Technological Changes and the Impact on Fishing Capacity

– A Case Study of the Hawaii-based Longline Fishery

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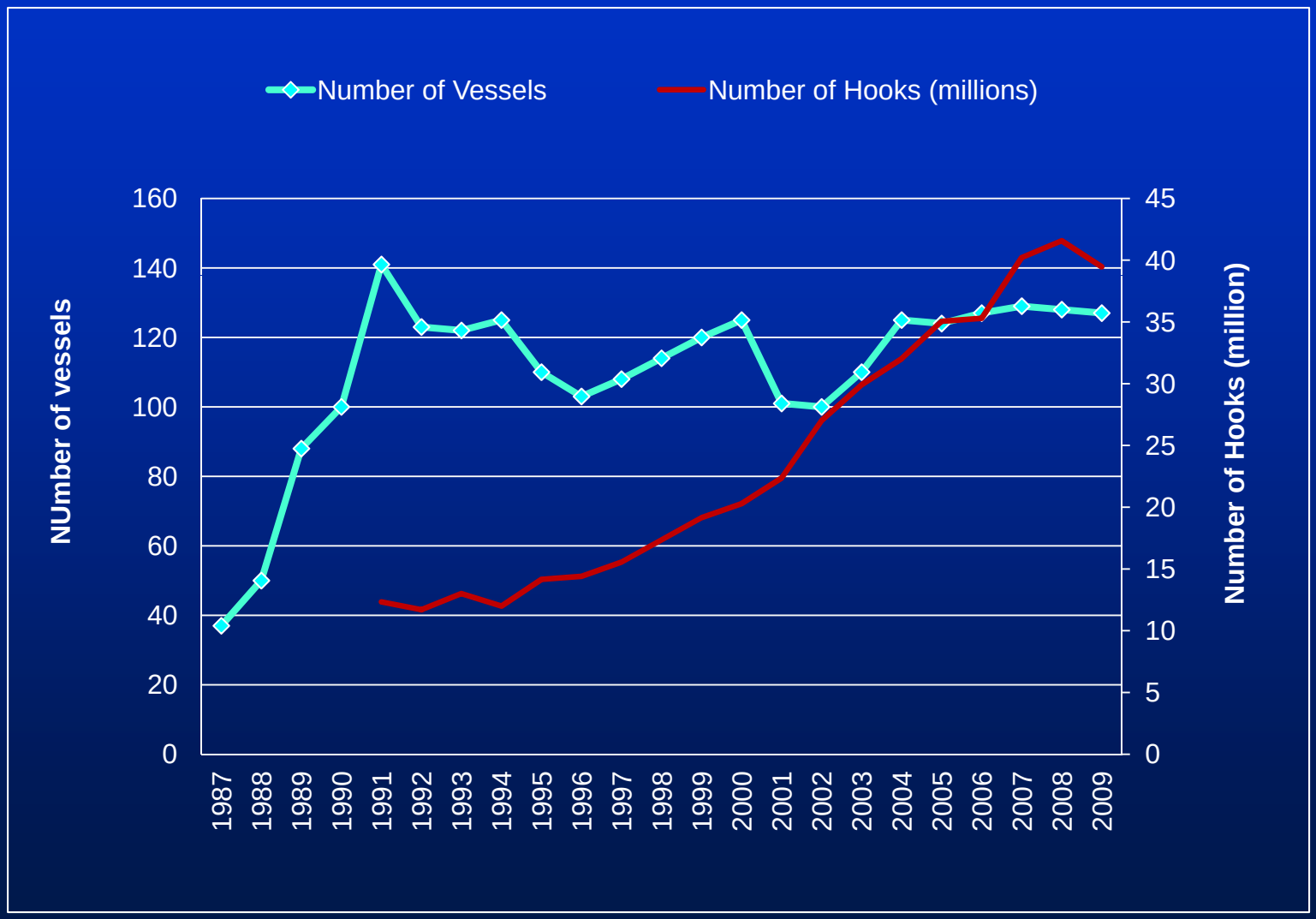
Research Background

- ✓ Nominal measurement of fishing effort: number of vessels, vessel size, fishing days, etc
  - Bias measures on fishing effort/capacity
- ✓ Actual fishing power is enhanced by technology
  - 9% annual increase in the world fishing power by technology (Fitzpatrick 1995)
- ✓ In Hawaii longline fishery
  - Observable changes in technology
  - Increase of fishing effort in the longline fishery, under the limited entry program (limited number of vessels)

No. of Vessel & No. of Hooks of Hawaii Longline Fleet (1987-2009)



Research Objectives

- ✓ To assess current status & trends of fishing technologies in the Hawaii longline fishery
- ✓ To analyze the impact of fishing technological changes on fishing capacity/fishing power
- ✓ To anticipate technological changes in fisheries management

Theoretical Framework

- ✓ A standard production function to example technological changes (Kirkely et. al. 2006)

$$Y = Y\left(X, K, T_E, t_D, S\right)$$

- ✓ Where

  X: vector of inputs (e.g. fishing days)

  K: vector of capital stock (physical and human capital)

  T_E : vector of embodied technological factors (Satellite)

  t_D: disembodied technical change drivers (regulation changes)

  S: environmental conditions (fish stock)

Data Sources

- ✓ Logbook
  - Fishing effort (X) and Landings in vessel level
- ✓ In-person survey
  - Physical capital and human capital stock (K)
    - vessel size (length and width)
    - Vessel speed
    - Captain's fishing experiences & education
    - Crew duration (the longest time stayed with the vessel)
  - New Technological (T_E)
    - GPS, Computer (HiPlot), Satellite, etc.

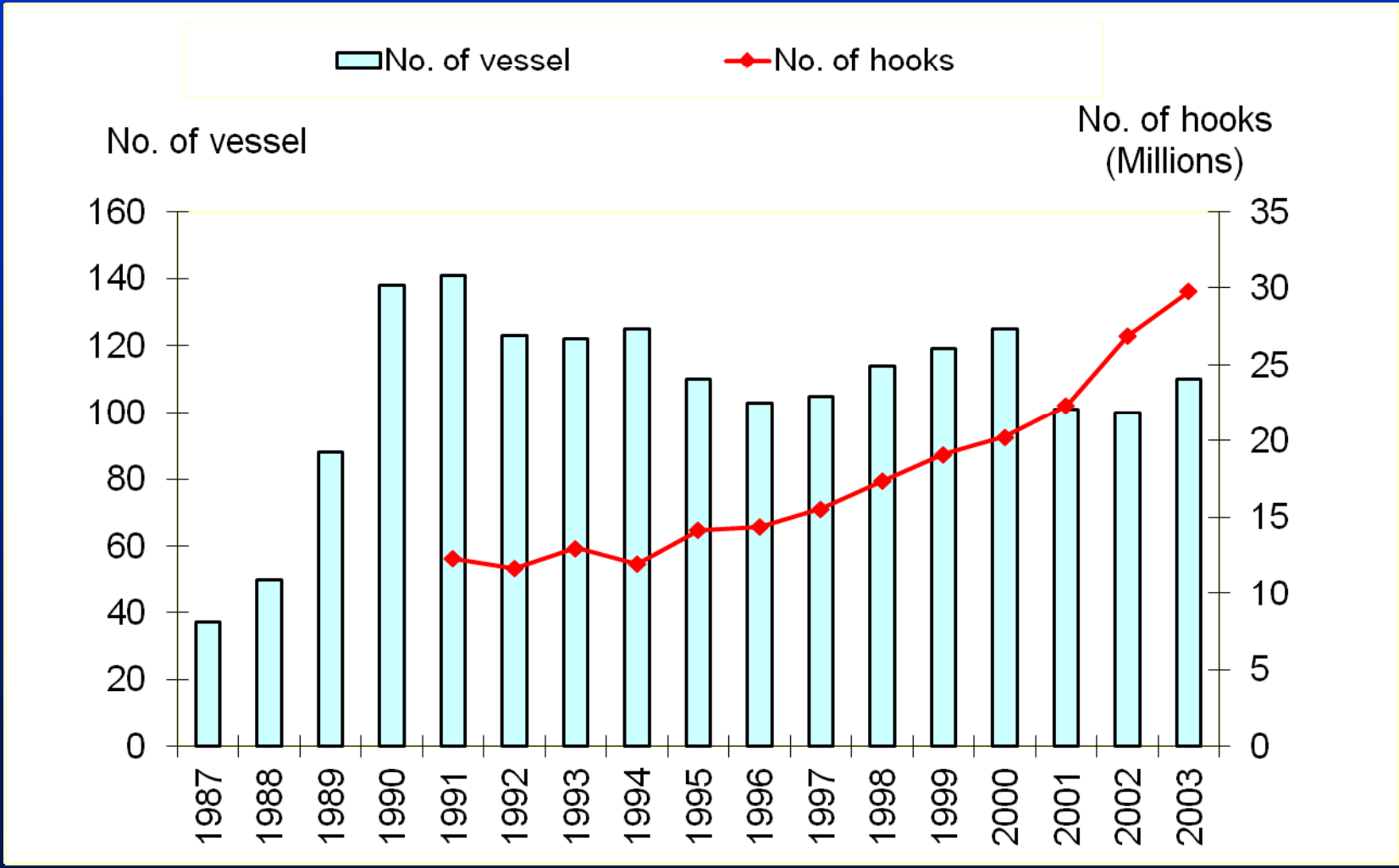
Fieldwork Person-to-person interview 2005

70% vessels surveyed (86/120)

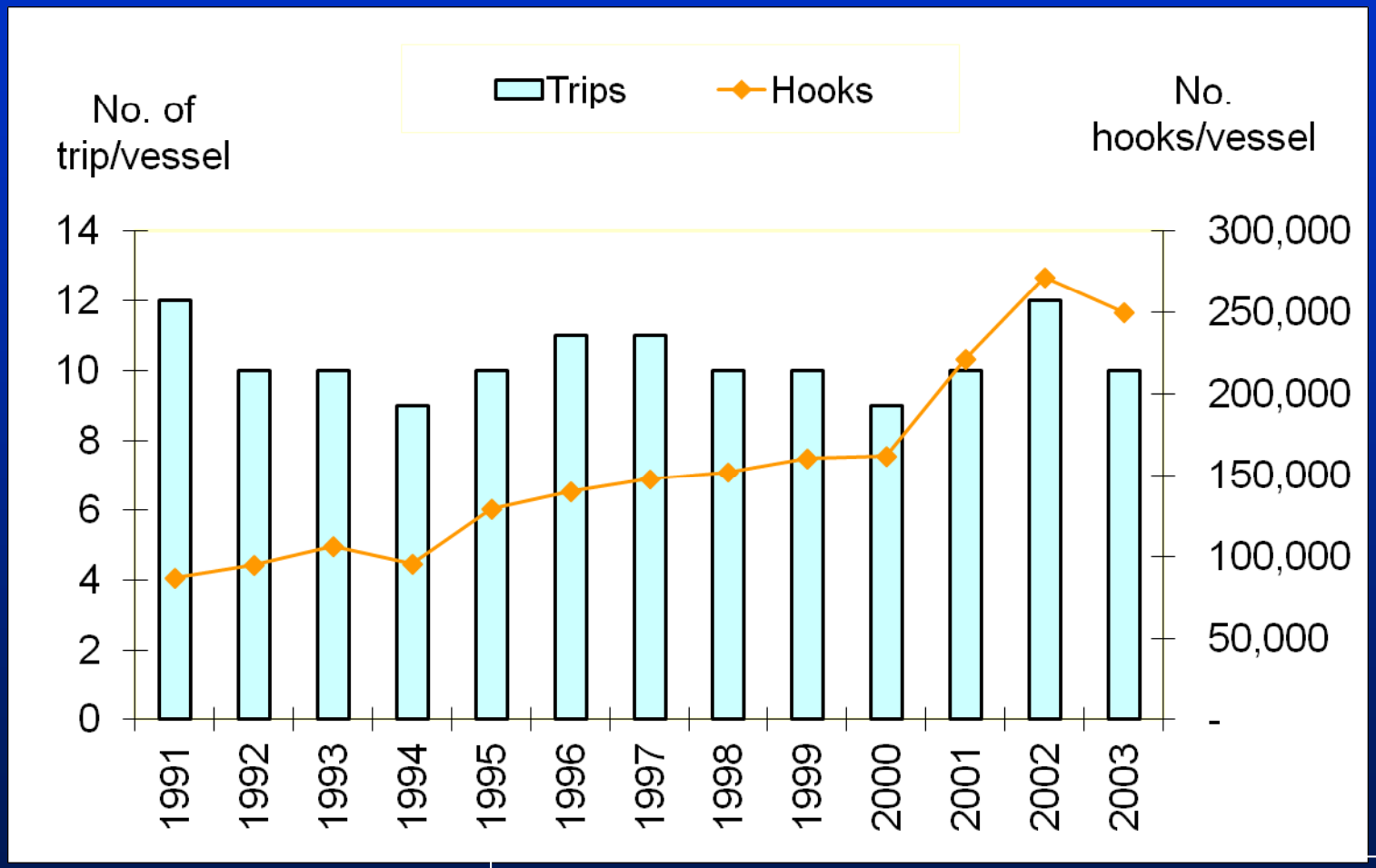
Preliminary Results

- ✓ Trends of technological adoption and the factors that affected technological adoption
- ✓ Impact of technological changes on the fishing effort (increasing hooks)
- ✓ Impact of technological changes on the fishing capacity
  - ➢ Production function

No. of Vessel & No. of Hooks of Hawaii Longline Fleet (1987-2003)

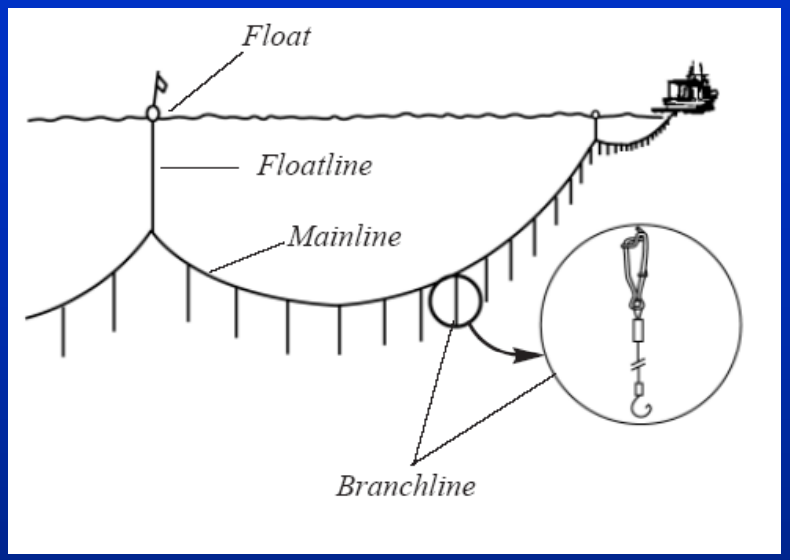


of Hooks and # of Trips per Vessel
(Hawaii Longline, 1991-2003)

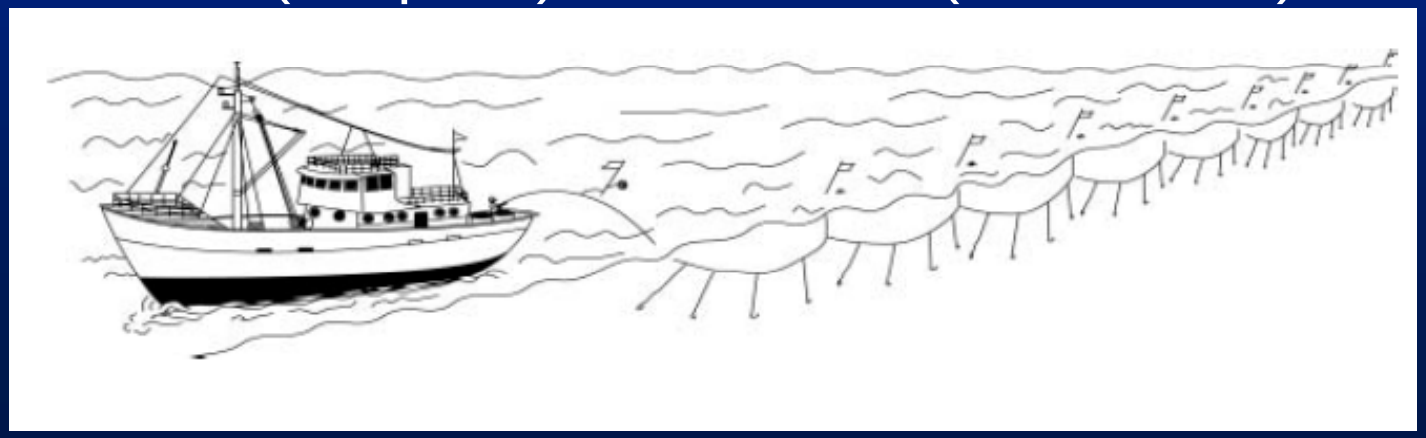


# of trip per vessel stable
# of hooks per vessel increased

Longlining in Hawaii



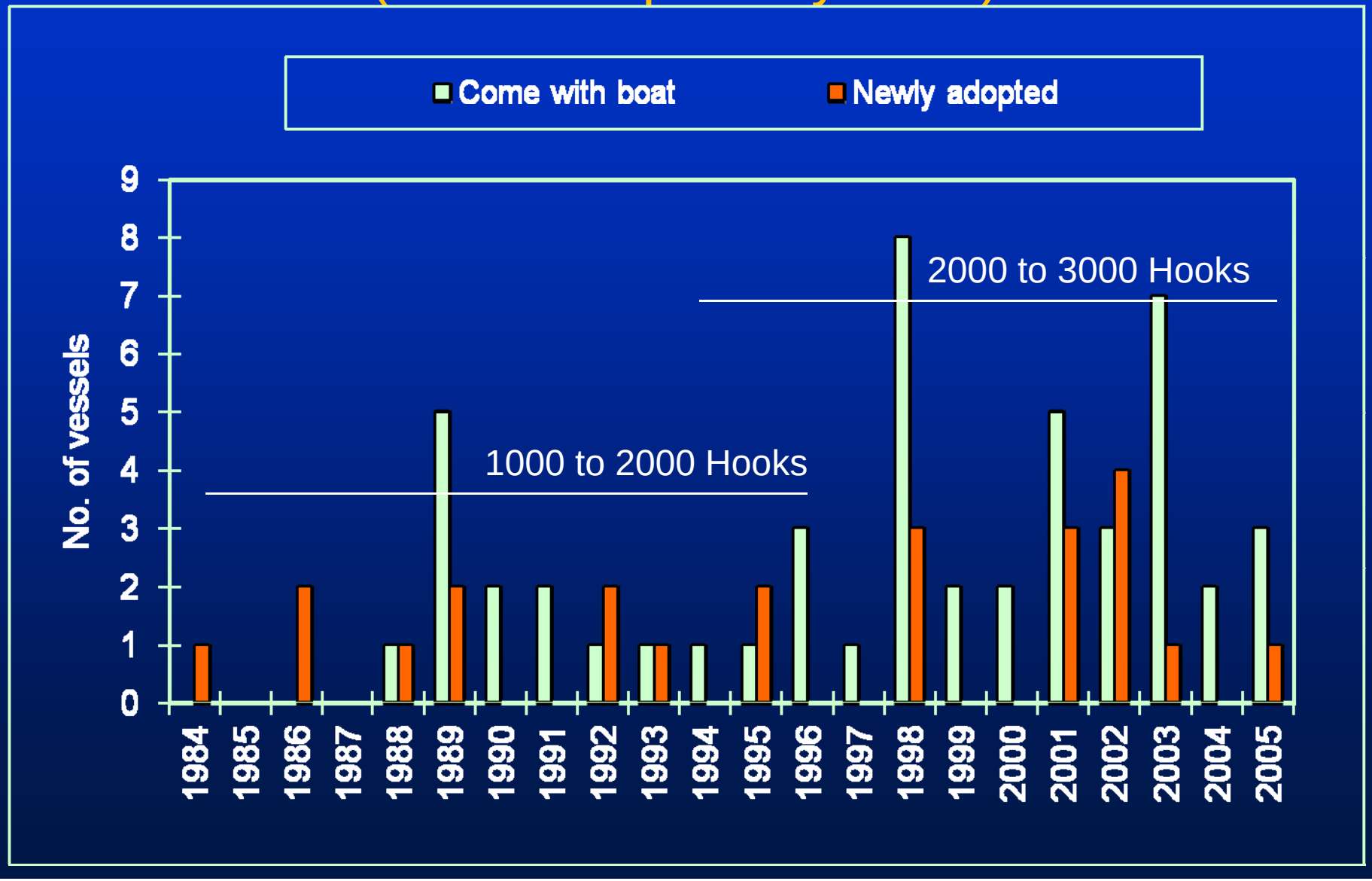
Tuna (deep set) or swordfish (shallow set)



Impacts of Technological Change on Fishing Effort (# of hooks)

- ✓ Traditional basket vs. monofilament gear
  - Thinner but stronger line so hold more hooks per set
    1000 vs. 2000 hooks in 1980-1990
  - Monofilament gear adopted gradually
- ✓ Technological improvement of monofilament gear
  - 2000 vs. 3000 hooks

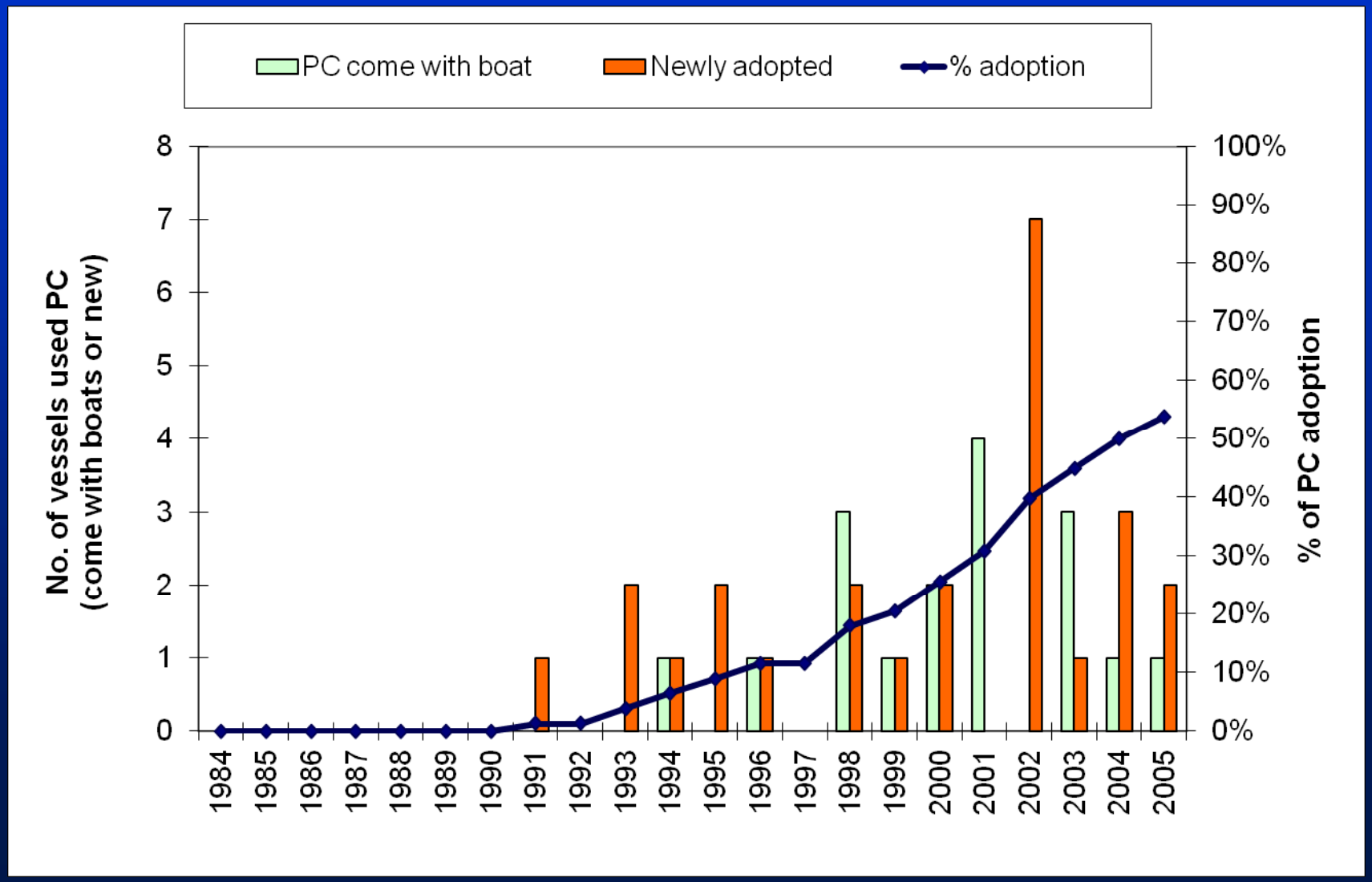
Adoption Schedule for Monofilament Gear
(100% adoption by 2005)



Equipment & New Technology

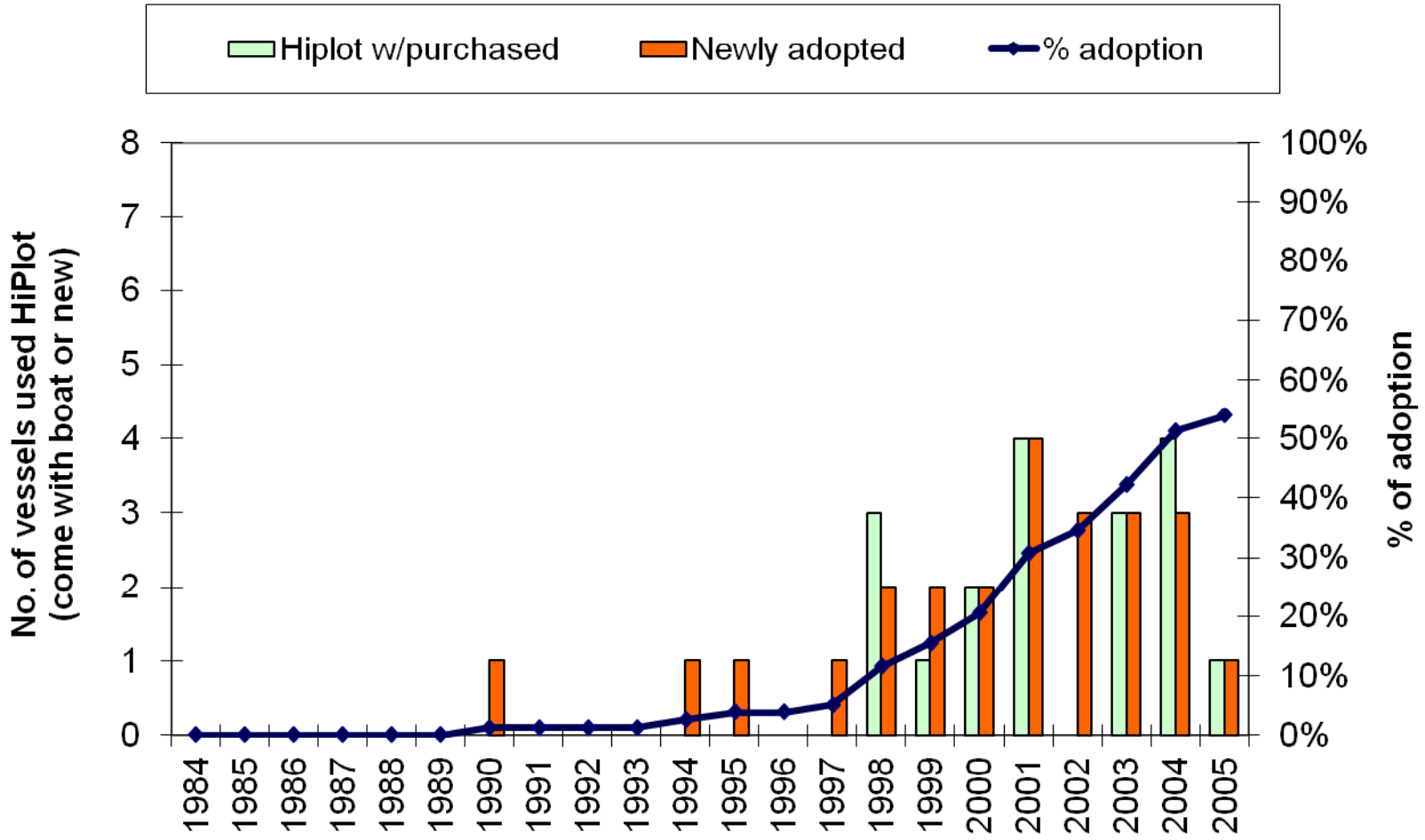
- ✓ Essential equipments
  - GPS
  - Autopilot
  - Single sideband radio
  - VHF radio
  - Direction finder
- ✓ New equipments
  - Hi-plot
  - Satellite Imagery
  - Inmarsat C

Adoption Schedule for PC
(58% adoption by 2005)

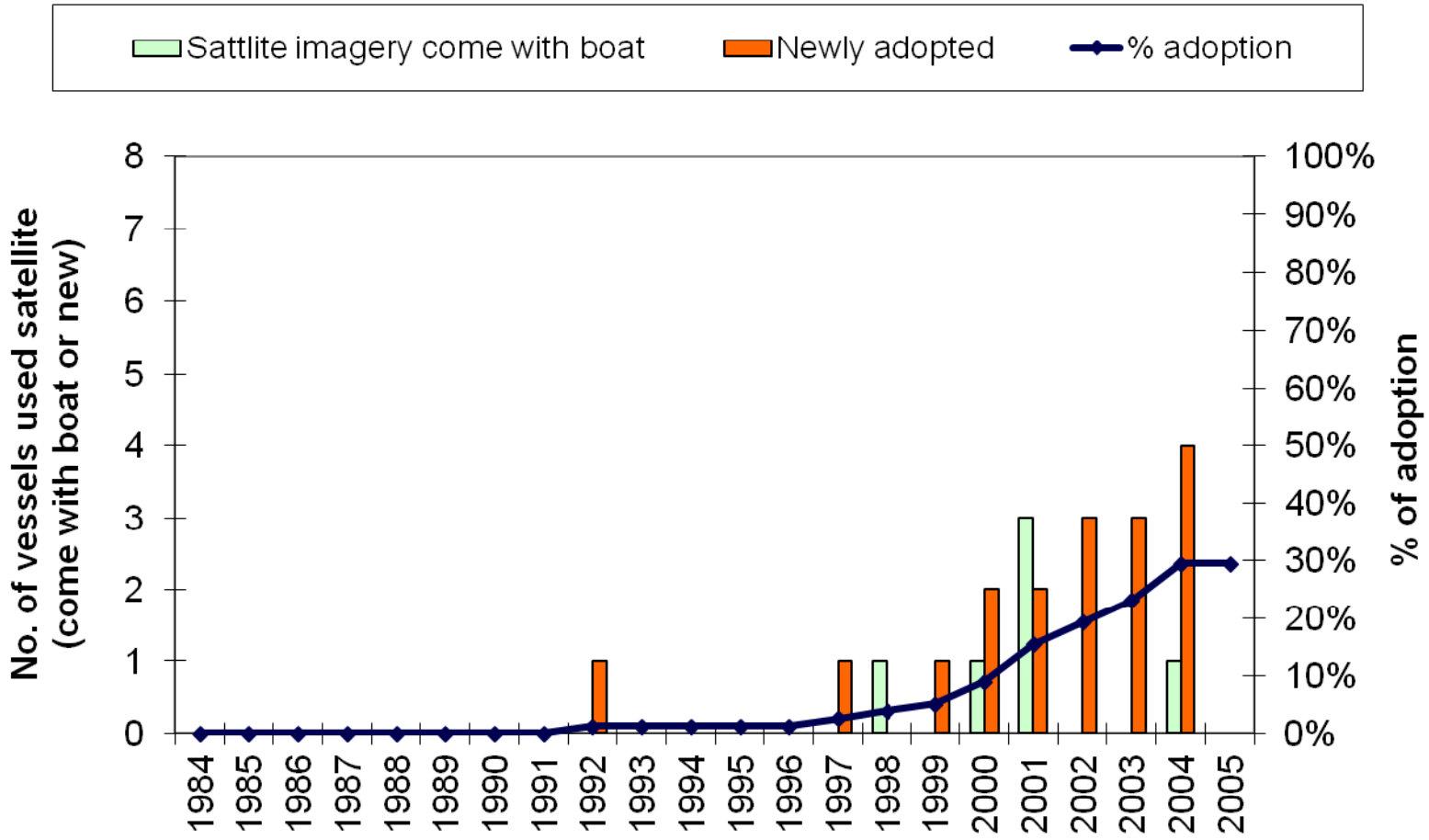


Adoption Schedule for HiPlot (with PC)

(50% adoption by 2005)



Adoption Schedule for Satellite Imagery
(36% adoption by 2005)



Production Function

- ✓ A standard approximation to the production function (a 1st order log-linear Cobb–Douglas function)

$$\ln Y = \eta + \beta \ln X, + \gamma \ln K + \delta T_E + \alpha$$

- ✓ Where

  X: variable inputs (fishing days, # of hooks)

  K: the capital stock (vessel size, speed, experiences)

  T_E : embodied technological factors

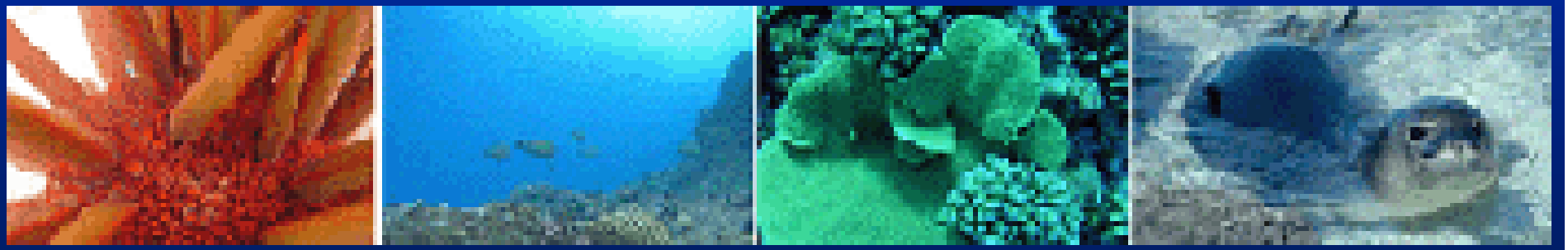
Regression Results

Revenue per trip	Category	Coef.	t-value	
Vessel size (width)	K	0.509	2.82	*
Vessel speed	K	0.788	3.01	*
Captain longline experiences (yrs)	K	0.081	2.46	*
Crew employment duration	K	0.062	2.58	*
Computer/Fishing finding software	TE	0.110	1.70	**
Satellite imagery	TE	-0.063	0.33	
# of hooks per set (per fishing day)	X (TE)	0.631	2.96	*
Fishing days per trip	X	0.414	2.96	*

N= 62, R^2 adjusted = 64%

*5% & **10% significant level

Conclusions and Implications

- ✓ Technological changes have significant impacts on fishing capacity
  - Enhanced fishing capacity (in terms of trip output) through the increase of technical efficiency
  - Enhanced fishing capacity (in terms of trip output) through the increase of fishing effort within the same vessel
- ✓ Capacity control by restricting number of vessels has its limitation

Comments or Questions?