

Life Cycle Assessment of Seafood Production Systems

Review of Co-Product Allocation Problems



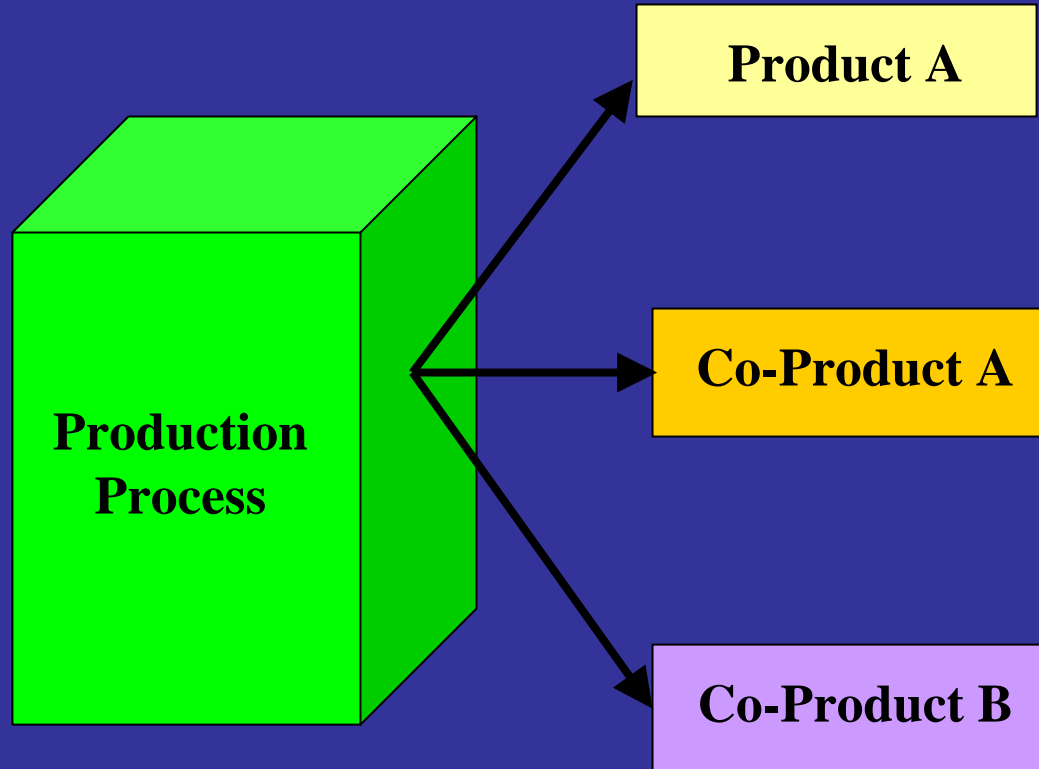
LCA of Salmon Fishing and Farming in the North East Pacific



- Using LCA to describe and compare the life cycle environmental and socioeconomic impacts of :
 - Salmon fisheries in BC and Alaska
 - Conventional net-pen salmon farming systems
 - Net-Cage Alternatives: Closed-containment and organic salmon farming systems
- Methodological development of LCA is also being undertaken
 - Impact categories
 - Co-Product allocation
 - Socioeconomic aspects

What is Co-Product Allocation in Life Cycle Assessment?

Attributing environmental burdens to the products of a multifunction process

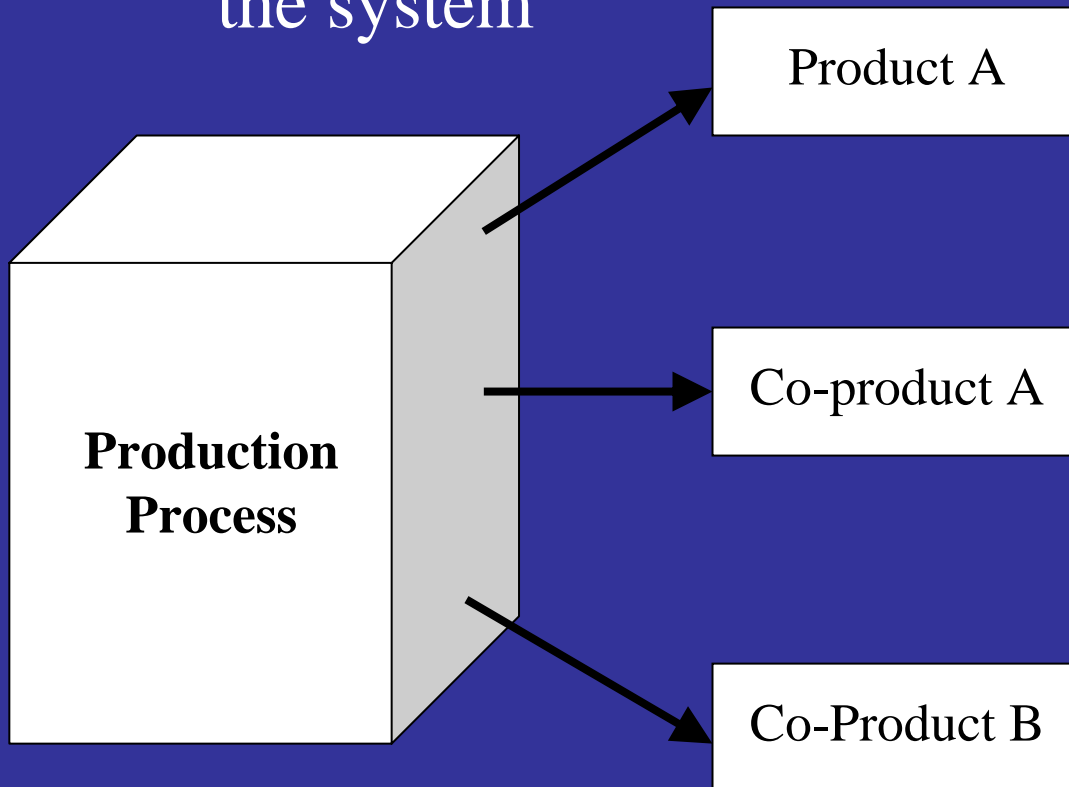


What Should We Do About It?

- ISO 14041 outlines a hierarchy of 3 options:
 1. Avoid allocation by sub-dividing or expanding the system

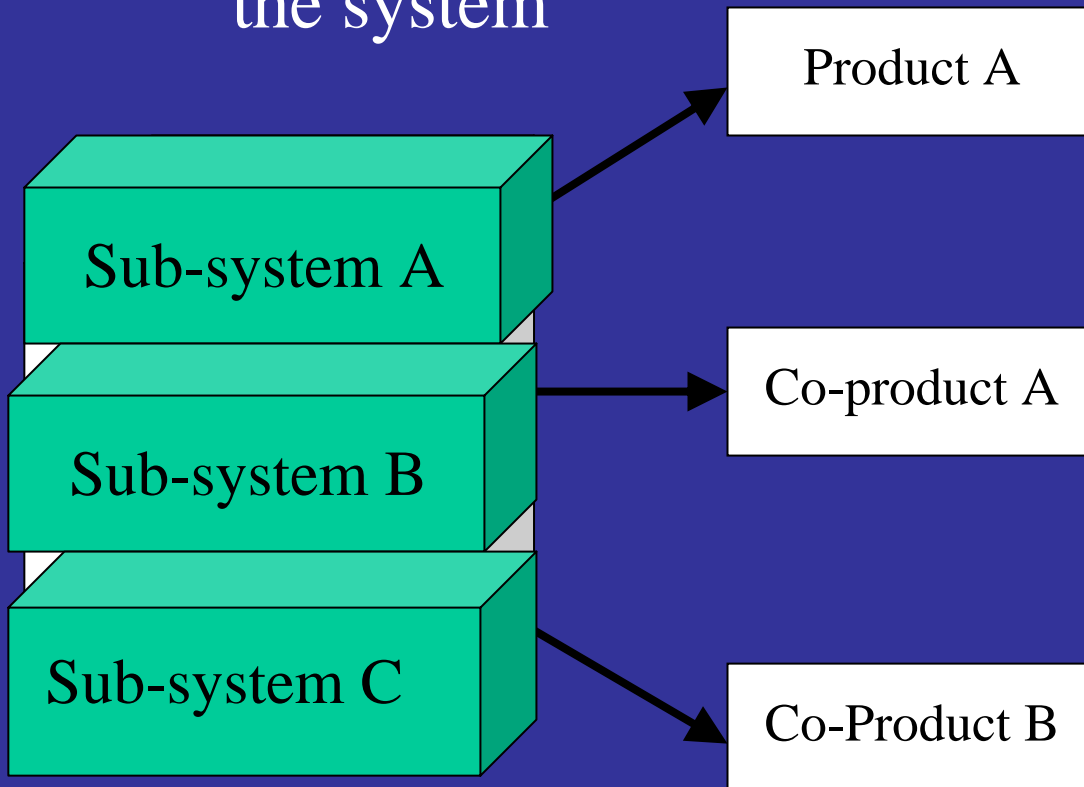
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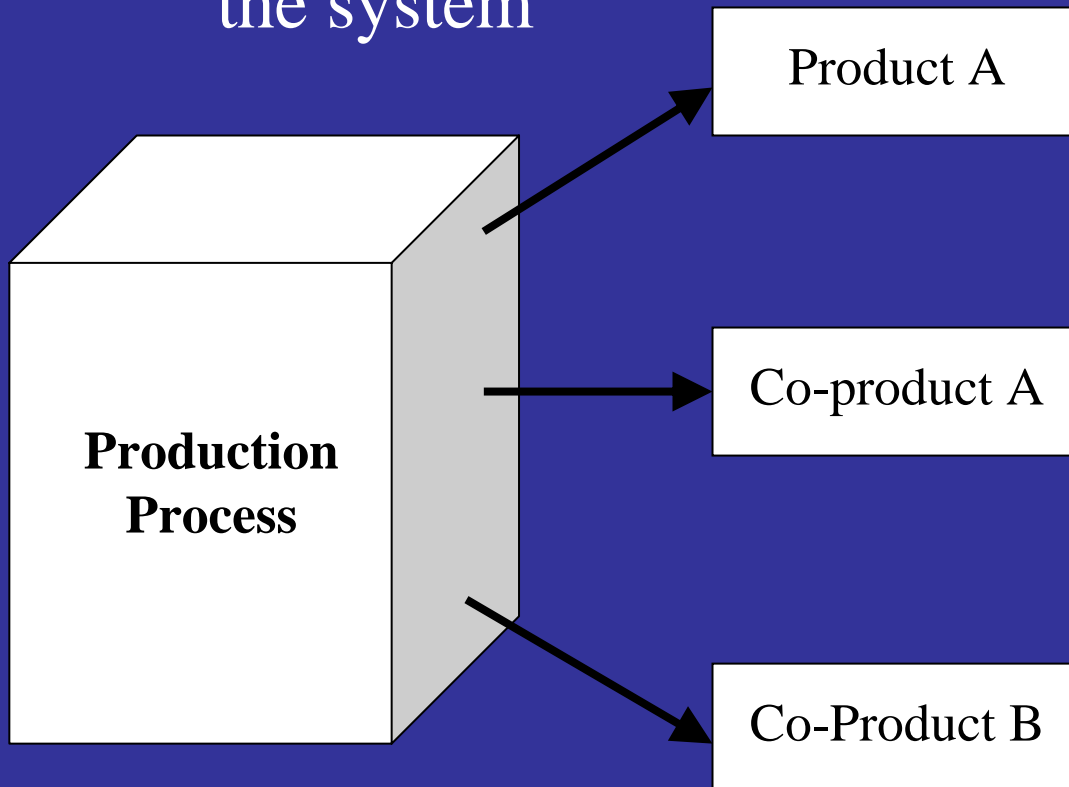
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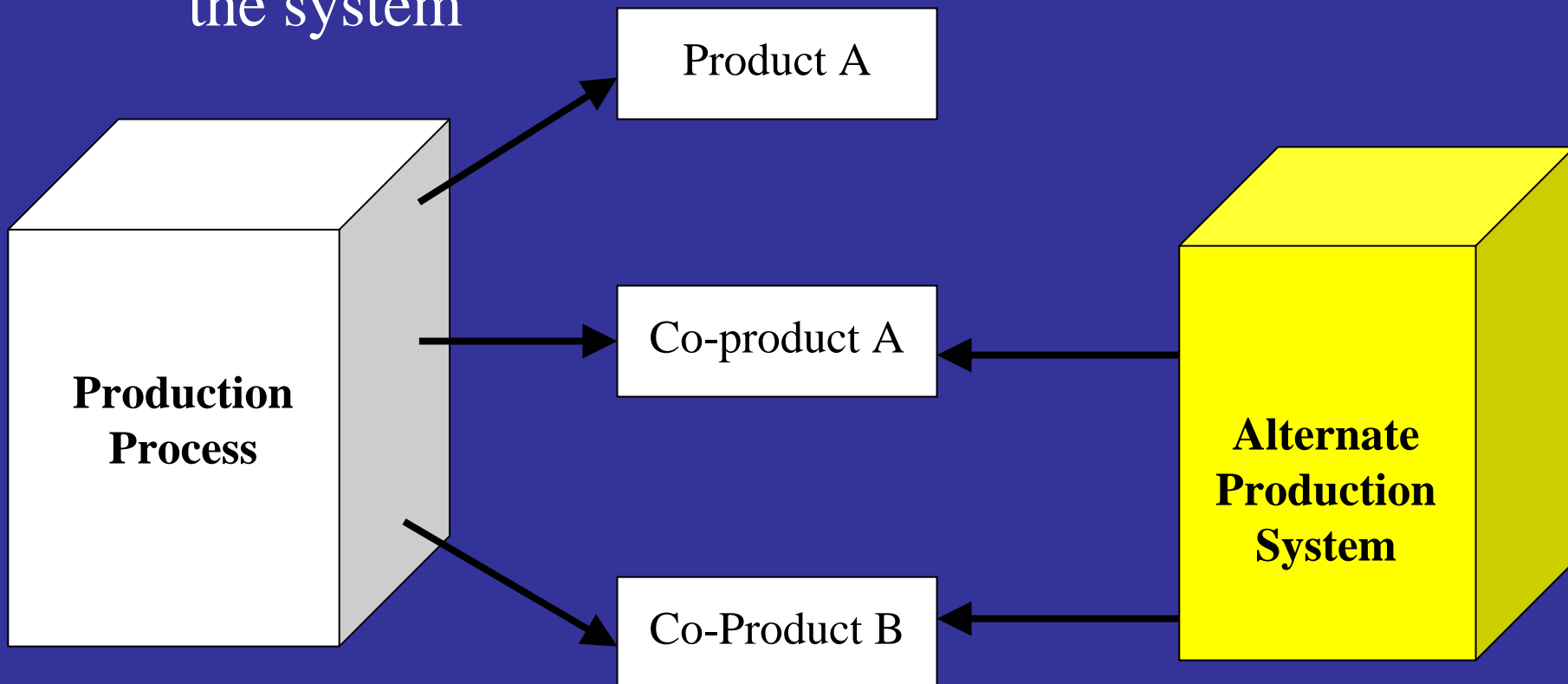
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- ISO 14041 outlines a hierarchy of 3 options:
 1. Avoid allocation by sub-dividing or expanding the system
 2. Allocate according to an underlying causal physical relationship
 3. Allocate according to some other form of relationship, such as economic value

What Should We Do About It?

- ISO 14041 outlines a hierarchy of 3 options:
 1. Avoid allocation by sub-dividing or expanding the system
 2. Allocate according to an underlying causal physical relationship
 3. Allocate according to some other form of relationship, such as economic value
- If several alternatives seem applicable:
 - Sensitivity analysis should be conducted
 - Decision should be documented and justified

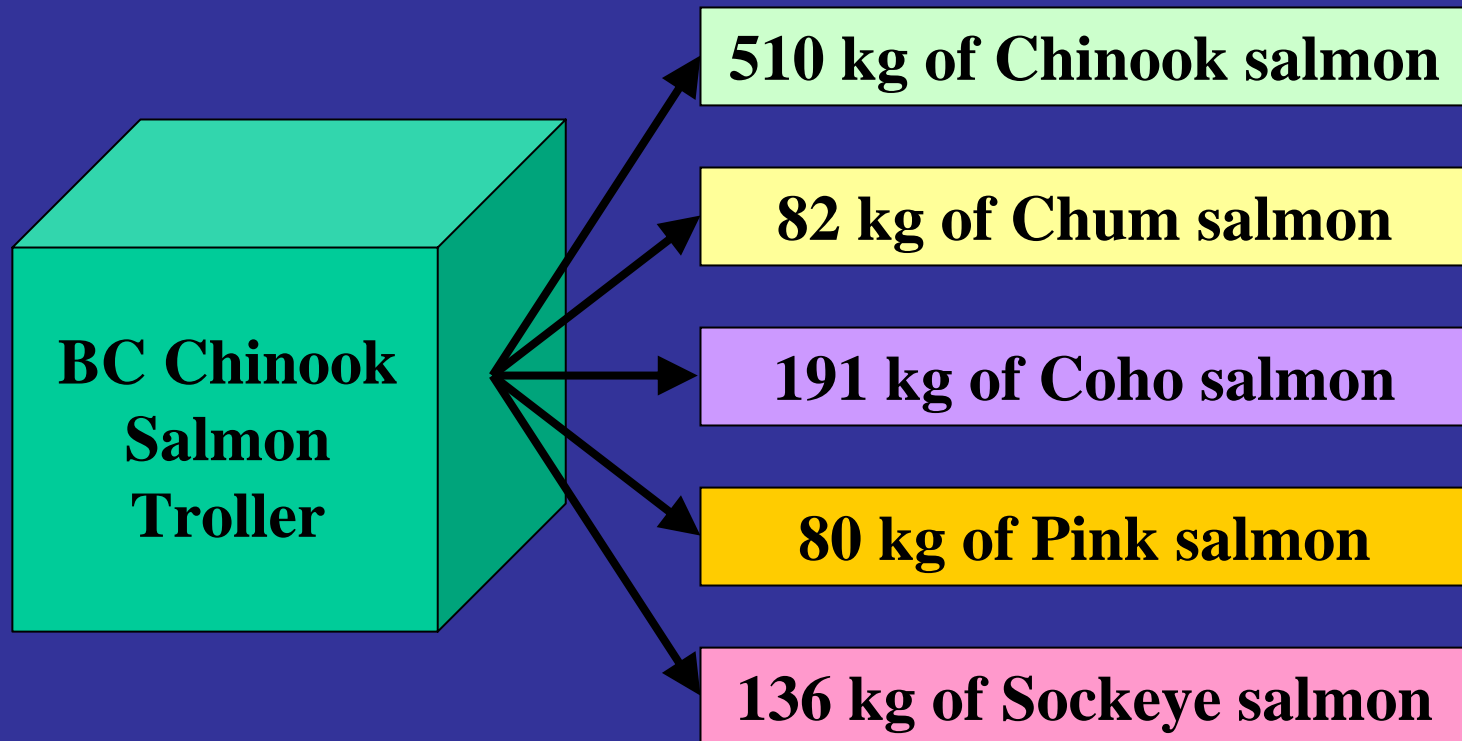
Methodology of this Study



- Literature review of 10 seafood LCAs
- Identified key allocation problems
- Explored selected allocation procedures for
 - Rationale
 - Adherence to ISO and other guidance
- Recommendations for future seafood LCAs

Allocation in the Fishery

How much of the fishing effort should be attributed to the target species?



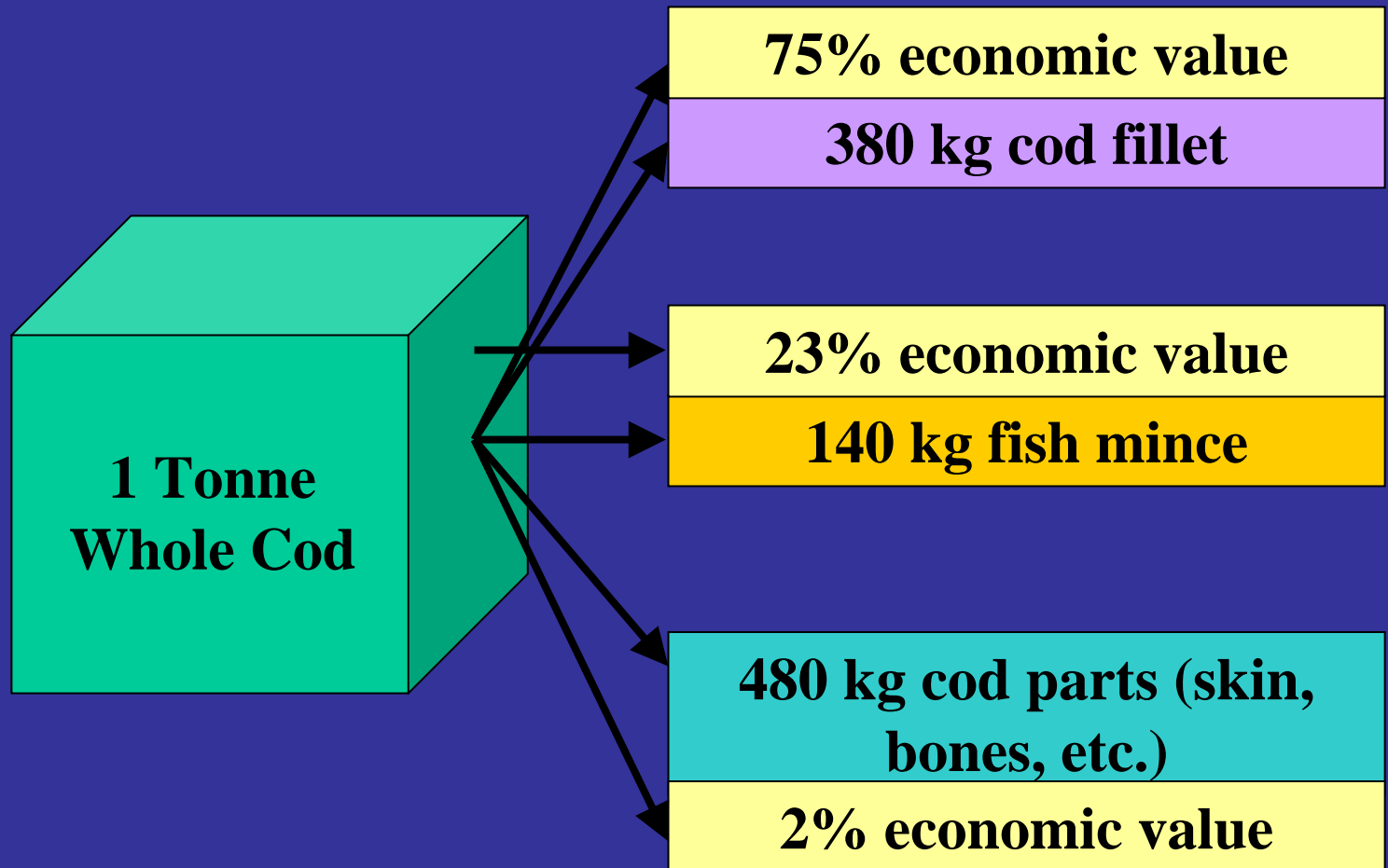
Allocation in the Fishery



Study	Allocation Method
Danish Flatfish (Thrane, 2006)	System Expansion
Swedish Cod (Ziegler <i>et al</i> , 2003)	Economic Value
Norwegian Cod (Ellingsen & Aanonsen, 2006)	Mass of Catch
Icelandic Cod (Eyjólfsdóttir, 2003)	Mass of Catch
Norway Lobster (Ziegler, 2006)	Economic Value
Thai Shrimp (Mungkung, 2005)	Economic Value

Allocation in Fish Processing

How much of the impact should be attributed to the fish fillet?



(From Ziegler *et al*, 2003)

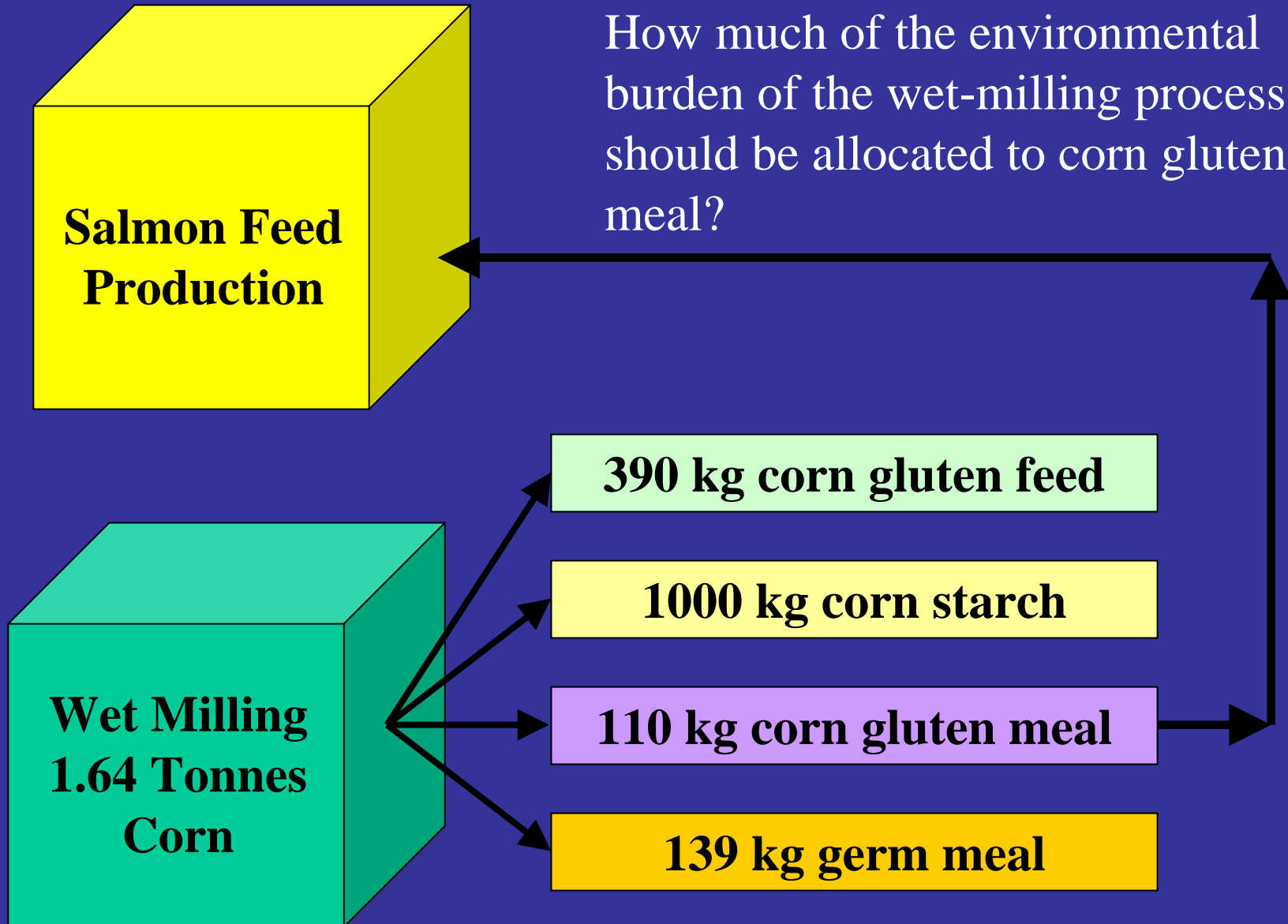
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Study	Allocation Method
Danish Flatfish (Thrane, 2006)	System Expansion
Swedish Cod (Ziegler <i>et al</i> , 2003)	Economic Value
Icelandic Cod (Eyjólfsdóttir, 2003)	100% to Cod
Spanish Tuna (Hospido <i>et al</i> , 2006)	100% to Tuna
Thai Shrimp (Mungkung, 2005)	100% to Shrimp

Allocation in Feed Production

How much of the environmental burden of the wet-milling process should be allocated to corn gluten meal?



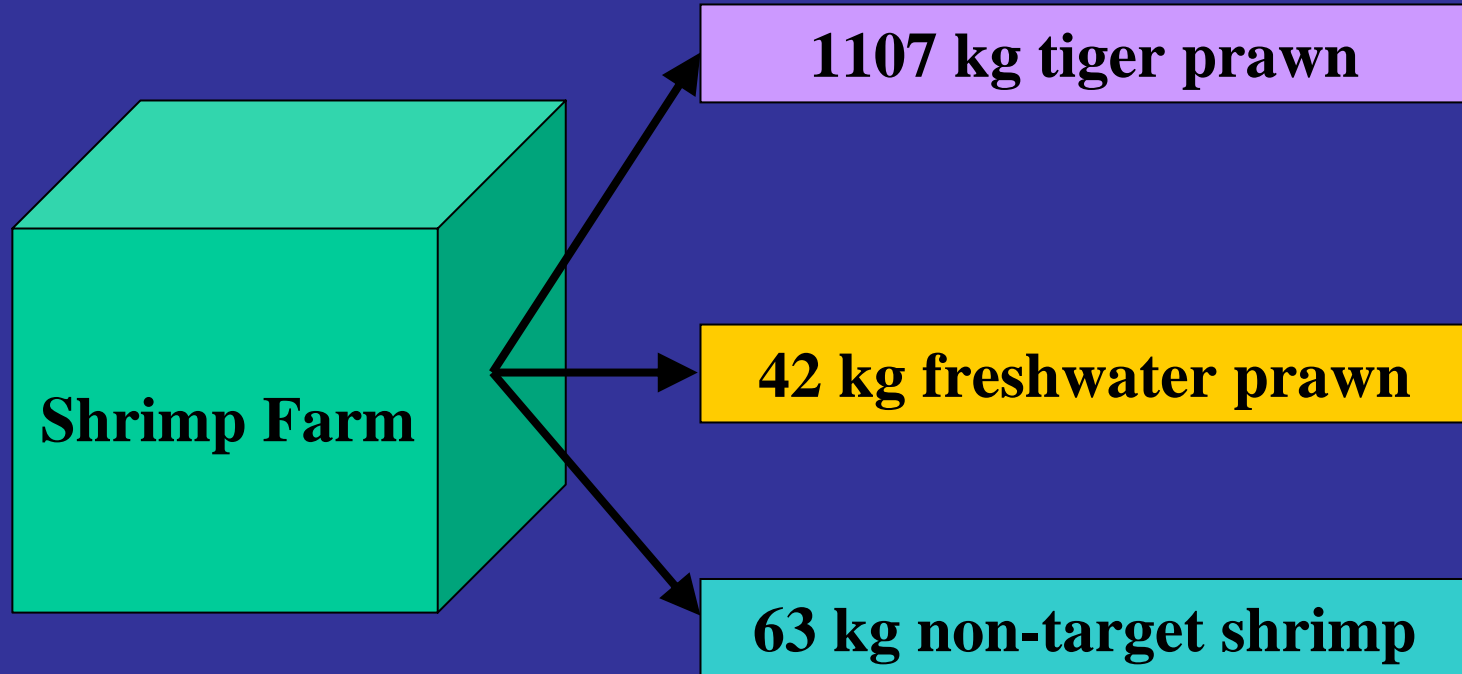
Allocation in Aquaculture Feed Production



Study	Allocation Method
Salmonid Feed (Papatriphon <i>et al</i> , 2004)	Economic Value
French Rainbow Trout (Papatriphon <i>et al</i> , 2003)	Economic Value
Thai Shrimp (Mungkung, 2005)	Economic Value

Allocation at the Fish Farm

How much of the environmental burden of farming should be allocated to the tiger prawn?



(From Mungkung, 2005)

Allocation at the Fish Farm



Study	Allocation Method
Thai Shrimp (Mungkung, 2005)	Economic Value

Summary of Review



- Sub-dividing system not possible, system expansion applied only in one study
- No allocation by causal relationships
- Economic allocation used most frequently
- Inconsistent level of detail and justification of allocation decisions

Summary of Review



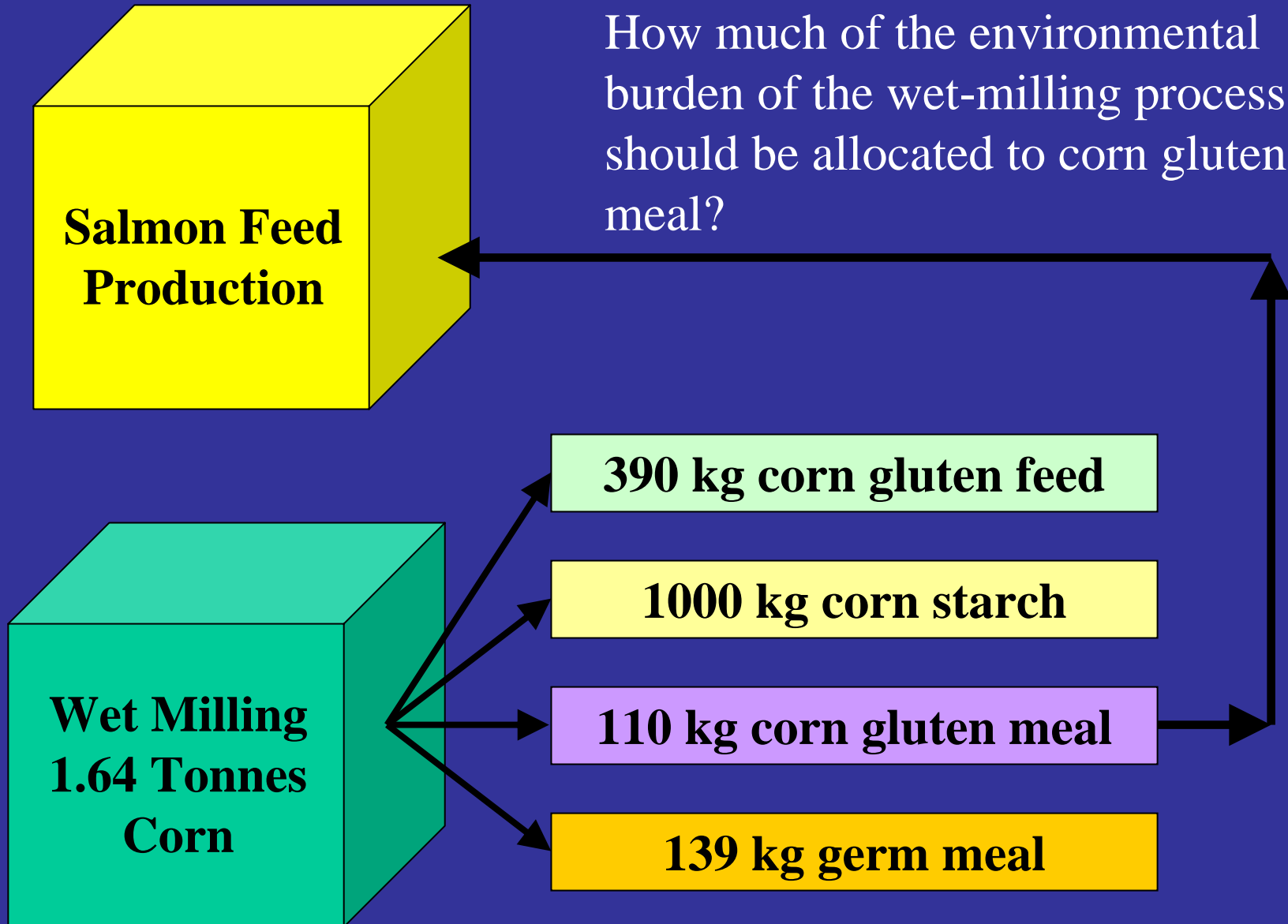
- System expansion not feasible
 - Lack of data, appropriate alternative production systems
- Economic allocation primary method
 - Economic value of products and co-products reflect the incentive for production
 - Is economic allocation ideal for seafood LCAs?

Alternatives to Economic Allocation?

- Allocation should reflect biophysical flows
- LCA of Salmon project exploring allocation by gross energy content in some instances
 - Common currency of products and co-products of food production systems
 - Reflects economic and biophysical values
 - May be particularly useful in feed production systems (e.g. corn gluten meal)

Allocation in Feed Production

How much of the environmental burden of the wet-milling process should be allocated to corn gluten meal?



Sensitivity Analysis – Allocation for a Salmon Feed Ingredient

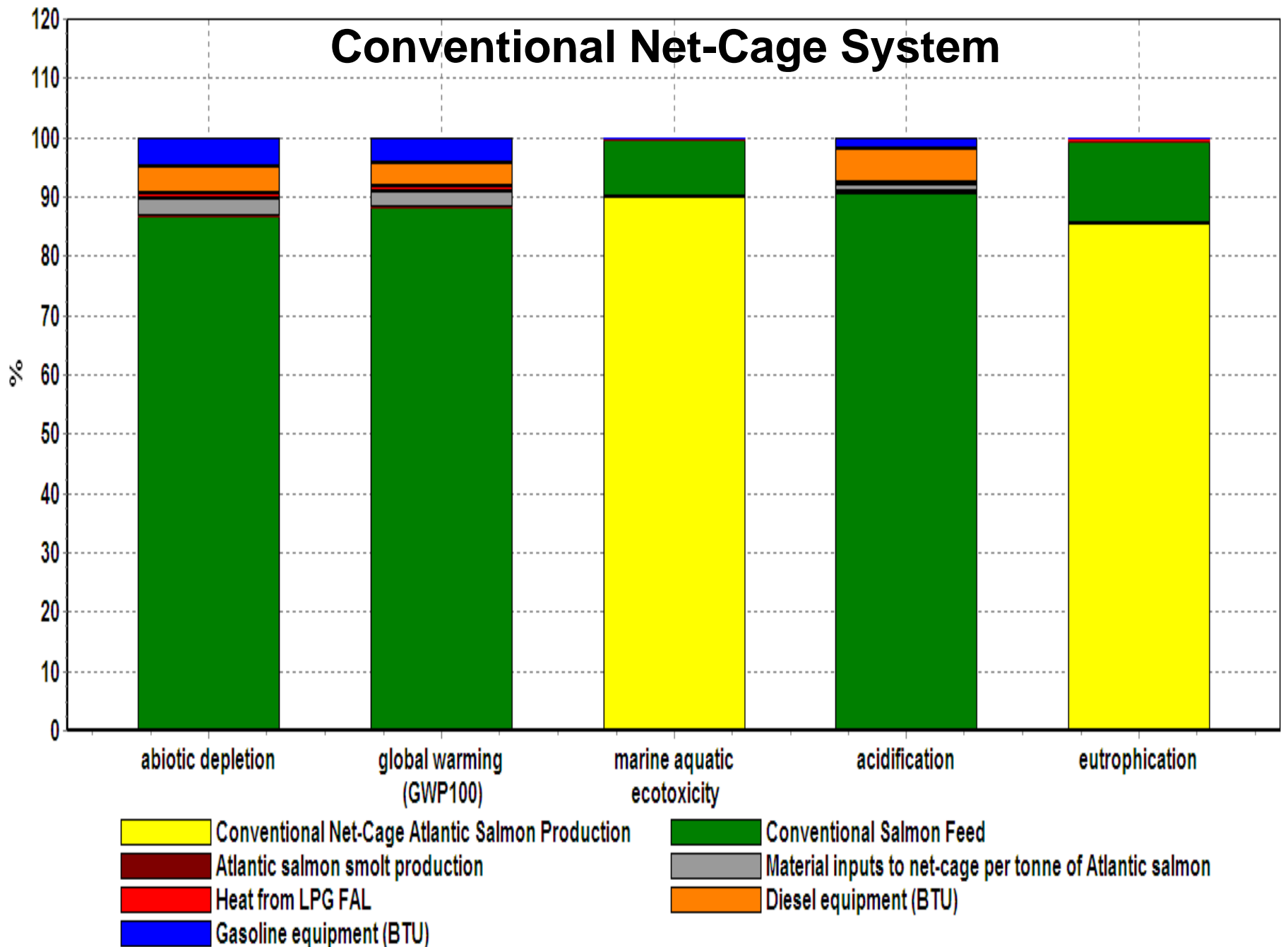
Co-Product	Mass	Energy	Economic
Corn Starch	61%	68%	78%
Corn Germ Meal	8.5%	11%	4%
Corn Gluten Meal	6.7%	8.9%	10%
Corn Gluten Feed	23.8%	12.8%	8%

Fish Processing By-Products in Salmon Feed



- Salmon feed production is the largest contributor to the environmental impact in the net-cage system

Conventional Net-Cage System

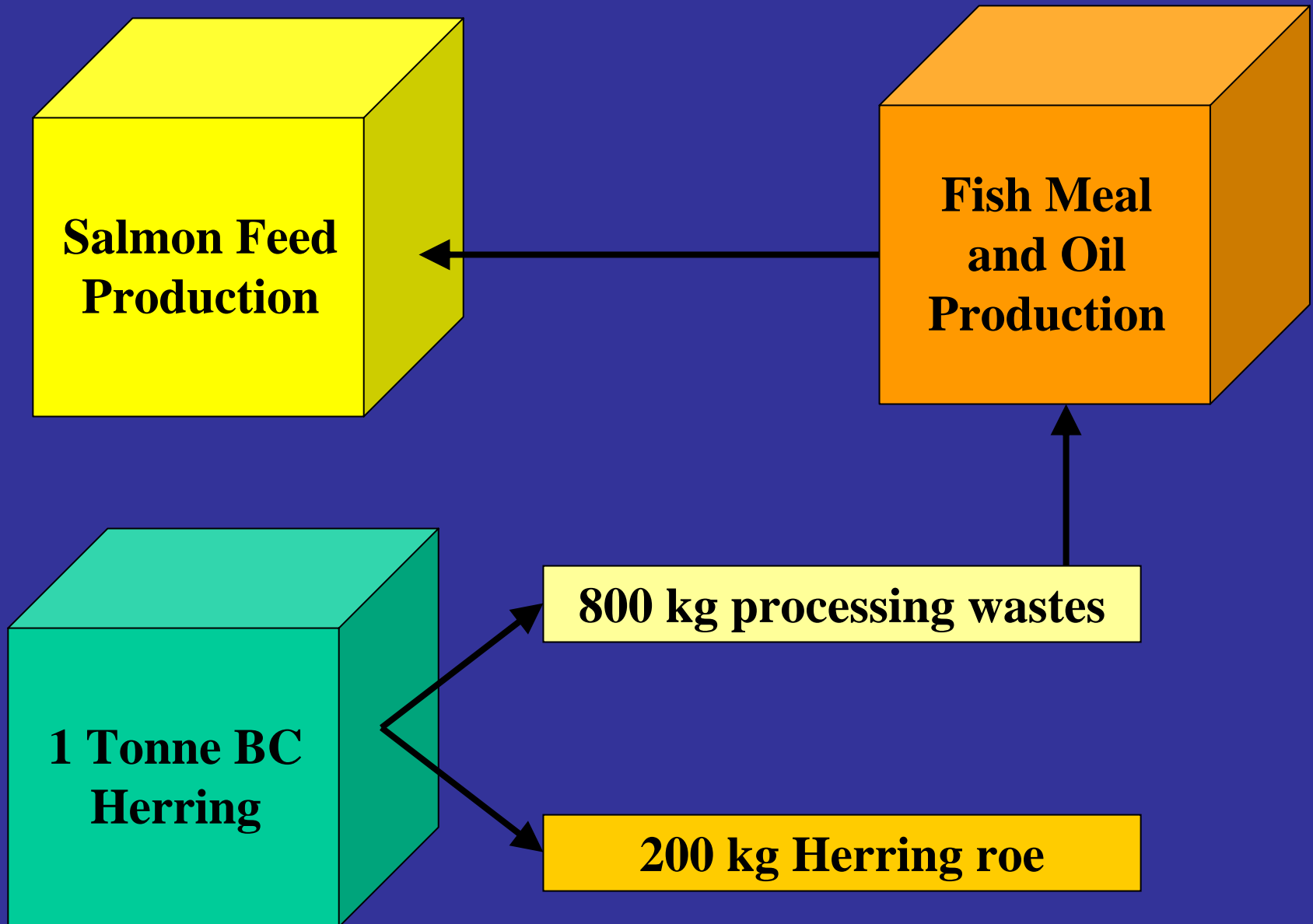


Fish Processing By-Products in Salmon Feed



- Salmon feed production is the largest contributor to the environmental impact in the net-cage system
- Conventional salmon feed contains fish meal and fish oil derived from energy intensive processes in the Peruvian and Menhaden reduction fisheries
- One proposed organic scenario is to use fish meal and oil derived from by-products of the local BC Herring fishery
- Method of allocation to by-products makes a significant difference in results

Allocation in Salmon Feed Production



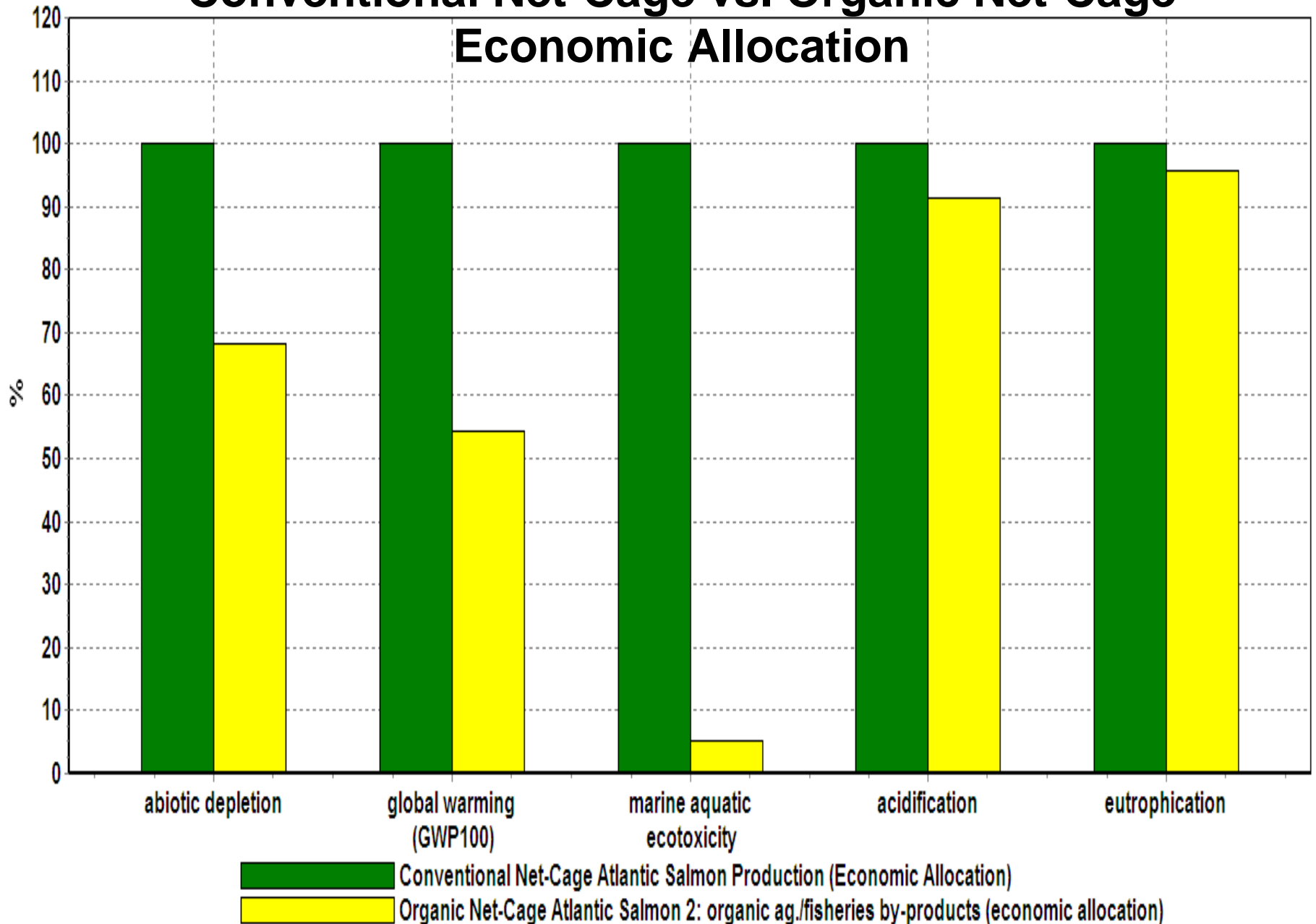
Economic Allocation Scenario



- By-products of BC Herring fishery have very little economic value (~5% of value)
- Allocating by economic value makes these by-products a “free” input in terms of environmental impact

Conventional Net-Cage vs. Organic Net-Cage

Economic Allocation

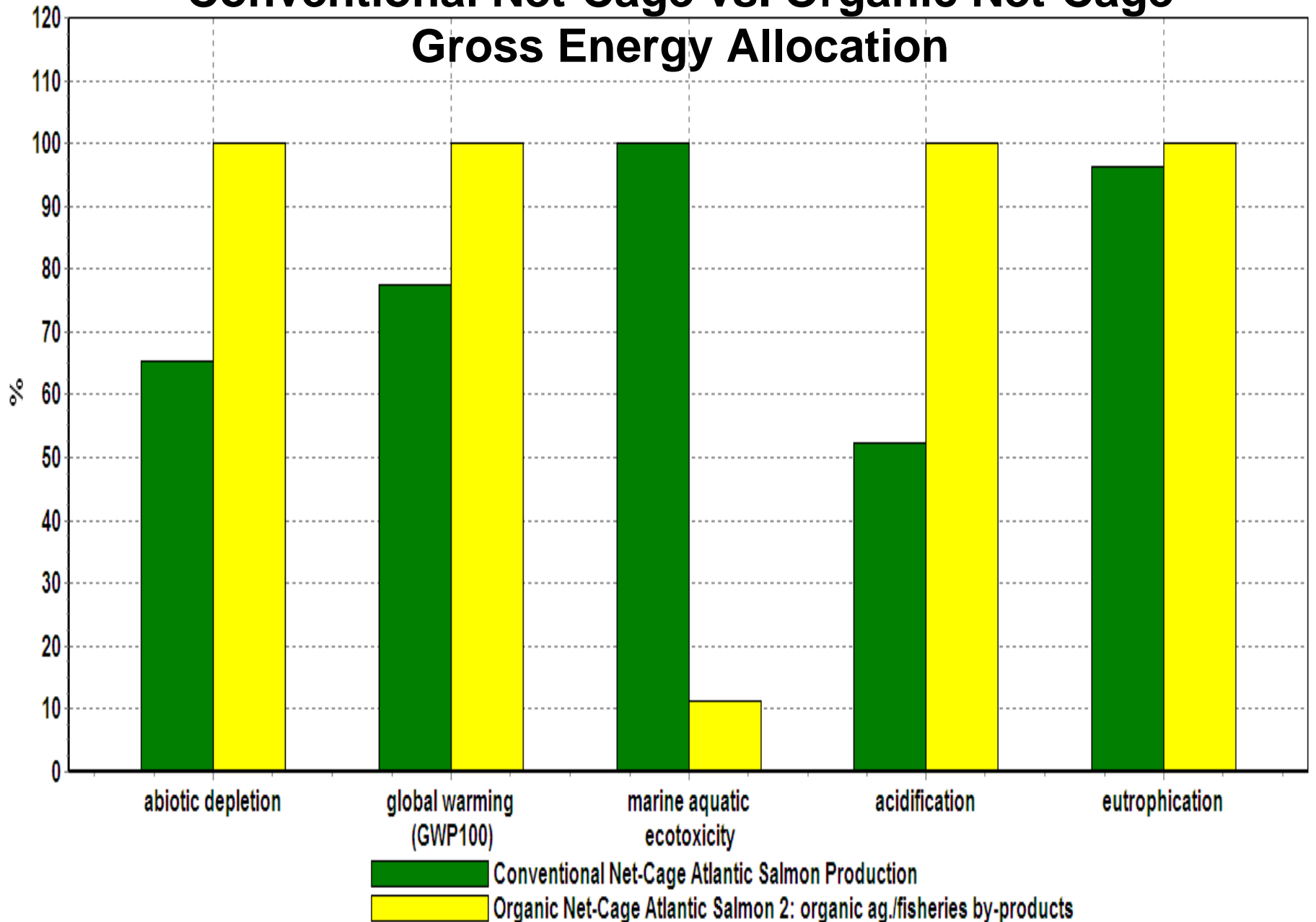


Energy Allocation Scenario



- The BC Herring fishery is the least efficient of the three fisheries providing fish meal and oil
 - Herring fishery: 135 L/tonne captured
 - Peru fishery: 42 L/tonne captured
 - Menhaden fisher: 32 L/tonne captured
- Allocation by energy content provides a more accurate reflection of the biophysical flows between background and foreground systems

Conventional Net-Cage vs. Organic Net-Cage Gross Energy Allocation



Reporting Allocation Decisions

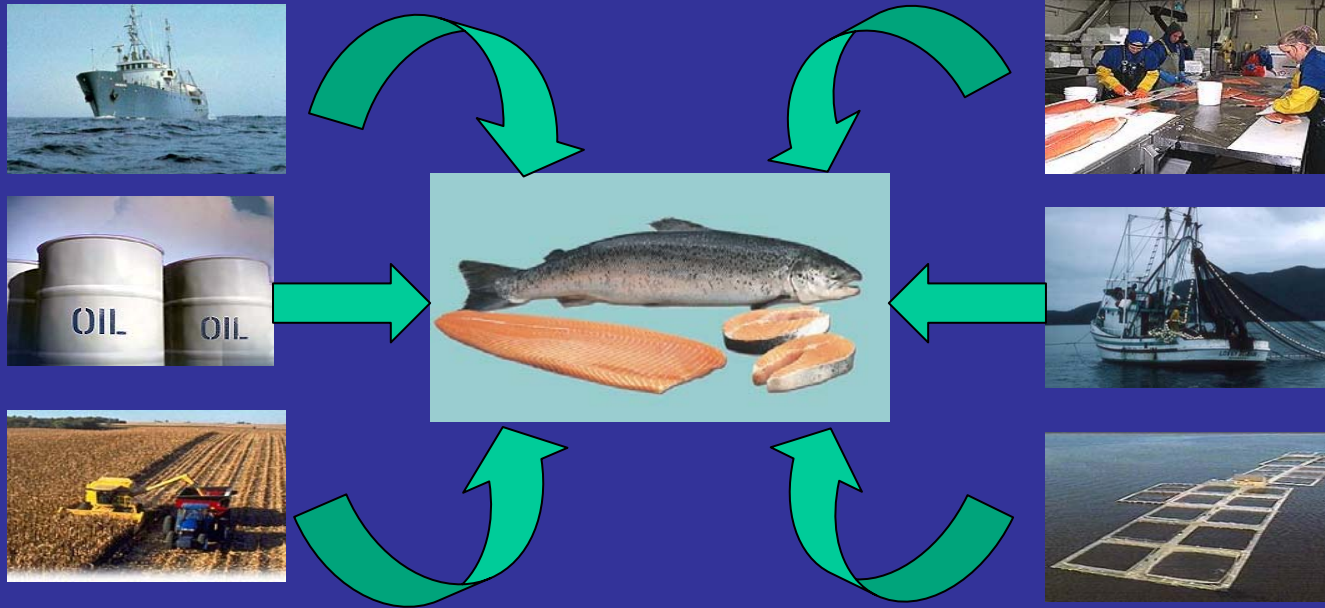


- Varying level of detail provided in published reports
- ISO 14041 – Sensitivity analysis should be conducted, allocation procedures should be documented and justified
- In order to be published an LCA report must provide:
 - A clear explanation of allocation procedures
 - A table showing sensitivity analysis

Conclusions

- Four key allocation problems in seafood LCAs
- ISO hierarchy
 - System expansion and physical causality not applied
 - Economic allocation most commonly applied
- Need alternatives to economic allocation
 - Allocation procedures should reflect biophysical flows of material and energy
 - E.g. Allocation by gross energy content
- Reporting of allocation procedures and sensitivity analysis must be standardized

Thank You Very Much! Questions or Comments?



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