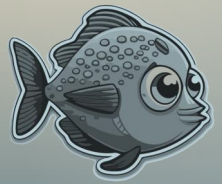
SAMONA PACIFIC

SAMONA PACIFIC: PRODUCTION PLANNING



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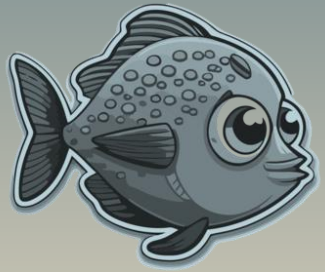
“Are you ready? The first boat with the harvest is on its way to the plant. Everything is set up to start processing in four hours, right? I just sent you an e-mail with the harvest specifications.”

-Email we received

SAMONA
PACIFIC

Product Offering

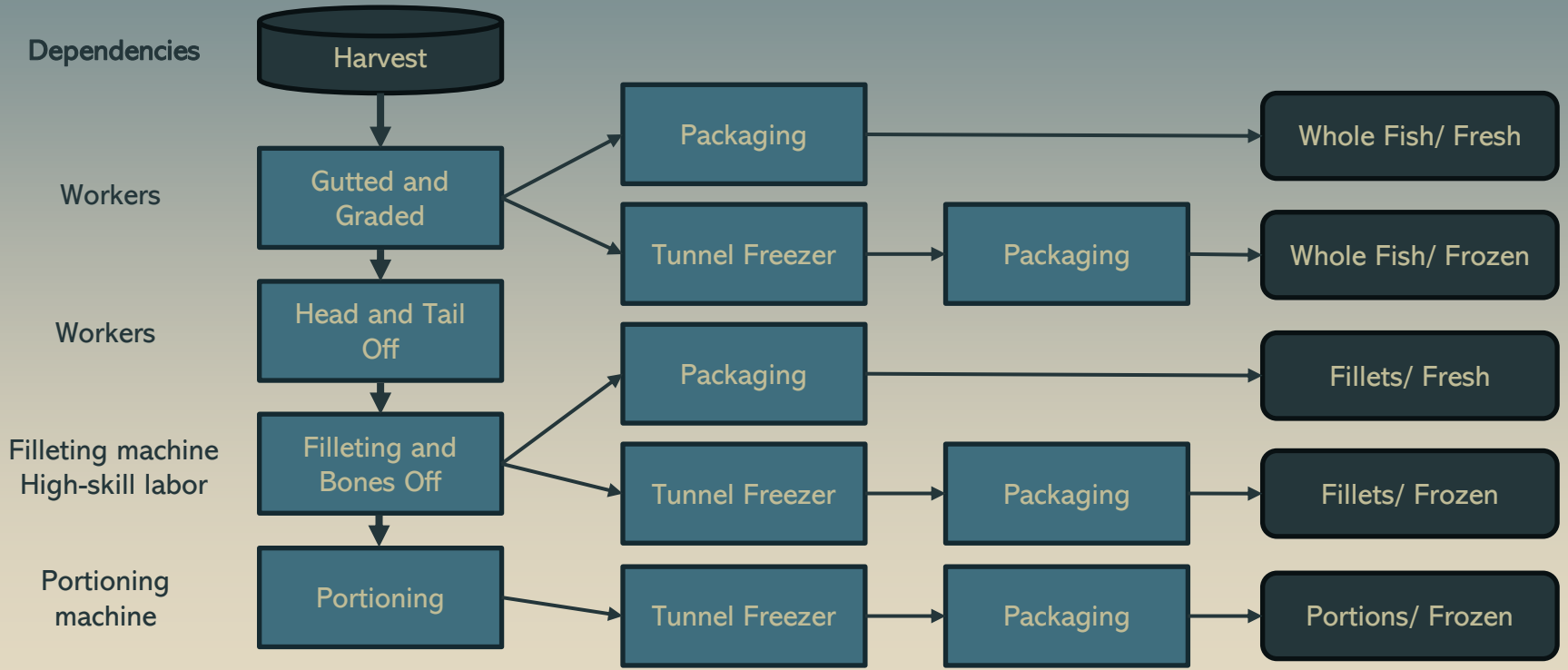


Whole
Fresh / Frozen

Fillet
Fresh / Frozen

Portion
Frozen

Production Flow



Our Duties

Determine best production mix based on

HARVEST CHARACTERISTICS

Number of Fish
Weight
Quality

PROCESSING CAPACITIES

Tunnel freezers
Filleting machine
Portioning machine

MARKET CONDITIONS

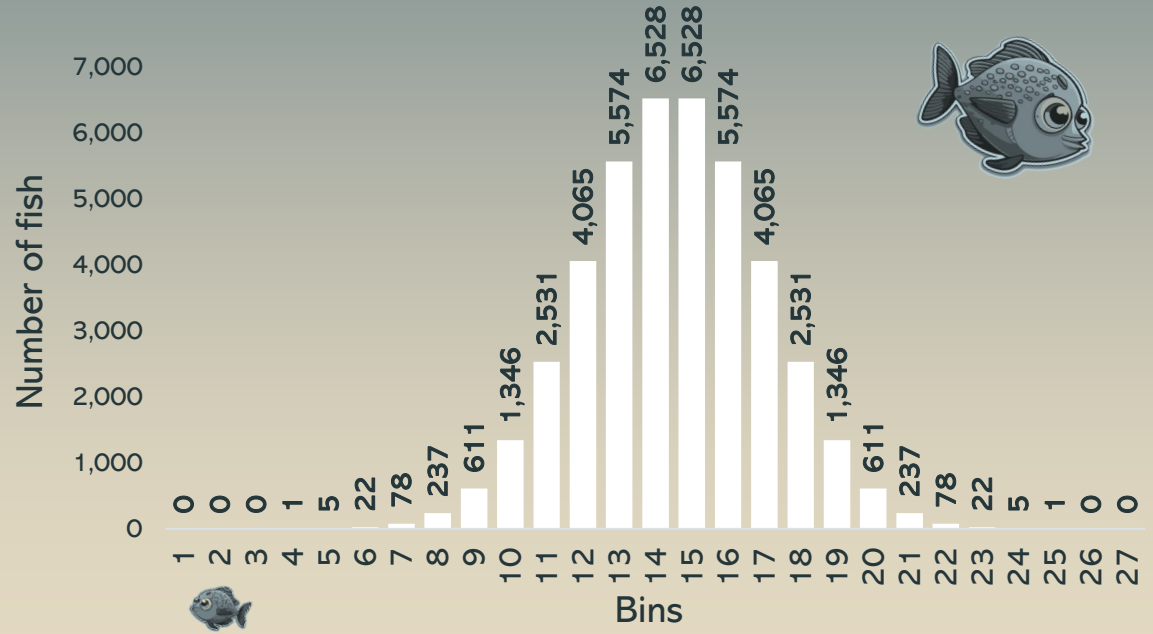
Prices
Processing Costs
Customer Requirements

Harvest Details

42,000 fish

Normally distributed by weight with mean as 4.3kg and SD of 0.5kg

Split into **27** bins



Pricing information

	Live Weight (kg)		Whole		Fillet		Portion
Bin	Min.	Max.	Fresh	Frozen	Fresh	Frozen	Frozen
1	1.5	1.7	$2.00	$2.30	$3.00	$3.20	$8.51
2	1.7	1.9	$2.00	$2.30	$3.00	$3.20	$8.53
3	1.9	2.1	$2.00	$2.30	$3.00	$3.20	$8.54
4	2.1	2.3	$2.00	$2.30	$3.00	$3.20	$8.56
5	2.3	2.5	$2.80	$3.10	$3.00	$3.20	$8.57
6	2.5	2.7	$2.80	$3.10	$3.00	$3.20	$8.59
7	2.7	2.9	$2.80	$3.10	$3.00	$3.20	$8.60
8	2.9	3.1	$2.80	$3.10	$4.80	$5.10	$8.61
9	3.1	3.3	$2.80	$3.10	$4.80	$5.10	$8.63
10	3.3	3.5	$3.00	$3.30	$4.80	$5.10	$8.64
11	3.5	3.7	$3.00	$3.30	$4.80	$5.10	$8.66
12	3.7	3.9	$3.00	$3.30	$4.80	$5.10	$8.67
13	3.9	4.1	$3.00	$3.30	$4.80	$5.10	$8.68
14	4.1	4.3	$3.00	$3.30	$4.80	$5.10	$8.70
15	4.3	4.5	$3.00	$3.30	$4.80	$5.10	$8.71
16	4.5	4.7	$3.20	$3.50	$5.00	$5.40	$8.73
17	4.7	4.9	$3.20	$3.50	$5.00	$5.40	$8.74
18	4.9	5.1	$3.20	$3.50	$5.00	$5.40	$8.75
19	5.1	5.3	$3.20	$3.50	$5.00	$5.40	$8.77
20	5.3	5.5	$3.20	$3.50	$5.00	$5.40	$8.78
21	5.5	5.7	$3.20	$3.50	$5.00	$5.40	$8.80
22	5.7	5.9	$0.00	$0.00	$5.00	$5.40	$8.81
23	5.9	6.1	$0.00	$0.00	$5.20	$5.70	$8.83
24	6.1	6.3	$0.00	$0.00	$5.20	$5.70	$8.84
25	6.3	6.5	$0.00	$0.00	$5.20	$5.70	$8.85
26	6.5	6.7	$0.00	$0.00	$5.20	$5.70	$8.87
27	6.7	6.9	$0.00	$0.00	$5.20	$5.70	$8.88

($ per finished kg)

Determined based on the weight of the fish in each bin

Processing costs

($ per finished kg)

Determined based on product type

Product	Fresh	Frozen
Whole Fish	0.45	0.35
Fillets	0.70	0.60
Portions	-	1.70

Yield

$$\frac{\text{Finished Product Weight}}{\text{Live Product Weight}}$$

Product	Yield
Whole Fish	89%
Fillets	61%
Portions	45%

Client Contracts

Long-standing relationships backed up by contracts that stipulated prices, payment method, and product specifications

The contracts did not specify minimum or maximum quantities of finished products

Our customers are willing to buy all the product SP could produce

Objective

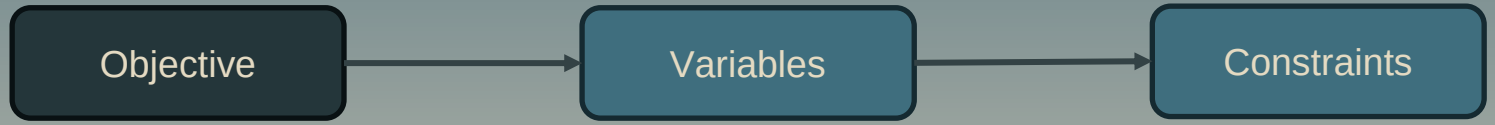
$

PROFIT!!!!

Each bin is assigned to at least one product to ensure

MINIMAL WASTAGE

Modeling

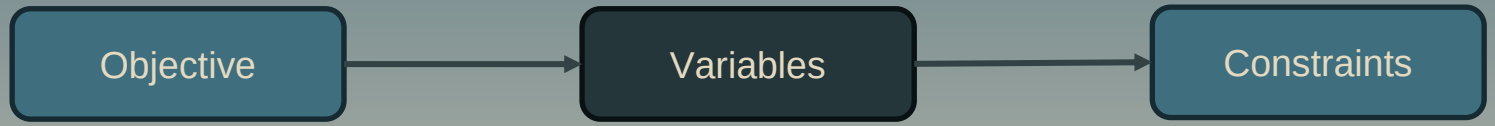


Objective Function: Maximize Profit

$$max\left(\sum_{i=1}^{27}\sum_{j=1}^{5} LW_i . x_{ij} . Y_j \left(P_{ij} - PC_j\right)\right)$$

LWi = Live Weight in bin i (i =1,2,….,27)
xij = Number of fishes in bin i processed as product j (j = 1,2,…,5)
Yj = Yield for product j
Pij = Price per finished kg in bin i processed as product j
PCj = Production cost for product j

Modeling



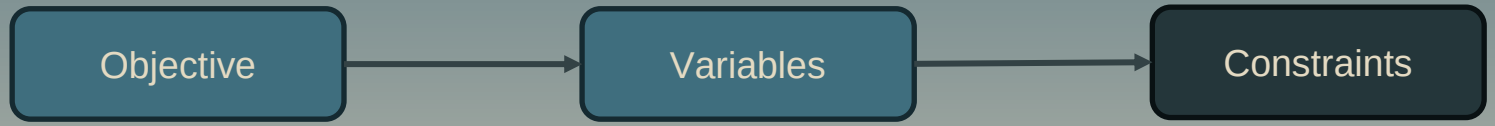
Decision Variables

x_{ij} = Number of fishes in bin i processed as product j

Where
i = 1,2,…,27 (Bins in which fishes are distributed based on weights)

j = 1,2,3,4,5 (Final processed products; Whole fresh, Whole frozen, Fillet fresh, Fillet frozen, Portion frozen respectively)

Modeling



Let's start off simple!!

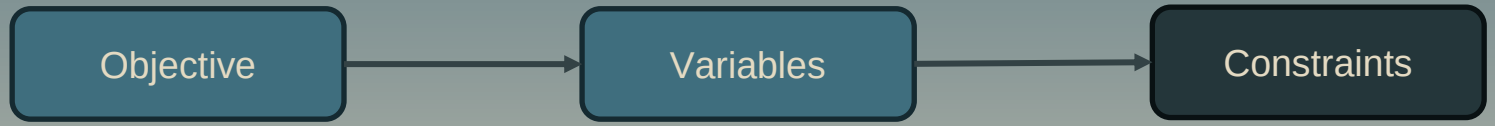
Non-negative constraint

$$x_{ij} \geq 0$$

i = 1,2,…,27 (Bins in which fishes are distributed based on weights)

j = 1,2,3,4,5 (Final processed products)

Modeling



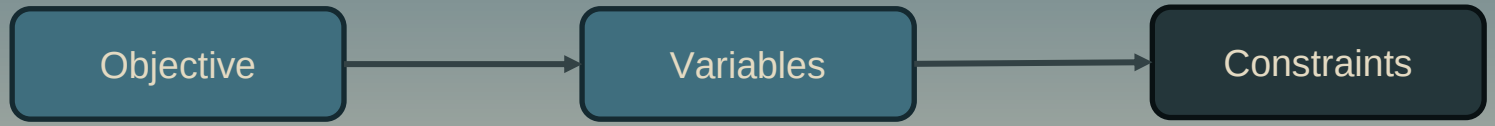
Demand-Supply Constraint

$$x_{ij} \leq 42{,}000$$

i = 1,2,…,27 (Bins in which fishes are distributed based on weights)

j = 1,2,3,4,5 (Final processed products)

Modeling



Filleting Machine Constraint

$$\sum_{i=1}^{27} \sum_{j} x_{ij} \leq 28{,}800 \; ; where \; j = 3{,}4{,}5$$

Fileting machine capacity: 15 fish/min = 15 * 60 fish/hr = 900 fish/hr

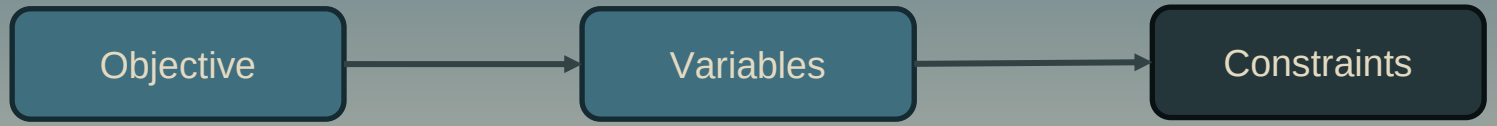
Number of hours the fileting machine can be run: 16 hrs

Number of fileting machines: 2

Maximum number of fish that can be fileted by 2 machines in 16 hours:

900 * 16 * 2 = 28,800

Modeling



Trimming Labor Constraint

$$\sum_{i=1}^{27} \sum_{j} x_{ij} \,.2 \leq 67{,}200 \,; where\ j = 3{,}4{,}5$$

Trimming capacity: 10 fillets/min = 10 * 60 fillets/hr = 600 fillets/hr

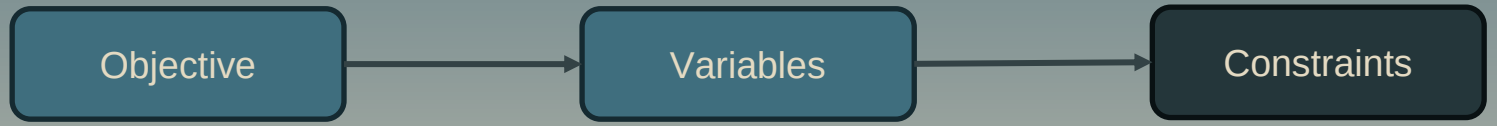
Number of hours each skilled trim worker works for: 7 hrs

Number of skilled trim workers: 16

Maximum number of fillets that can be trimmed by 16 workers in 7 hours:

600 * 7 * 16 = 67,200

Modeling



Portioning Machine Constraint

$$\sum_{i=1}^{27} x_{i5} \cdot 2 \leq 22{,}400$$

Portioning machine capacity: 1400 fillet/hr

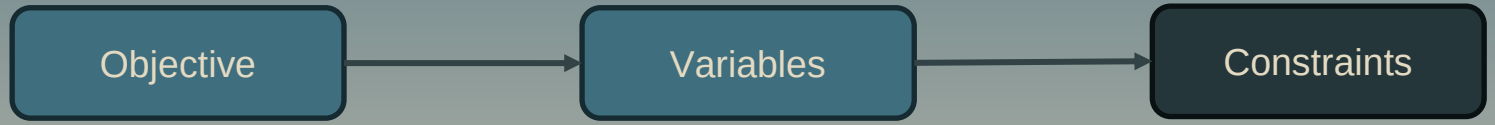
Number of hours the portioning machine can be run: 16 hrs

Number of portioning machines: 1

Maximum number of fillets that can be portioned in 16 hours:

1400 * 16 = 22,400

Modeling



Freezer Capacity Constraint

$$\sum_{i=1}^{27} \sum_{j} LW_i \,.\, x_{ij} \,.\, Y_j \leq 54{,}431 \,;\, where\ j = 2{,}4{,}5\ (frozen)$$

Freezing capacity: 60,000 pounds/day = 27,215 kgs/day

Number of freezers: 2

Maximum kgs of fish that can be frozen by 2 freezers in 1 day:

27,215.52 * 2 = 54,431

What should be the production plan recommended to Karen Hunt?

Task 1

Model Formulation

Objective

Maximize Profit

No change from base understanding

Decision Variables

Quantities of Fish processed as different products

No change from base understanding

Constraints

Fileting Capacity
Trimming Capacity
Portioning Capacity
Freezer Capacity
Binning Limit
Weight Bound

No change from base understanding

Production Plan

Live Weight	Whole		Fillet		Portion
Bin	Fresh	Frozen	Fresh	Frozen	Frozen
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	1	0	0	0	0
5	5	0	0	0	0
6	22	0	0	0	0
7	78	0	0	0	0
8	0	0	237	0	0
9	0	0	611	0	0
10	1,346	0	0	0	0
11	2,531	0	0	0	0
12	4,065	0	0	0	0
13	1,897	0	3,677	0	0
14	0	0	2,171	0	4,357
15	0	0	0	0	6,528
16	3,253	0	0	2,321	0
17	0	0	0	4,065	0
18	0	0	0	2,531	0
19	0	0	0	1,346	0
20	0	0	0	611	0
21	0	0	0	0	237
22	0	0	0	0	78
23	0	0	0	22	0
24	0	0	0	5	0
25	0	0	0	1	0
26	0	0	0	0	0
27	0	0	0	0	0
Totals →	*13,200*	*0*	*6,697*	*10,903*	*11,200*

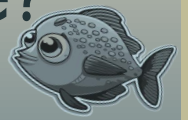
1. **Prioritizes frozen** fish due to their **higher per-kilogram price**, with a particular focus on **Portion and Fillet** frozen products because they command the **highest prices**.

2. Processing **Whole fish only as fresh**, as our freezing capacity is fully utilized by the Fillet and Portion categories which provide higher margins as compared to Whole frozen fish.

3. Despite the premium price of fresh Fillet fish, we **opt for Whole fresh** fish due to **limitations in our filleting machinery's capacity**

Profit: $496,905

What opportunities for improvement are most lucrative?



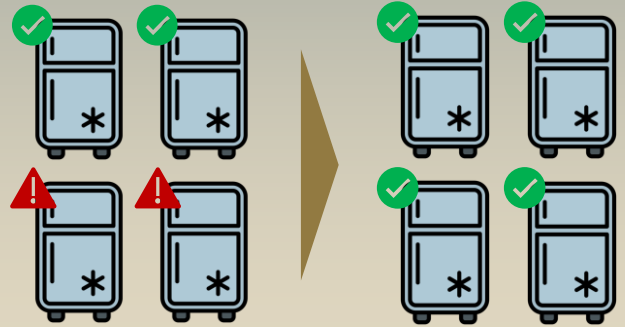
Task 2

How can we improve (1/3)

Identify weakness → Work on it i.e., Identify limiting constraints → Increase capacity

1 Increase Freezing Capacity

- ✓ Currently using two out of four available freezers.
- ✓ Full use doubles capacity, enabling freezing of 39,730 fish versus the previous 22,100.
- ✓ Increased freezing capacity allows for higher-margin sales of additional frozen fish.



Profit: $496,905

Profit: $519,230

How can we improve (2/3)

2 Increase Fileting Capacity

- ✓ Profits capped by the plant's current filleting capacity, processing 28,800 fish daily.
- ✓ Increasing filleting rate from 15 to 18 fish per minute raises profits till portioning is maxed out.
- ✓ Adding a third filleting machine can achieve this profit peak; more machines won't increase gains.

Profit: $496,905

Profit: $501,222

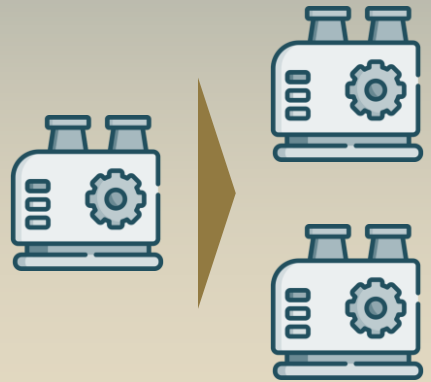
Profit: $523,680

If four freezers are utilized

How can we improve (3/3)

3 Increase Portioning Capacity

- ✓ Portioning machine has capacity of 22,400 units and additional machine would ease the constraint.
- ✓ Additional machine could push profits up since portions have higher profit margin.
- ✓ Optimizing freezers plus removing fileting and portioning constraints could get higher profits still.



Profit: $496,905

Profit: $525,795

Profit: $547,070

If four freezers are utilized

Model Formulation

Objective

Maximize Profit

No change from base understanding

Decision Variables

Quantities of Fish processed as different products

No change from base understanding

Constraints

Fileting Capacity x 2
Trimming Capacity
Portioning Capacity
Freezer Capacity x 2
Binning Limit
Weight Bound

No change from base understanding

Production Plan

Live Weight	Whole		Fillet		Portion
Bin	Fresh	Frozen	Fresh	Frozen	Frozen
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	1	0	0	0	0
5	5	0	0	0	0
6	22	0	0	0	0
7	0	78	0	0	0
8	0	0	0	237	0
9	0	0	0	611	0
10	0	1,346	0	0	0
11	282	2,249	0	0	0
12	0	4,065	0	0	0
13	350	0	0	5,224	0
14	0	0	0	1,855	4,672
15	0	0	0	0	6,528
16	0	0	0	5,574	0
17	0	0	0	4,065	0
18	0	0	0	2,531	0
19	0	0	0	1,346	0
20	0	0	0	611	0
21	0	0	0	237	0
22	0	0	0	78	0
23	0	0	0	22	0
24	0	0	0	5	0
25	0	0	0	1	0
26	0	0	0	0	0
27	0	0	0	0	0
Totals →	*661*	*7,739*	*0*	*22,400*	*11,200*

1. Fish as **Portions** are unchanged since the base plan prioritized it for **higher profit margin**.

2. **Higher number of fillets** are processed overall due to **increased filleting capacity**. Diving deeper, the fillets are **all processed frozen** due to **eased freezing constraint**.

3. After **exhausting the freezer constraint**, the remaining fish are processed as fresh.

Profit: $523,680

Does the plan make sense? What is the impact of freezer restrictions?

Task 3

Let's sense check

Live Weight	Whole		Fillet		Portion
Bin	Fresh	Frozen	Fresh	Frozen	Frozen
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	1	0	0	0	0
5	5	0	0	0	0
6	22	0	0	0	0
7	78	0	0	0	0
8	0	0	237	0	0
9	0	0	611	0	0
10	1,346	0	0	0	0
11	2,531	0	0	0	0
12	4,065	0	0	0	0
13	1,897	0	3,677	0	0
14	0	0	2,171	0	4,357
15	0	0	0	0	6,528
16	3,253	0	0	2,321	0
17	0	0	0	4,065	0
18	0	0	0	2,531	0
19	0	0	0	1,346	0
20	0	0	0	611	0
21	0	0	0	0	237
22	0	0	0	0	78
23	0	0	0	22	0
24	0	0	0	5	0
25	0	0	0	1	0
26	0	0	0	0	0
27	0	0	0	0	0
Totals →	*13,200*	*0*	*6,697*	*10,903*	*11,200*

1

All Fish Processed?

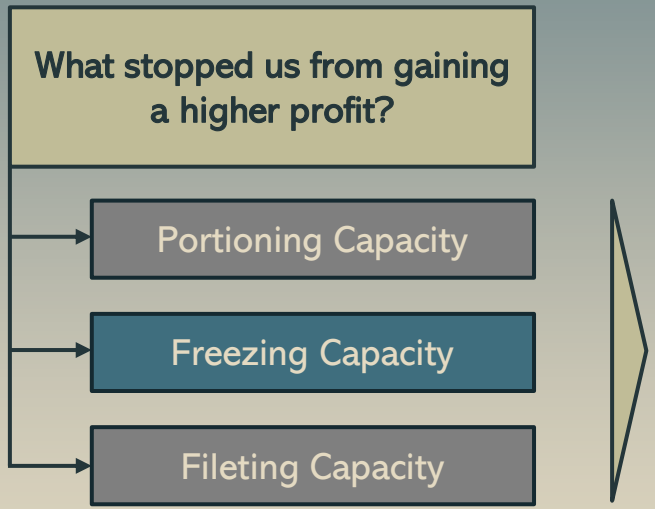
Sum of all fish processed adds up to 42,000
And no negative fish processed :)

2

Most profitable and feasible solution?

Max Portioning capacity of 11,200 exhausted with Portions.
Max Freezing capacity of 54,431kgs exhausted with Portions and Fillets. 0 whole frozen fish processed
Max Filleting capacity of 28,800 exhausted with fresh fillet and remaining processed as fresh whole fish.

Freezing capacity impact



These are called **Binding constraints**.
Since freezing capacity is one of them, there is an impact on profit.

Removing this constraint would result in a higher profit than base scenario.

Model Formulation

Objective

Maximize Profit

No change from base understanding

Decision Variables

Quantities of Fish processed as different products

No change from base understanding

Constraints

Fileting Capacity
Trimming Capacity
Portioning Capacity
~~Freezer Capacity~~
Binning Limit
Weight Bound

No change from base understanding

Production Plan

Live Weight	Whole		Fillet		Portion
Bin	Fresh	Frozen	Fresh	Frozen	Frozen
	3		2		1
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	1	0	0	0
5	0	5	0	0	0
6	0	22	0	0	0
7	0	78	0	0	0
8	0	0	0	237	0
9	0	0	0	611	0
10	0	1,346	0	0	0
11	0	2,531	0	0	0
12	0	4,065	0	0	0
13	0	5,150	0	424	0
14	0	0	0	1,855	4,672
15	0	0	0	0	6,528
16	0	0	0	5,574	0
17	0	0	0	4,065	0
18	0	0	0	2,531	0
19	0	0	0	1,346	0
20	0	0	0	611	0
21	0	0	0	237	0
22	0	0	0	78	0
23	0	0	0	22	0
24	0	0	0	5	0
25	0	0	0	1	0
26	0	0	0	0	0
27	0	0	0	0	0
Totals →	*0*	*13,198*	*0*	*17,597*	*11,200*

1. Fish as **Portions** are unchanged since the base plan prioritized it for **higher profit margin**.

2. **All fillets** processed as **frozen** because of higher profit margin. **Eased freezing capacity** allows all fillets to be processed as frozen. Filleting capacity is the binding constraint now.

3. Fishes that couldn't be fileted are processed as frozen whole fish due to higher profit margin. **No fish is processed as fresh**.

Profit: $496,905

Profit: $522,272

With all the tasks completed, Karen is now ready for her promotion.

THANK YOU