Durable entitlements and resilience in fishery social ecological systems

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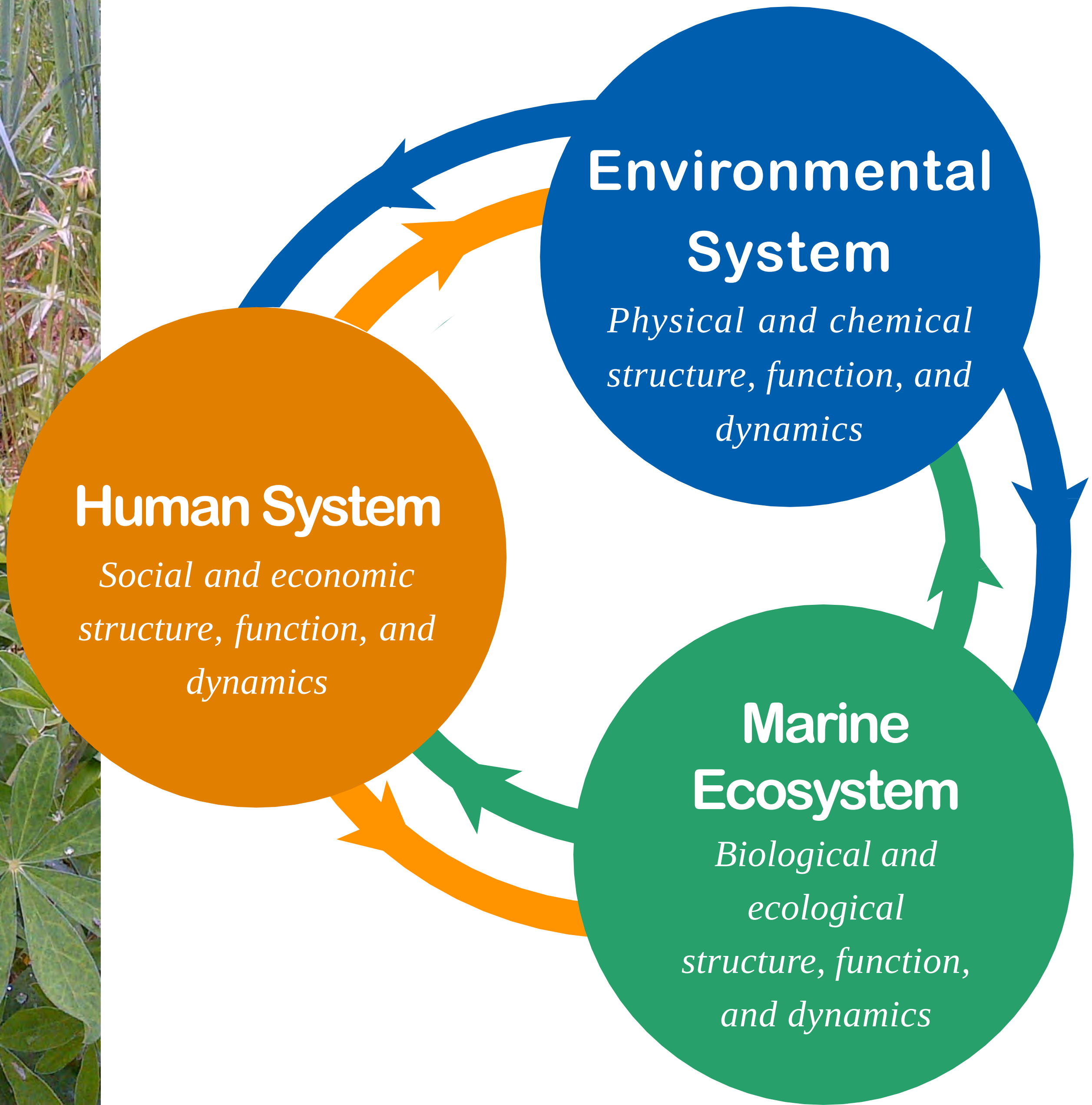
Marine Social-Ecological System



Sustainable resource management consists of practices which ensure that the expected flows of social benefits provided by the resource are not degraded through time.

Choices of **which** combination of benefits to sustain are inseparable from choices of **who** will benefit.

Elements of a Social-Ecological System

The structure of a Social-Ecological System (SES) can be represented as an optimization of present and future social wellbeing (*SW*) constrained by stochastic dynamic processes that relate abundance ($\mathbf{x_t}$) to influential states of nature ($\mathbf{y_t}$), harvests ($\mathbf{h_t}$), and other controls ($\mathbf{w_t}$).

$$max\ \mathsf{E}\left(SW\right) = \mathsf{E}\sum_{t=0}^{\infty}\left(\tfrac{1}{1+r}\right)^{t} g\left(\mathbf{x}_t, \mathbf{y}_t, \mathbf{h}_t, \mathbf{w}_t\right)$$

$$\mathbf{x}_t = f\left(\mathbf{X}_{t-l}, \mathbf{Y}_{t-k}, \mathbf{H}_{t-j}, \mathbf{W}_{t-i}\right) + \boldsymbol{\varepsilon}_t$$

$$\mathbf{h}_t = \phi\left(\mathsf{E}\left(\mathbf{X}_{t+m}\right), \mathsf{E}\left(\mathbf{Y}_{t+m}\right), \mathsf{E}\left(\mathbf{W}_{t+m}\right)\right) + \boldsymbol{\upsilon}_t$$

$$\mathbf{w}_t = \breve{\mathbf{w}}_t$$

$$For\ sustainability,\ \frac{\partial SW}{\partial t} \geq 0.$$

Elements of a Social-Ecological System

The objective function, $\boldsymbol{g}(\bullet)$, describes social preferences about risk, alternative states of nature ($\mathbf{x}_t$, $\mathbf{y}_t$) and fishing removals ($\mathbf{h}_t$), but does not ensure that preferred solutions are feasible. Implicit in the specification of the objective function are assumptions that:

- The utility associated with stocks and flows of use and nonuse benefits can be reified and meaningfully summed;
- That individuals are rational and act in their own perceived interest;
- That $\boldsymbol{g}(\bullet)$ is a convex hull ;
- That mechanisms exist for reconciling gains and losses across individuals;
- That the controls ($\mathbf{h}_t$, $\mathbf{w}_t$) are legally permissible, efficacious, and enforceable.

Elements of a Social-Ecological System

Stock dynamics, $f(\bullet)$, are assumed to be stationary stochastic processes that relate current and future abundance to past levels and to influential environmental factors, which are assumed to be observable and stationary, and are influenced by fishing mortalities and other control variables that are assumed to be controllable.

The error process ($\boldsymbol{\varepsilon}_t$) for this system will be characterized by contemporaneous and serial correlations and may reflect:

- (measurement) error in the observation of $\mathbf{x}_{t-l}$ and $\mathbf{y}_{t-k}$,
- (process) error due to misspecification of $f(\bullet)$,
- (estimation) error in the parameters in $f(\bullet)$, and
- errors in implementation (controllability) of $\mathbf{h}_{t-j}$ and $\mathbf{w}_{t-i}$.

Missing slide on g()

Elements of a Social-Ecological System

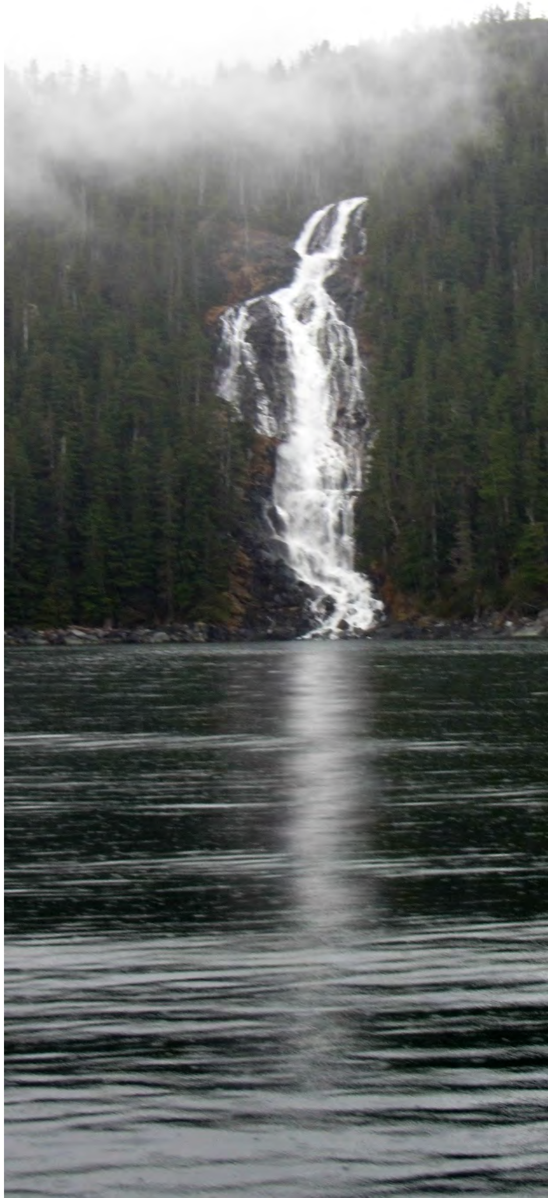
Ideal harvest control rules, $\phi(\bullet)$, should account for trophic relationships, environmental forcing (which is assumed to be observable and stationary) and the effects of other control variables.

The error process ($\boldsymbol{\nu}_t$) for the harvest controls will be characterized by contemporaneous and serial correlations and may reflect:

- (measurement) error in the observation of $\mathbf{x}_{t-l}$ and $\mathbf{y}_{t-k}$,
- (process) error due to misspecification of $\phi(\bullet)$,
- (estimation) error in the parameters in $\phi(\bullet)$, and
- errors in implementation (controllability) of $\mathbf{h}_{t-j}$ and $\mathbf{w}_{t-i}$.

But …

- the specific structure of functional relationships is unknown,
- the length and saturation of lagged relationships is unknown,
- the complexity of contemporaneous and intertemporal interactions in modeled relationships and associated errors is unknown,
- and the variables are, for the most part, unobservable.



Moreover …

it is uncertain

- whether the social wellbeing associated with stocks and flows of use and nonuse benefits can be reified and summed,
- whether mechanisms exist for reconciling gains and losses across individuals,
- whether efficacious and enforceable controls exist.

In addition…

- SES are inherently nonstationary and the behavior of nonstationary systems is inherently different from the behavior of stationary systems.
- Consequently, governance systems and management strategies designed for stationary systems will likely fail to achieve their objectives and may exacerbate instability.


Do durable entitlements affect resilience in fishery social ecological systems?

Fisheries have shifted from generalist fleets that pursue multiple species to specialists that focus on individual species or species assemblages.

This shift has been fueled, in part, by extended jurisdiction, technological change, and the issuance of durable entitlements.

Durable Entitlements in Alaska Fisheries

Fishery	Start	Mgmt sys	% wt	% value
Salmon	1973	LLP	11	26
Herring	1973	LLP	1	1
Pollock+	1992, 1998	CDQ	*	*
Halibut	1995	IFQ	1	9
Sablefish	1995	IFQ	1	7
Pollock	1999/2000	Coops	54	20
Scallop	2000	LLP*	tr	tr
BSAI crab	2005	IFQ/IPQ	2	16
GOA Rockfish	2007	Coops	2	2
BSAI GF trawl	2008	Coops	19	12
BSAI GF LL	2010	Coops	8	6

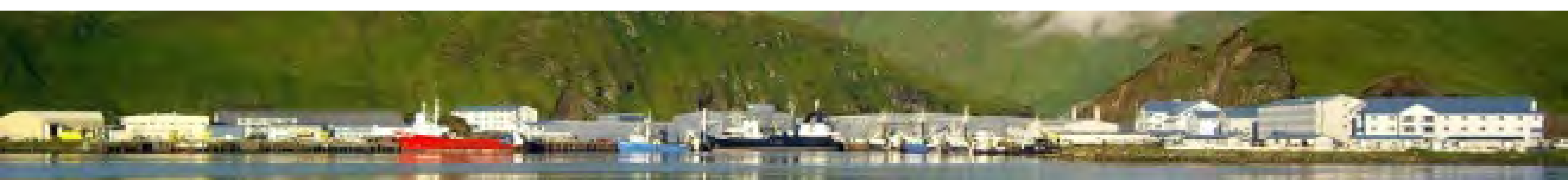
Ruminations

Durable entitlements have increased management precision, technical (production) efficiency, profits to fishing and processing sectors, and consumer surplus.

Ruminations

There are tradeoffs between economic efficiencies engendered by durable entitlements and heightened exposure to factors that affect individual stocks, associated product markets, etc.

Generalist fleets trade reduced economic efficiency for reduced exposure to losses associated with variations in the abundance or value of any one species.



Ruminations

Fishery SES with durable entitlements are resilient to moderate and short-duration fluctuations in stock abundance associated with quasi-stationary ecosystems.

However, real ecosystems exhibit low-frequency (decadal-scale) dynamics and nonstationarities (fundamental alterations of underlying data-generating processes).

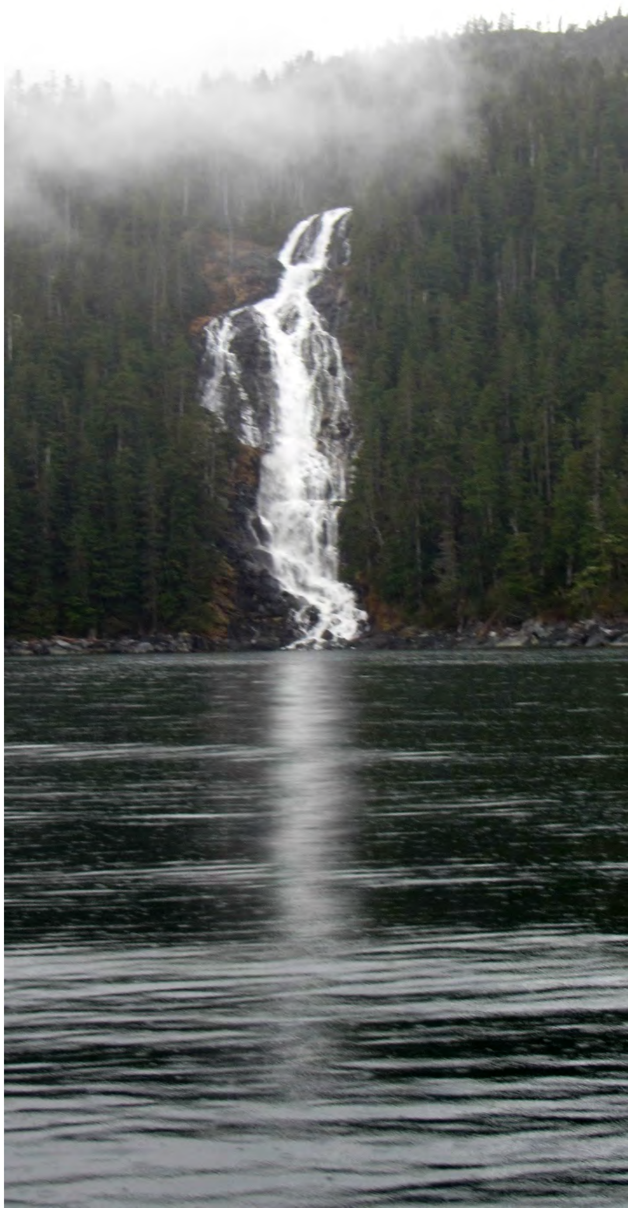
Ruminations

Durable entitlements to shares of the allowable catch increase profitability which helps buffer against modest adverse changes in stock abundance, exvessel prices, and input costs but can increase their fragility to larger perturbations.

Durable entitlement increase choice and resilience from the perspective of individuals but can decrease the resilience of fishery dependent communities.

Ruminations

While stock assessment systems and harvest control strategies may recognize and respond to ecosystem change, experience suggests that specialist fishery-social systems are ill-equipped to weather large or long-lasting changes in the abundance of target stocks of fish or shellfish.



Snatching Failure from the Jaws of Success—Five Alaskan Case Studies

- **Salmon**—racing for catch and losing market share
- **Pollock**—rigid rules in a changing world
- **Halibut**—the sporting death of a shrinking fish
- **Sablefish**—is a sustained decline sustainable?
- **Crab**—from boom to sustained bust

Pollock—Rigid Rules in a Fluid World

Americanization

- Pre-1976 – Foreign fishing
- 1976-1985—Foreign fishing replaced by joint ventures
- 1985-1990—Joint ventures replaced by fully domestic

All-American Over Capitalization

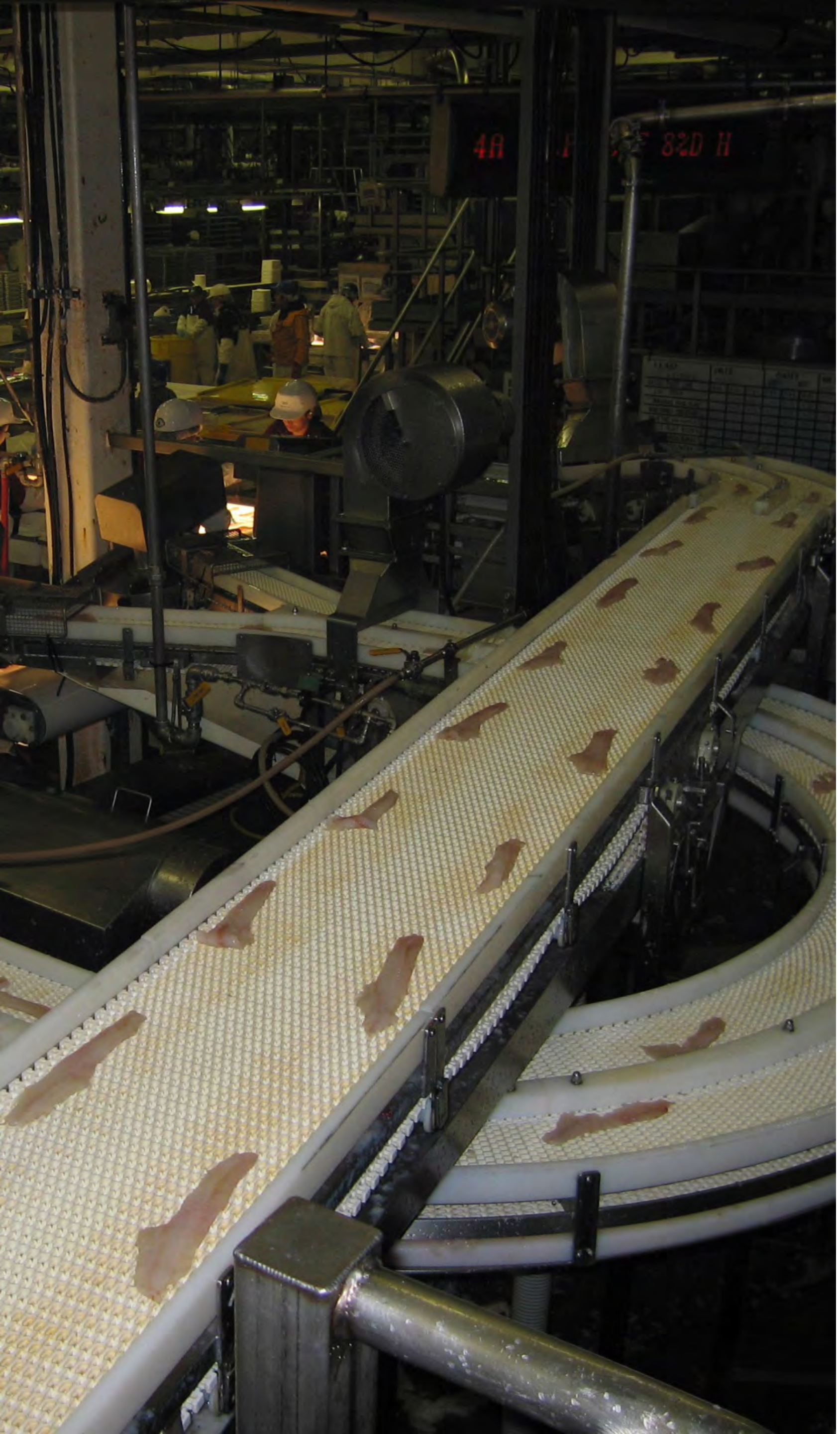
- 1991-1995—cycle of bankruptcy and recapitalization due to excess harvesting and processing capacity. Inshore-Offshore allocation wars, season compression.
- 1996—Moratorium on entry

The American Fisheries Act (1998)

- Established permanent allocation to each sector with permanent moratorium on entry—usable as collateral
- $75 million to retire 9 of 29 catcher-processors
- Explicit authority for companies within each sector to negotiate sub-allocations
- Market-based transfer of sub-allocations within each sector
- CDQ and high seas catcher boat quotas could be leased to any sector

The AFA

- Increased product recovery rate by ~150%.
- Increased production of high value product forms.
- Increased economic returns.
- Reduced bycatch.
- Improved management precision.



The AFA

- Helped industry accommodate changes in fishing seasons and areas required to meet ecological concerns.
- Provided the resources needed to modernize vessels and processing equipment

Exogenous Drivers

Changing seafood consumption patterns

– Japanese household demand for pollock roe and high-grade pollock surimi is declining

Increased production of substitute seafood products

– Farmed whitefish compete with pollock in fillet and surimi markets

Increased fuel costs

– Diesel prices (inflation-adjusted) are rising

Variations in distance to productive fishing grounds

– Regulatory measures (SSL closures, salmon bycatch)

– changes in the spatial distribution of pollock.

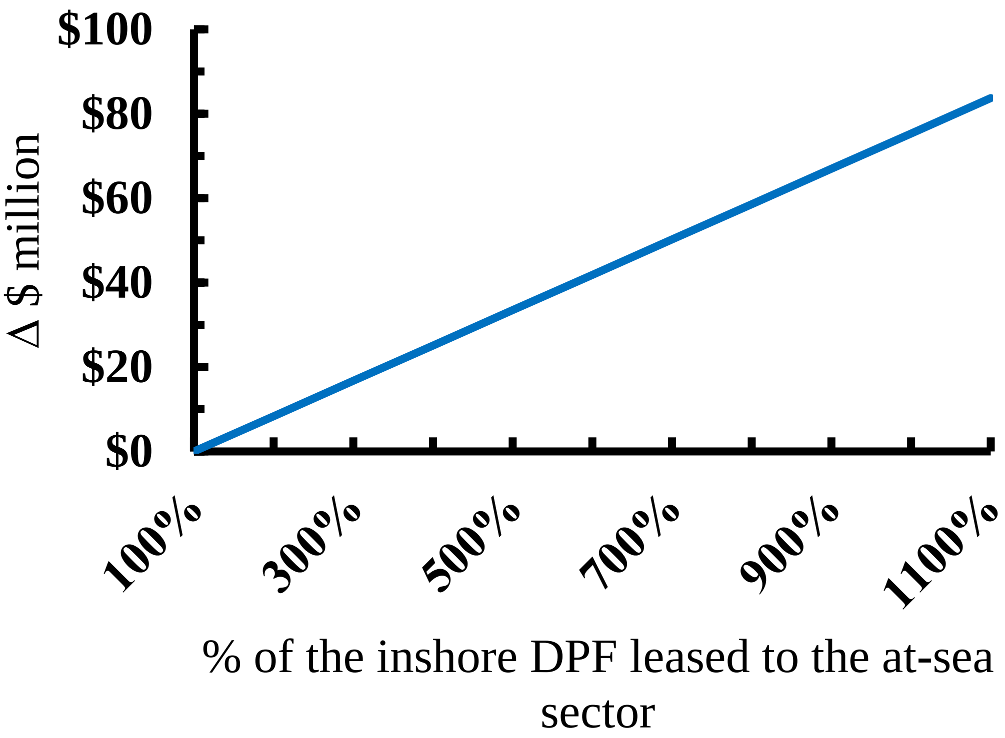
Exogenous Drivers

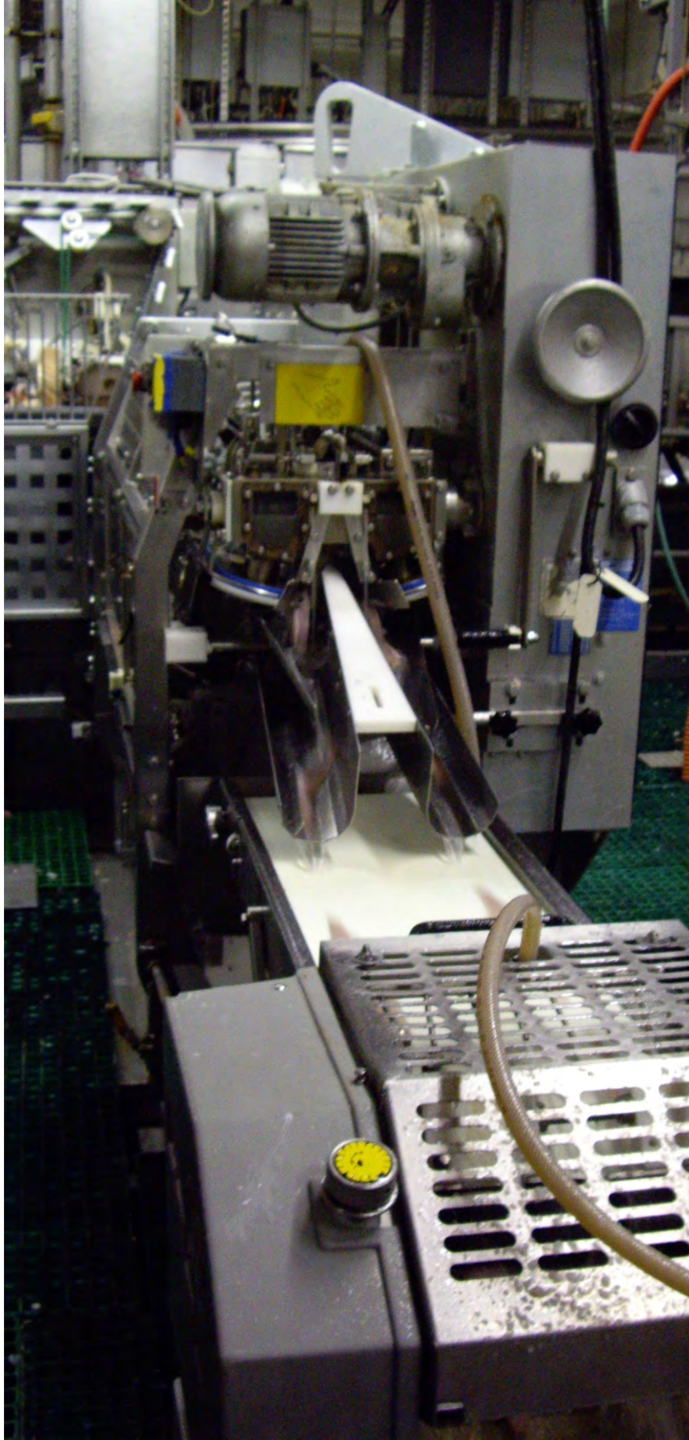
- Variation in the distribution of pollock as well as the need to avoid salmon bycatch have led the fleet to fish at increased distances from port.
- When combined with high fuel prices, the need to fish at long distances from port has caused the inshore sector to under-harvest its allocation.
- Thus, while the AFA has increased the economic resilience of the pollock fishery as a whole, prohibitions against inter-sector quota transfers reduce potential revenues and increase the vulnerability of the shore-based fleet.

Value of Foregone Harvest

	2007	2011	2011 CDQ
Underharvest	37,991mt	62,980mt	
Exvessel loss	$11.8M	$19.6M	
1st Wholesale loss	$38.4M	$63.6M	
Inshore	$11.8M	$10.5M	$1.6M
CP		$5.8M	$0.8M
MS		$0.2M	$0.02M
CDQ		$3.1M	$5.6M

Relaxation of transfer restrictions would increase wholesale revenues to the fishery as a whole.





Pollock in the Eastern Bering Sea

- The AFA increased the fitness of governance and economic systems but created an imperative for analogous governance and management strategies for other BSAI and GOA groundfish fisheries.
- In the inshore sector, the AFA shifted bargaining power of from processors to fishing vessel owners.
- Variation in the distribution of pollock as well as the need to avoid salmon bycatch have led the fleet to fish at increased distances from port.
- When combined with high fuel prices, the need to fish at long distances from port has caused the inshore sector to underharvest its allocation.

Pollock in the Eastern Bering Sea

Inefficient design features of the AFA have reduced net benefits that could become available if the AFA were amended to permit intersectoral trades.

The ability of inshore cooperatives to harvest their catch shares is uncertain under conditions such as

- rising fuel costs,
- falling real product prices,
- decreased CPUE,
- reduced abundance of large pollock, and
- increased in distances to productive fishing grounds.

Pollock in the Eastern Bering Sea

The inshore B-season allocation is likely to be under-harvested for three reasons:

1. Inshore sector catches generate $0.13/kg less, on average, than at-sea sector catches.
2. Roe, which comprises 25% of pollock revenue, is primarily harvested in the A season, thus the overall price per kg for B-season pollock is much lower.
3. Pollock are distributed further away from shore during the B season so fuel costs per ton of harvest are generally higher in the B season.

Questions?

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POLLOCK CONSERVATION COOPERATIVE
Research Center

UAF
UNIVERSITY OF ALASKA FAIRBANKS

NORTH PACIFIC RESEARCH BOARD

Lagniappe

Our harvest control rules are not always efficacious at nudging SES towards increased levels of social wellbeing:

- For some stocks, fishing is a minor component of mortality, a weak control;
- Wellbeing is not solely dependent on extractive exploitation of fish;
- Social preferences evolve.

Changing social preferences may be more effective than setting harvest controls.