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Water as a Habitat: Episode 5 What's Lurking in the Waters?

If You Can't Beat Them, Eat Them!

"Big problems call for big solutions, and there has been a lot of talk recently about how to address the big problem of invasive Lionfish (*Pterois volitans/miles*) in the Atlantic, Caribbean, and Gulf of Mexico. Although experts believe complete eradication of lionfish is highly unlikely, we can – and should – work toward population control. Divemasters are hunting them on dives, conservation organizations like REEF are hosting successful lionfish derbies, and lobstermen are hauling them up by the hundreds in their traps. But how can the average person help the lionfish problem?

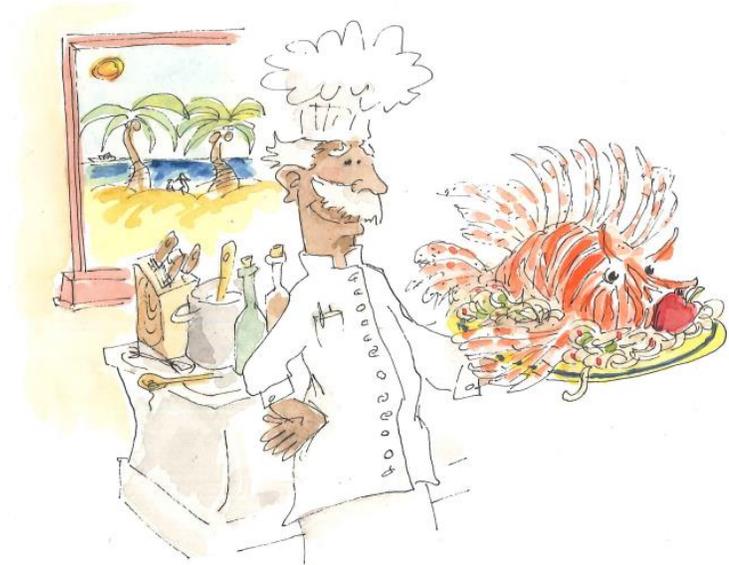


Illustration by Richard King for *CORAL Magazine*

The answer is simple. **Eat them.**"

Erin Spencer, *National Geographic Young Explorer*

Background Information

- Starting in May 2016, grocery chain Whole Foods began selling lionfish to consumers. The price per pound for an entire fish was set at \$9.99. Another grocer, Publix, also began selling the invasive fish by special order. Lionfish fillets at Publix can be special ordered for \$27.99 per pound.
- Lionfish is available to restaurants at 35% of the retail price. Whole Lionfish are sold for \$3.50 per pound and fillets for \$9.80 per pound.
- The typical restaurant mark-up, from cost to menu, is 300% of the food cost.
- The typical lionfish yield, or amount of edible flesh when the fish is filleted, is 30.5%.
- On average, lionfish weigh 1 to 2 pounds and are 13 inches in length.
- Depending on the season, an estimated 10 to 20 restaurants in Florida feature lionfish on their menu, including 4 on the Treasure Coast.

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Scenario

You are the head chef at a popular restaurant on the Treasure Coast. Some of the responsibilities of the head chef include planning menus, ordering food, and managing the budget. The owner is requesting a cost analysis for the sale of the proposed lionfish dishes.

You have created 3 special dishes: Lionfish Ceviche Appetizer (5 oz), Fried Whole Lionfish Dinner (whole fish, 24 oz), and Sautéed Lionfish Fillet Dinner (9 oz).

As the busy season approaches, November through April, you have estimated that the number of lionfish appetizers sold will be 12 per evening, while the number of entrees sold will be 20 per evening (12 Fillet and 8 Whole fish). Assume the restaurant is open every night over the 6 month period.

Task

1. Determine the number of pounds of filleted fish, the number of pounds of whole fish, and the total number of pounds of lionfish that will need to be purchased for the entire season.

Per Night Calculations

Whole Fish needed = 8 per night @ median weight 1.5 pounds each = 12 pounds

Filleted Fish needed = $12(5) + 12(9) = 168 \text{ oz} = 10.5 \text{ pounds}$

Total Lionfish needed = 22.5 pounds

Season = 181 Days (30+31+31+28+31+30)

Total Season Calculations

Whole Fish needed = $12(181) = 2,172 \text{ pounds}$

Filleted Fish needed = $10.5(181) = 1,900.5 \text{ pounds}$

Total Lionfish needed = 4,072.5 pounds

2. Determine the cost of purchasing all of the required fish as whole fish.

$2,172 \text{ pounds of whole fish} = (\$3.50)(2172) = \$7,602.00$

$1,900.5 \text{ pounds of filleted fish from whole fish needed with } 30.5\% \text{ yield} = 6,231.148 \text{ pounds}$
of whole fish required to generate 1,900.5 pounds of fillets.

$6,231.148 \text{ pounds of whole fish} = (\$3.50)(6,231.148) = \$21,809.02$

Total cost of purchasing required fish as whole fish = \$29,411.02

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3. Why is purchasing the entire quantity of fish needed as whole fish the most expensive option?

Justify your reasoning by finding and comparing the true cost of lionfish fillet from the whole fish.

The true cost of lionfish fillet from whole lionfish = $\$3.50/0.305 = \11.48 which is \$1.68 more per pound than purchasing the fillets, not including the labor required to fillet the fish.

4. Determine the cost for the amount and selection of fish that is most cost effective.

The most cost effective way to purchase the fish would be to purchase the least amount of whole fish necessary and the rest as fillets. This is due to the fact that the lionfish has a small yield percentage. This is not the case for all fish.

$$3.50(2,172) + 9.80(1,900.5) = \$26,226.90$$

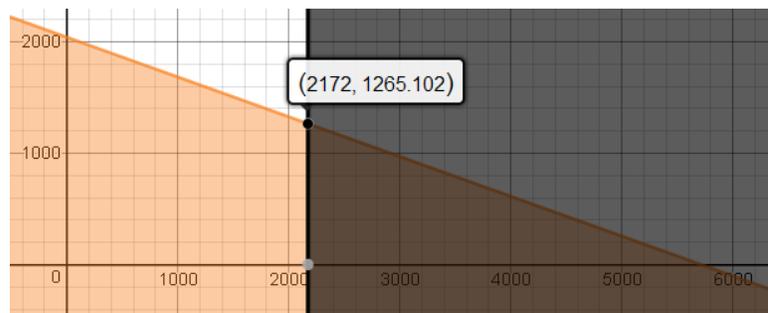
5. In order to maximize profits, the owner limits the lionfish budget for the season to \$20,000.

Write and graph a system of linear inequalities that can be used to represent the constraints on the combinations of types of fish to be purchased in order to optimize cost.

Let x be the number of pounds of whole fish purchased

Let y be the number of pounds of filleted fish purchased

$$\begin{cases} 3.50x + 9.80y \leq 20,000 \\ x \geq 2,172 \end{cases}$$



6. Assuming you keep the number of whole lionfish dinner entrees constant, determine how the \$20,000 restraint on the budget could affect the number and types of the other 2 dishes being served per evening.

The variation comes by adjusting the number of ceviche appetizers and or fillet dinners served. The number of ounces of fish used for these two dishes would need to be no more than 1,265 pounds or 20,240 ounces. This can be represented with the inequality $5x + 9y \leq 20,240$.

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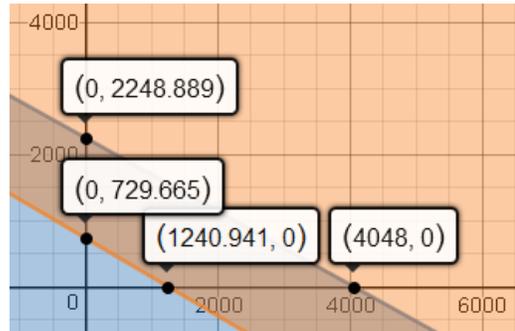
7. Using a system of inequalities, determine the number of appetizers and fillet dinners to be sold that maximizes the profit. The appetizer is sold for \$9.99, and the fillet entrée is sold for \$16.99. Write and graph the system below. Label the vertices of the feasible region.

Lionfish purchase = 1265 pounds @\$9.80 per pound = \$12,397

Let x be the number of ceviche appetizers sold

Let y be the number of fillet dinners sold

$$\begin{cases} 5x + 9y \leq 20,240 \\ 9.99x + 16.99y \geq 12,397 \end{cases}$$



Feasible region vertices shown in graph:

Lionfish fillet cost = \$9.80 per pound = 0.6125 per ounce

Appetizer Profit = $9.99 - 5(.6125) = \$6.9275$ per dish

Fillet Dinner Profit = $16.99 - 9(.6125) = \$11.4775$ per dish

Profit = $6.9275x + 11.4775y$

(0, 729) $0 + 11.4775(729) = \$8,367.10$

(0, 2248) $0 + 11.4775(2248) = \$25,801.42$

(1240, 0) $6.9275(1240) + 0 = \$8,590.10$

(4048, 0) $6.9275(4048) + 0 = \$28,042.52$

The maximum profit occurs when 4,048 appetizers are sold and no fillet entrees are sold.

8. Is it reasonable to predict that this combination will occur? Why or why not?
No. Over a 6 month period of time, you should assume that you will sell at least one fillet entrée.

9. Is the combination of dishes that yield the maximum profit the same as the combination that maximizes the amount of lionfish used? Explain why or why not.

Ounces of Fish Used = $5x + 9y$

(0, 729) $0 + 9(729) = 6,561$ oz

(0, 2248) $0 + 9(2,248) = 20,232$ oz

(1240, 0) $5(1,240) + 0 = 6,200$ oz

(4048, 0) $5(4,048) + 0 = 20,240$ oz

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Yes. This is true because the maximum amount of fish purchased, 20,240 ounces, is divisible by 5 and not by 9; meaning that there would be no wasted fish if only 5 ounce dishes were sold.

10. CHALLENGE: What other, more reasonable, combination of lionfish fillet dishes, inside the feasible region would use the most purchased fish? Which of these solutions would generate the most profit? Justify your reasoning.

Possible answers must lie on the line $5x + 9y = 20240$. This will guarantee that all of the fish is used.

All the points on this line are solutions to the equation, but the solution that will generate the largest profit is the point that is closest to the original maximum (4048, 0). That would be (4039, 5). This combination would yield a profit of \$28,037.56.