Cap-and-trade bycatch management with costly avoidance and stock uncertainty

Rajesh Singh and Quinn Weninger

Department of Economics
Iowa State University

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Introduction

Approaches to reduce Bycatch:

1. Technological solutions, e.g., TEDs, circle hooks (Gilman et al., 2006).
2. Regulate/reduce fishing: spatial-temporal closures, gear restrictions, lower TACs for target species.
3. Incentives to encourage costly avoidance, e.g., fines, taxes, quotas (Bisack and Sutinen, 2006; Pascoe et al., 2010; Segerson, 2011)

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Can a cap-and-trade bycatch management program achieve management goals?

- Study cap-and-trade bycatch management in a general equilibrium framework
- Derive endogenous (costly) bycatch avoidance under uncertainty
- Compare outcomes with and without quota trade, with and without at-sea observability
- Provide framework for empirical analysis of costly bycatch avoidance
- Add to empirical literature on costs of bycatch regulations (Curtis and Hicks, 2000; Chakravorty and Nemoto, 2000; Huang and Leung, 2007; Pradhan and Leung, 2005)

Model of a quota/bycatch permit fishery

Key model elements:

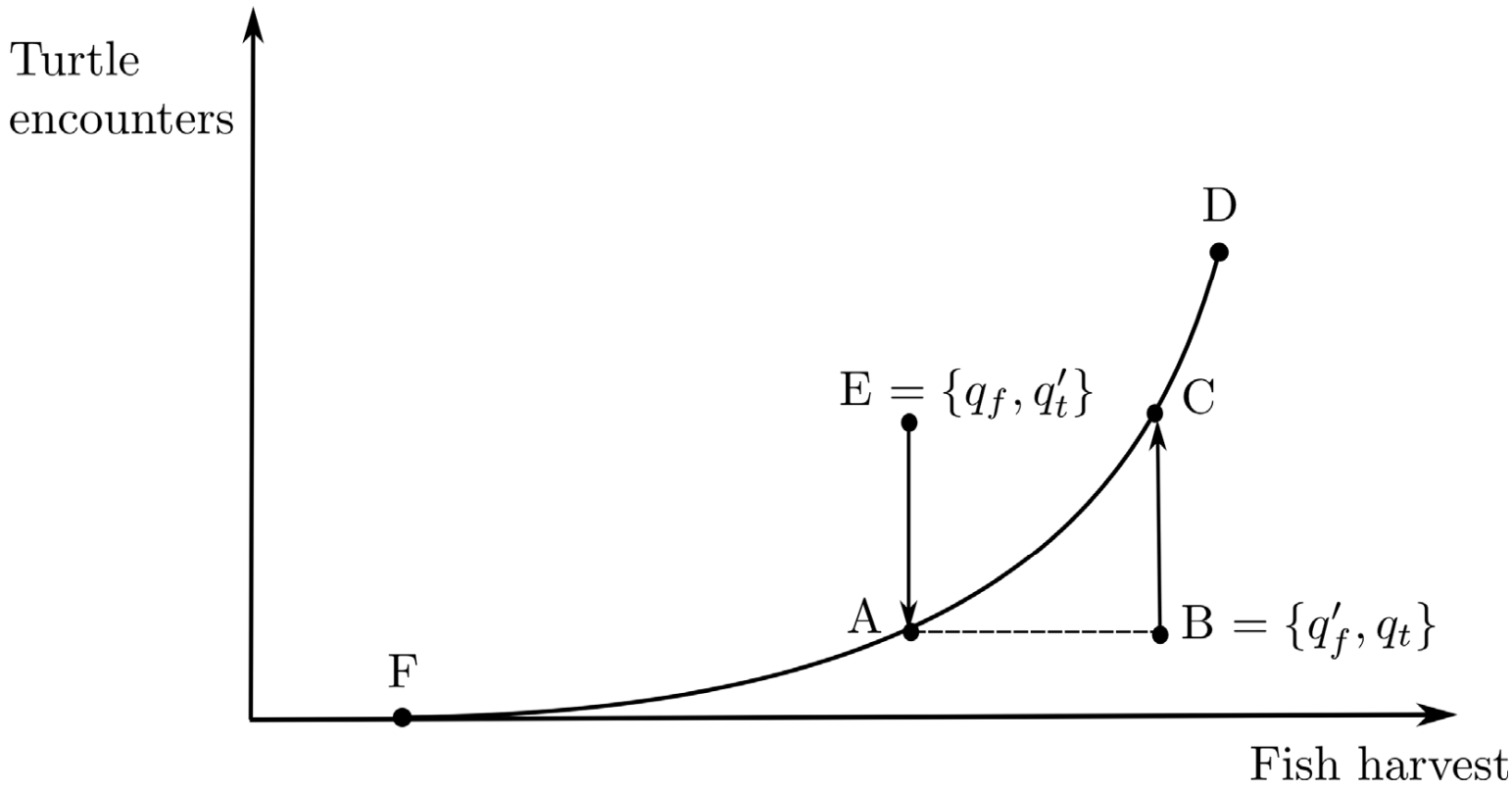
- Two products: marketable fish and non-marketable bycatch (sea turtles)
- Scalar factor input, multi-product, weak output disposability technology
- Unit mass of atomistic, profit maximizing fishermen
- Exogenous aggregate fish quota and turtle cap
- Stock uncertainty as a two stage decision problem:
  - fishermen commit factor input based on expected (uncertain) stock conditions
  - target/bycatch stock mix is realized and fishermen choose a location on the target/bycatch transformation frontier

Target quota and bycatch permit prices, input allocations, bycatch avoidance all endogenous to the model

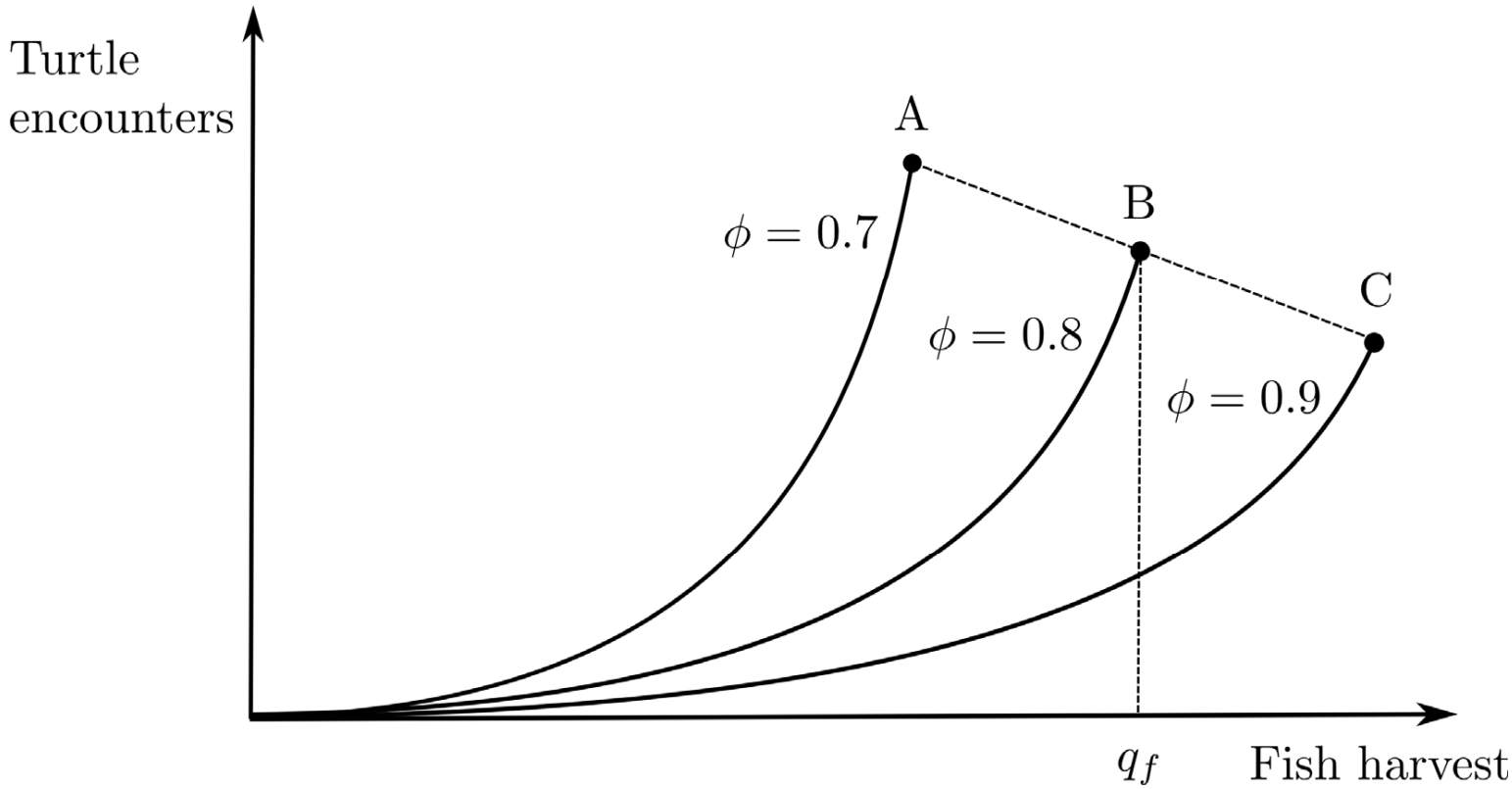
What the model does not have:

- multiple production periods
- purely random bycatch or fish harvest

Technology and operations stage behavior



Stock uncertainty and trade



Results: At-sea behavior unobserved

Turtle bycatch cap-and-trade is irrelevant $\rightarrow$ no efforts to avoid turtles

When fish quota is freely tradeable:

- Fish harvest matches target species quota
- Harvesting operations are efficient (no wasted effort)
- Bycatch is proportional to target quota

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When fish quota is freely tradeable:

- Fish harvest matches target species quota
- Harvesting operations are efficient (no wasted effort)
- Bycatch is proportional to target quota

When fish quota cannot be traded:

- Fish harvest falls below quota
- Excessive effort is allocated
- Turtle bycatch can be smaller

Results: At-sea behavior observed

Bycatch permits are priced $\rightarrow$ fishermen incur costs to avoid turtles

When quota/permits are freely tradeable:

- Turtle avoidance is increasing in turtle permit price, decreasing in net fish price, $p_f - r_f$
- Fishermen who encounter high fish concentration buy quota and sell bycatch permits (and vice versa)
- Fish harvest and bycatch exactly match the manager's target

What does at-sea observability buy?

- Fish quota and turtle permits can be set independently (bycatch is proportional to fish quota without observability)
- Higher fish TAC/bycatch combinations are implementable

Non-quota-based management

Amendment 31 to the GOM reef fish management plan

1. Hook limits
2. Effort reductions for longline gear
3. Area closures

GOM longline reef fish fishery

Longline Gear Effort, Landings and Revenue, 2006-10							
		Effort		Landings ('000 lbs.)		Revenue ('000 $)	
Year	Trips	Vessels	DAS	All Spec.	Red Grp.	All Spec.	Red Grp.
2005	2,028	170	12,908	7,508	3,085	$16,303	$8,974
2006	2,128	145	14,343	7,482	2,991	16,268	9,461
2007	1,362	134	12,068	4,968	1,938	13,835	6,456
2008	1,385	124	12,405	5,338	2,772	15,172	8,473
2009	793	105	7,690	3,214	1,084	8,713	3,242

- Longline effort, landings and revenues declined in 2009 (first full year of Amend. 31 regs.)
- 10% increase in vert. line trips
- Fishery wide landings declined (4.4%), revenue declined (11%)

Cost of Amendment 31

Harvest Costs per landed pound (all reef fish species)								
	Longline Gear				Vertical Line Gear			
	Trips	Ave.	Std. Error	Med.	Trips	Ave.	Std.	Med.
2005	1,495	1.53	0.93	1.23	9,039	2.53	1.52	2.04
2006	1,409	1.74	0.97	1.47	8,570	2.63	1.55	2.14
2007	1,175	1.83	0.97	1.50	6,029	2.68	1.60	2.16
2008	1,209	1.66	1.02	1.33	6,086	2.51	1.51	2.03
2009	689	1.70	1.14	1.36	6,639	2.44	1.44	2.01

- Cost/pound is roughly \$0.70 lower on longline gear boats
- Cost of Amendment 31 roughly \$1.7 million in 2009 alone
- Cost of a cap-and-trade bycatch regulation?
  - on-board observer cost may be \$1.86 million (in 2009)
- Electronic video monitoring
  - fraction of on-board observer cost
  - ancillary management benefits

Conclusions

Present a GE analysis of cap-and-trade bycatch management under uncertainty
Contrasted outcomes with and without quota/permit tradability, at-sea observability

Without at-sea observability of fishing activities:

- Bycatch avoidance efforts will be low (Segerson, 2010)
- Bycatch reduction through costly reduction of target quota
- Trade lowers harvest cost but can increase bycatch

With at-sea observability of fishing activities:

- Bycatch avoidance under positive bycatch permit price
- Trade induces efficient harvest outcomes (observer costs aside)
- Trade enables independent choice of target quota and bycatch cap

Amendment 31 regs. cost $1.7 million in 2009 alone in GOM longline reef fish fishery Cap-and-trade bycatch mgt. should be given serious consideration