathering data to solve "The Case of the Invaded Reef" so that they will notify the Pacific American Foundation to have resource people assist with the activities and have equipment ready for your student teams.
- ☐ Select a day for the field trip when the tide will be low in the morning so that students can conduct their transect study.
- ☐ Review the DOE's water safety protocols and, if required, arrange for a lifeguard to accompany the students.
- ☐ Make a copy of Learning Log - 7, the Data Display sheets, and the self-assessment form for each student.
- ☐ Make a copy of the culminating activity rubrics (in Unit Introduction) for each student or copy them onto a transparency and project them to review with the class.
- ☐ If your students will be conducting protocol at the site, select an *oli* from the CD and *Oli* Appendix (or other source) for students to learn and present when they arrive at Moku o Loʻe.

Vocabulary

abiotic - nonliving

alien species – species that are not native to an area; species introduced intentionally or accidentally to an area

biotic – living; having to do with living organisms

carrying capacity – the number of individuals that an environment can support without diminishing that environment's future ability to sustain life

hōʻihi – respect

invasive species – species whose introduction does or is likely to cause economic or environmental harm or harm to human health

lōkahi – balance, harmony

nitrates – nutrients released with the decomposition of dead plants and animals and animal waste; also from sewage and fertilizer run-off

overfishing – the practice of harvesting marine life faster than it can be replenished naturally

quadrat – a sampling plot used for studying plant or animal life

sedimentation – deposit of soil and other sediments by water

sustainability – meeting present needs for resources without compromising the ability of future generations to meet their needs

transect - a path along which one records and/or counts occurrences of the phenomenon of study for the process of estimating population entities in a study area

Teaching Suggestions

Before the Field Trip

1. **Revisit the essential question for this unit and discuss it with students as you write their ideas on the board:** How are human activities affecting coral reefs in Kāneʻohe Bay and what can we do to *hōʻihi* (respect) the bay and promote sustainability?

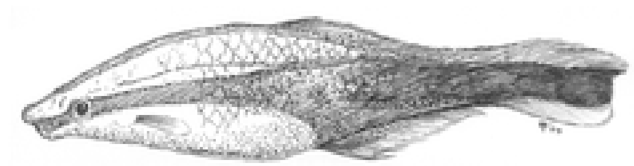
   Discussion Questions
   - What does it mean to *hōʻihi* (respect) the bay and why should we do this?
   - What is sustainability and how does it relate to the bay? Why should we be concerned about future generations?
   - What have we learned about how human activities are affecting the bay?
   - If we broke down the possible effects into biotic (living) and abiotic (nonliving) what might those effects on the bay be?

Biotic (Living)	Abiotic (Nonliving)
Overfishing	Sediments from run-off
Introduction of alien species	Pollutants such as nitrates from sewage and fertilizers
Human contact – stepping on live coral	Marine debris
	Ocean acidification (due to increased carbon dioxide emissions)

- How will our field trip help us to answer the unit essential question? (Transects will address biotic effects, and water quality testing and marine debris stations will address abiotic effects.)

2. **Review the culminating paper and project described in the student assessment overview in the Unit Introduction. (If this was not assigned in the first lesson, ask teams to select topics listed on the overview.)**
   - Check to see how students are doing with their projects to answer the essential question for this unit.
   - If you have not already done so, distribute the additional student readings from the Unit Resources to the appropriate student groups.
   - Ask student teams to make plans for gathering information and photographs during the field trip to be used in culminating projects.
   - Review the rubrics for student papers and team presentations and discuss criteria for evaluation.
   - Remind students of deadlines for completing papers and projects.

3. **Review logistics, safety precautions, protocol, and what students will need to wear and bring for their field investigations.**
   - Explain the process that will be followed in the field with teams rotating to different stations to collect data.
   - If students plan to offer an *oli* (chant) when they arrive, practice what they will do before the trip. Listen to the *oli* on the CD provided and follow along with written copies in the Appendix.



Ask students to:

- Return signed permission forms for the field trip.
- Wear covered shoes or *tabis*, old clothes, and a hat.
- Bring sunscreen, drinking water, snacks and lunch.
- At the site, stay with their teams and leader and move slowly and carefully to avoid holes in the reef flat. (Reminders will be given at the site along with boundaries to observe and precautions about reef animals that can sting or bite.)

During the Investigation at Moku o Loʻe (Coconut Island)

- Upon arrival at the island, students will be greeted by the site coordinator with an introduction to the site.
- They will be oriented to the stations that are set up for each team and introduced to volunteers and assistants.
- A general schedule for the field trip follows:

8:15 Arrive at the Heʻeia Pier to board boat to the island
8:45 Arrive at island / Protocol and orientation, walk to beach site
9:15 Teams rotate every 30 minutes and participate in each station.
Station 1 – Transect study (biotic factors)
Station 2 – Water quality testing (abiotic factors)
Station 3 – Interviews with scientists (if available) or
Marine debris (abiotic factors)
Station 4 – Invertebrate touch tanks
11:15 Teams clean up, store data in backpacks, and walk to lunch site
11:30 Lunch
12:30 Return to dock and board boat
1:00 Arrive at Heʻeia Pier and return to school

After the Field Trip

4. **Distribute and review Learning Log - 7 and the Data Display sheets and discuss ways to organize and display students' data.**
   - Discuss the appropriateness of different types of data display for the data they collected.
   - Ask students to describe the benefits of each type of graph for analyzing and drawing conclusions and displaying data.

- Explain that the selection of type of graph is generally determined by what is to be emphasized or demonstrated in the data set.
- Discuss the factors to consider when selecting a type of graph: clarity of presentation, contrast/comparison of the data, changes/trends/growth and the rate of change/growth, and a measure of the closeness or spread of the data.

5. Distribute the Help Using Excel sheet and review it with students.
- Show students how to create different types of charts and graphs using Excel computer software.

6. Solve the case! Have students each complete Learning Log - 7 and prepare team presentations of their findings to others in the class.
- Ask teams to present their findings and conclusions to the class.
- Generate a discussion.
- Show the final few slides in the **PowerPoint presentation** with the data collected by scientists. Note that sea lettuce is invasive even though it is a native species.
- Compare students' data to the data gathered by scientists. While students may not have seen all of the invasive species on the map, these species have been found in other areas of the bay.
- Discuss the need to replicate data and adjust ideas based on evidence.

  <u>Discussion Questions</u>
  - Were your hypotheses validated by the evidence you collected? If not, what alternative hypotheses might explain your results?
  - Which species (suspects) were most abundant?
  - What was the level of nitrates in the water? Under what conditions might this level change? *(After a heavy rain, especially when fertilizers have been applied to the land.)*
  - Why would it be important to replicate the data collection?

7. Plan a *hōʻike* (exhibit) for students' culminating projects.
- Set a date for students to share their unit culminating projects with others in the school or community.
- Provide time for student teams to discuss ideas about ways to share what they have learned with others.

8. Wrap up the unit.
- Ask students to complete a self-assessment of their work with others on their teams.
- Discuss their feedback and what individuals can do to promote successful teamwork.
- Congratulate teams for their hard work to solve the case and complete their projects.

Adaptation / Extension

Science 3: Organisms and the Environment:

Conduct a demonstration to reinforce the concepts of carrying capacity and sustainability and the impact of biotic and biotic factors.

Sustainability and Carrying Capacity Demonstration

- Place a large clear bowl in a central area of the classroom and identify it as a reef in Kāneʻohe Bay. Fill the bowl with 32 "fish" (peanuts or fish-shaped crackers). Explain that this represents the carrying capacity of the reef—the number of fish that the reef can support without the environment deteriorating. If there were more fish, the reef would be out of balance.
- Divide the class into four boats of fishers who will be fishing from this reef. (Don't emphasize conservation with the fishers, let them work on maximizing their harvest if they want. The need for conservation will soon become clear.)
  - Explain that there will be four harvesting periods, each lasting 30 seconds.
  - During the harvest, all boats fish at once and they may catch all of the fish, some of the fish, or none.
  - For every fish that a boat harvests, the fishers receive 1 point.
  - For every three fish remaining on the reef after each fishing round, one fish will be added up to the carrying capacity of 32 fish.

- After each harvesting period, add up team points and restock the reef, if adequate numbers of fish remain.
- Conduct another round of fishing and bring in biotic and abiotic factors to affect the population of fish on the reef. After the first harvest, remove an additional 8 fish that die due to destruction of habitat from an abiotic factor.
- Ask fishers to identify abiotic factors and provide an extra point for each correct answer (e.g., siltation, pollution, physical damage to coral heads from boat anchors).
- After the second harvest, remove another 8 fish that die due to a biotic factor. Ask fishers to identify biotic factors and provide an extra point for each correct answer (e.g., introduced *limu* smothers coral, overfishing)

After the final harvest, discuss what happened in the demonstration.

<u>Discussion Questions</u>

- What is carrying capacity?
- Why are fish only replaced if some fish remain on the reef?
- How do abiotic and biotic factors affect the fish population?
- Did the reef become overfished?
- What would be the best strategy for harvesting from the reef sustainably? (If each boat harvests 2 fish during each round, this would allow the same number of fish to be restored.)

THE CASE OF THE INVADED REEF

LEARNING LOG - 7

NAME: ______________________________ **DATE:** _______________

CRIME SCENE OBSERVATIONS: Summarize key observations and notes from the field investigation.

DATA COLLECTED: On a separate sheet, create a table of your team's data and a graph to summarize your data.

CONCLUSION: Solve the Case! State your conclusion and why you think it is the answer to the problem.

Did you need to revise your conclusions and explanations based on scientific evidence you collected? Explain.

When collecting data, why is it important to have replicable trials (collect information in the same way more than once)?

HELP USING EXCEL

1. Point the cursor to "start" in the lower left corner of the computer screen – click on "programs", Microsoft Excel (If you don't see it, click on Microsoft Office first). Open the program.
2. The program will open a new "book" automatically – it looks like this:

	A	B	C	D
1				
2				
3				
4				

3. Enter your column headings in the top row. See the example below:
If heading needs more room, expand the column by clicking at the end of the column, waiting until the cursor looks like an (I) and dragging the line to the left until the column is the width you want.

	A	B	C	D	E	F
1	Gorilla Ogo	Smothering Seaweed	Crown-of-Thorns	Green Bubble Alga	Prickly Seaweed	Other
2						
3						
4						

4. Enter your data (total percent cover) for each species in the correct columns and save your finished book or "spreadsheet." You can add more data later if you collect it.

5. From this table, you can create a graph. Select or highlight your table.
Click on "Insert" and select "Chart." Then select the type of graph you want to create. Alternatively, click on the mini bar graph icon at the top of the page, the "Chart Wizard," and select the type of graph.
    a. Try different types of charts. The most common types are bar charts, line charts, and pie charts just as one sees them in magazines, newspapers, and on the Internet.
    b. Choose the chart/graph type that best shows the basic relationships in your data and the idea(s) that you may wish to emphasize. For example, line graphs can show growth or shrinkage over time. Bar graphs are good for comparing amounts. Pie charts can show relative size or contribution at a specific time.
    c. Select "Next" and follow the directions to label the "x" and "y" axes on your graph and give the graph a name.

(*Adapted from file provided courtesy of Sandra Webb, Mililani High School, Oʻahu*)

SELF-ASSESSMENT TEAMWORK

NAME: ___________________________ **DATE:** ______________

Place a check in the box that matches your performance as a team member. Add up your points and answer the questions below about teamwork.

Laulima **(Cooperation)**	***Maikaʻi Loa!*** **(Excellent) 4 pts**	***Maikaʻi!*** **Good 3 pts**	***ʻAno Maikaʻi!*** **Not Too Good 2 pts**	***Auwē!*** **(Poor) 1 pt**
I did my best work for the team. It was in-depth, organized, neat and inspired!				
I helped others when they needed my *kōkua* (assistance).				
I finished my work on time.				
I listened to others' ideas with *hōʻihi* (respect).				
I gave positive feedback to others on my team.				
I asked for and used feedback from others.				
I'm proud of the work we did as a team.				

Total Score: ______

Explain what your contribution was to the team.

What was difficult for you in working with your team? Why?

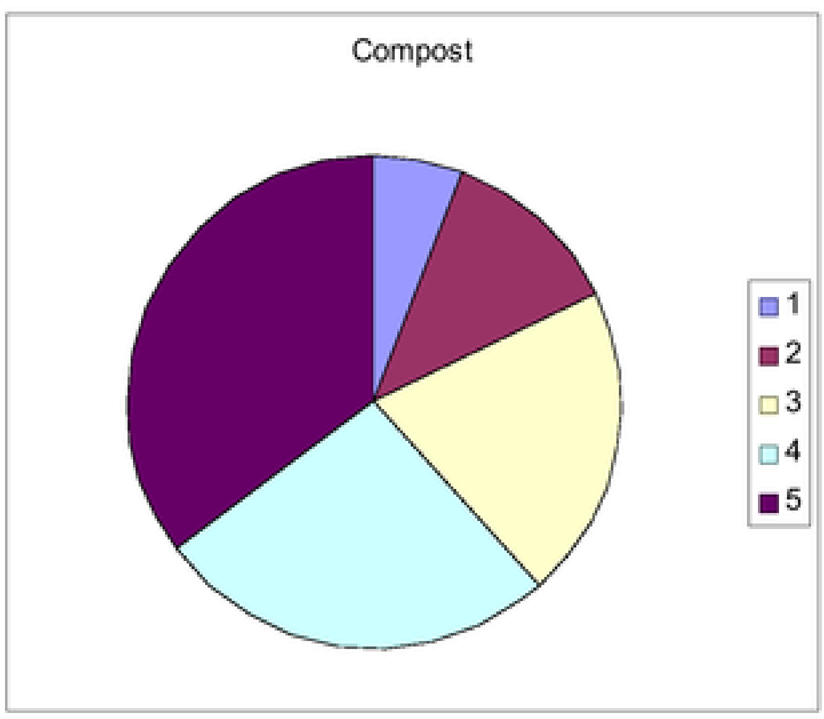
How could you improve and help your team to be more effective?
(Use the other side of the page if you need more room.)

Sample Data Display

Review the data in the chart below and the different types of graphs that can be used to display the data. Which type of graph do you think is most effective for comparing the plant growth with the different soil amendments? Why?

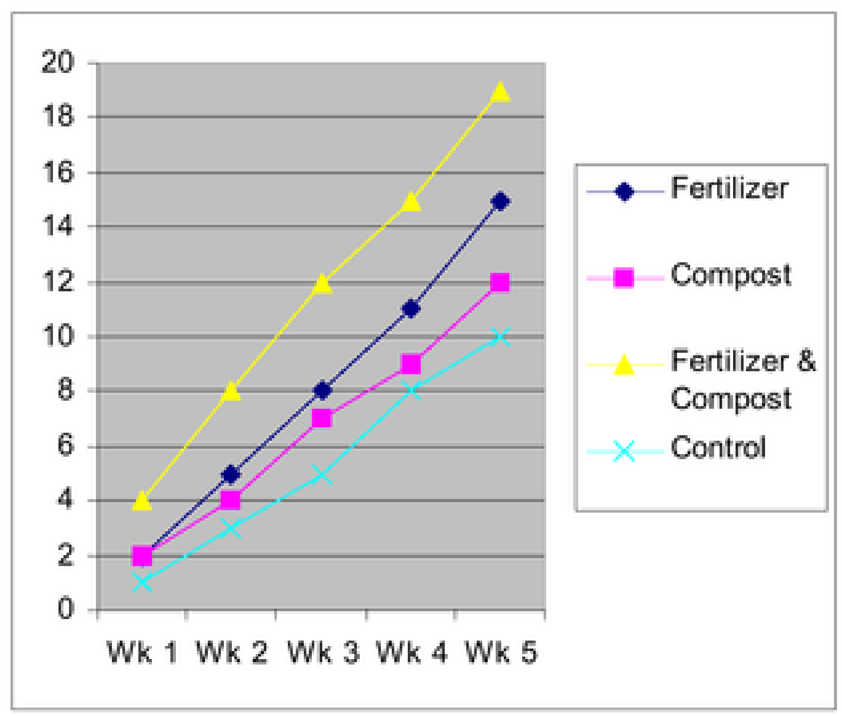
Soil Amendments (added at time of planting)	**Plant Height** (radishes)				
	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5
Fertilizer	2 cm	5 cm	8 cm	11 cm	15 cm
Compost	2 cm	4 cm	7 cm	9 cm	12 cm
Fertilizer & Compost	4 cm	8 cm	12 cm	15 cm	19 cm
None (Control)	1 cm	3 cm	5 cm	8 cm	10 cm

Circle Graphs

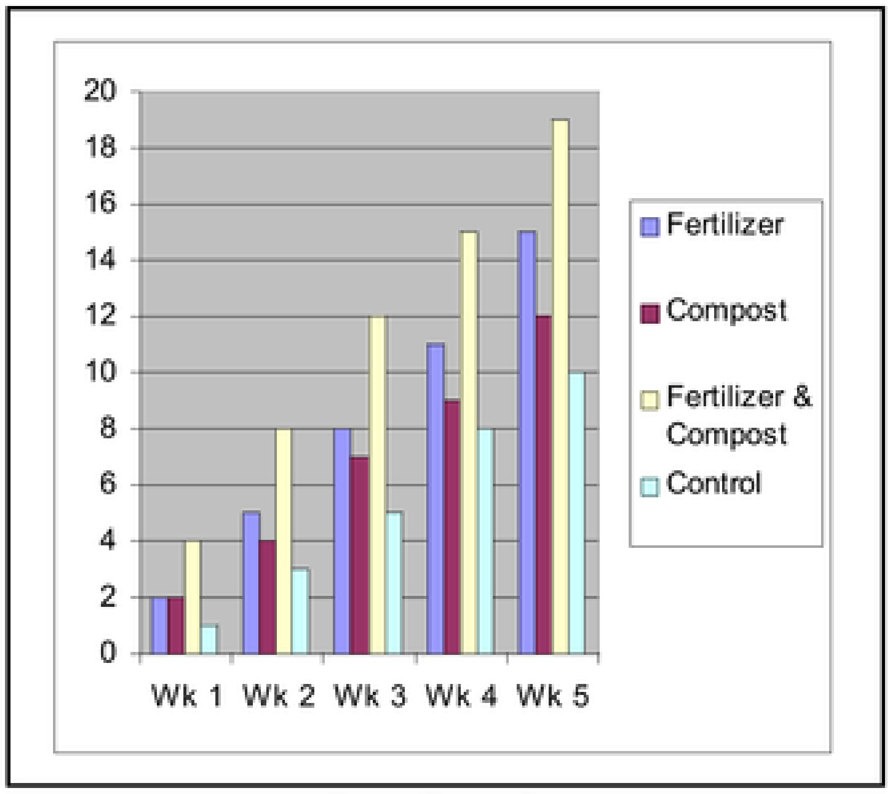


Circle graphs show the relative contribution of each of the progressive data points to the absolute total. In this case, the circle graph shows which weeks the plants are largest, e.g., the older the plant, the larger it appears.

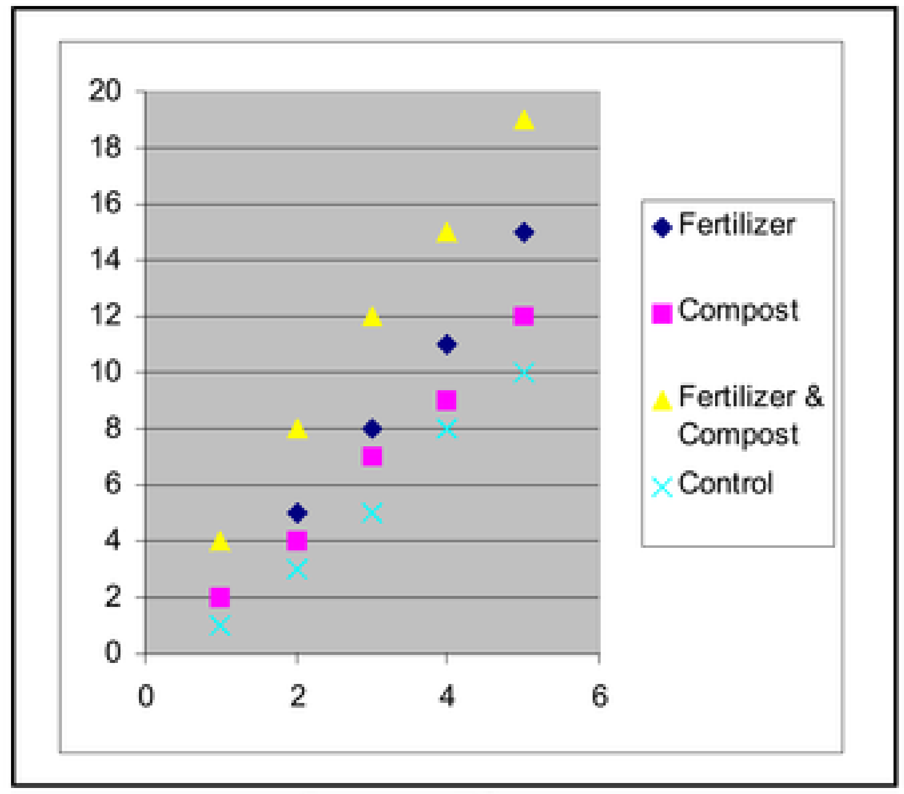
Line Graphs



Line graphs show changes, trends, or in this case, growth *versus* time. The slope of the line can also suggest rate of change, e.g., the fertilized and composted plants appear to grow fastest.



Bar Graphs



Scatter Plots

Bar graphs show absolute size and compare each case against each other at specific places/times. In this case, one can visualize which plant is largest at each of the 5 weeks.

Scatter plots are used when one might be looking for some correlation in the data. In this case, the scatter plot suggests a very linear growth over the 5 weeks of data.

Stem-and-Leaf Plots and Back-to-Back Stem and Leaf Plot

Stem and Leaf plot for all plants at week #3	Stem and Leaf plot for all plants at week #5

Wk #3	
0	578
1	2

Wk #5	
0	
1	0259

Stem and leaf plots show a numerical and visual distribution of the data. In this case, we can see that most plants were less that 10 cm at week 3, but all were over 10 cm at week 5. One also gets a visual feel for the distribution of the data. Also, since the data is numerically displayed, it allows for easy identification and/or calculation of the mean, mode, and median.

Back-to-Back Stem and Leaf Plot

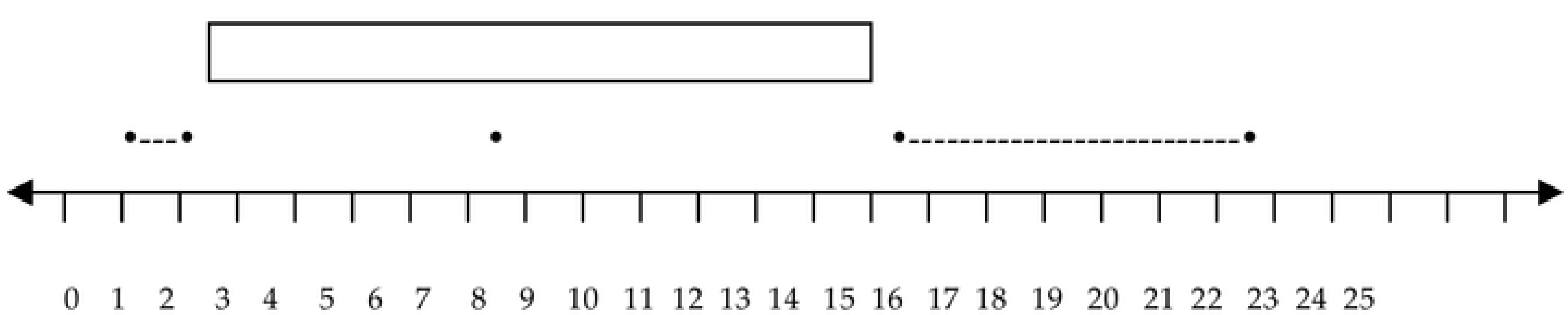
Week 3		Week 5
578	0	
2	1	0259

The Back-to-Back Stem and Leaf plot allows one to compare and contrast two sets of data. In this case, we contrast and compare weeks 3 and 5.

Box and Whisker Plots and Parallel Box and Whisker Plots

Week 1
1 2 2 4

Week 5
10 12 15 19



lower extreme: 1   median: 7   lower quartile: 2
upper extreme: 19   upper quartile:13.5

Box and whisker plots allow one to easily see how the data is distributed. Parallel Box and Whisker plots allow one to compare data sets to each other by comparing directly the relative spread in data. In this case, we see that at week 1, the plants are close in size. At week 5, the data shows that the plants have "spread" out in relative and absolute size.