Aquaculture
Overview of Trends and Current Issues

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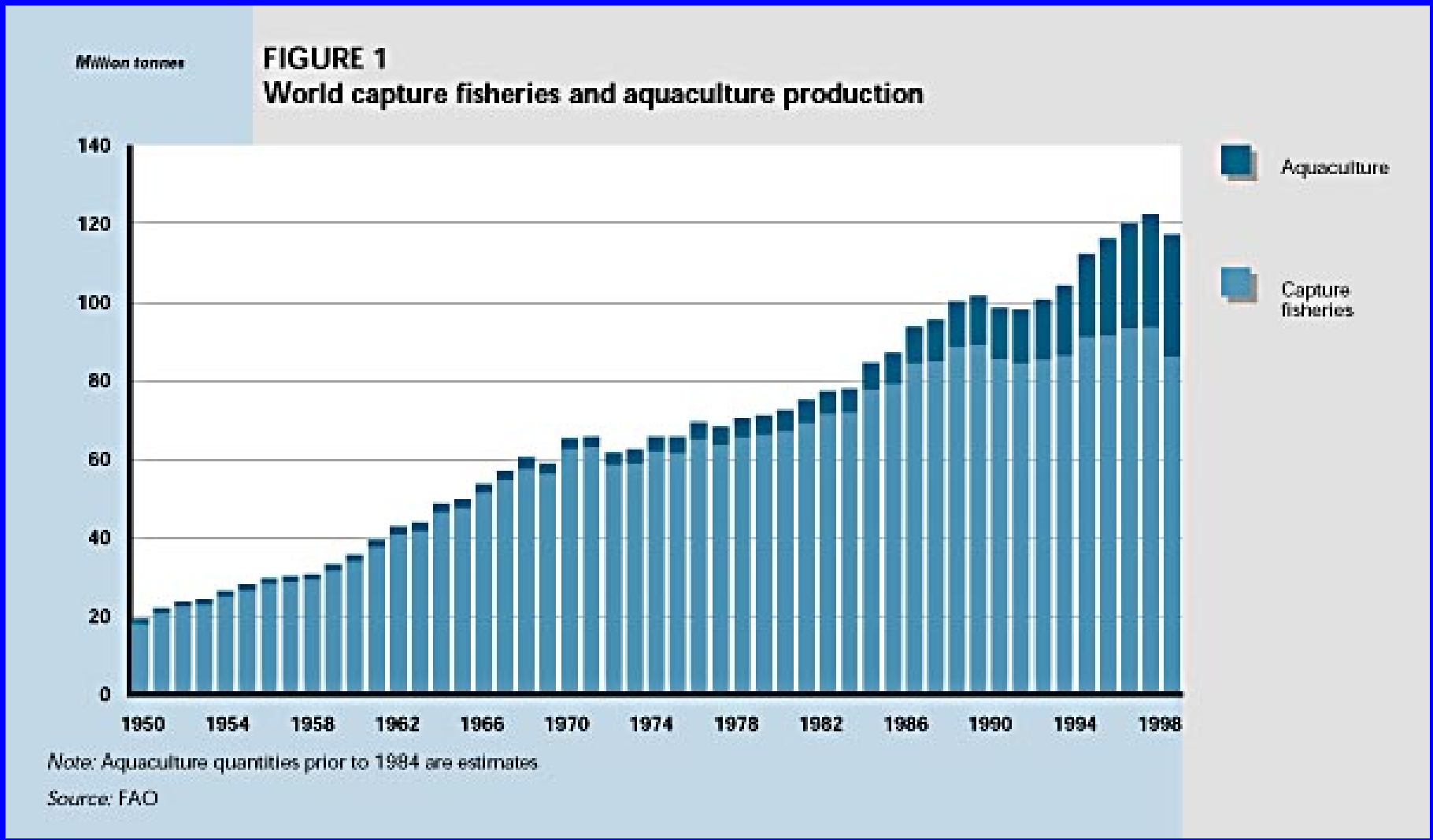
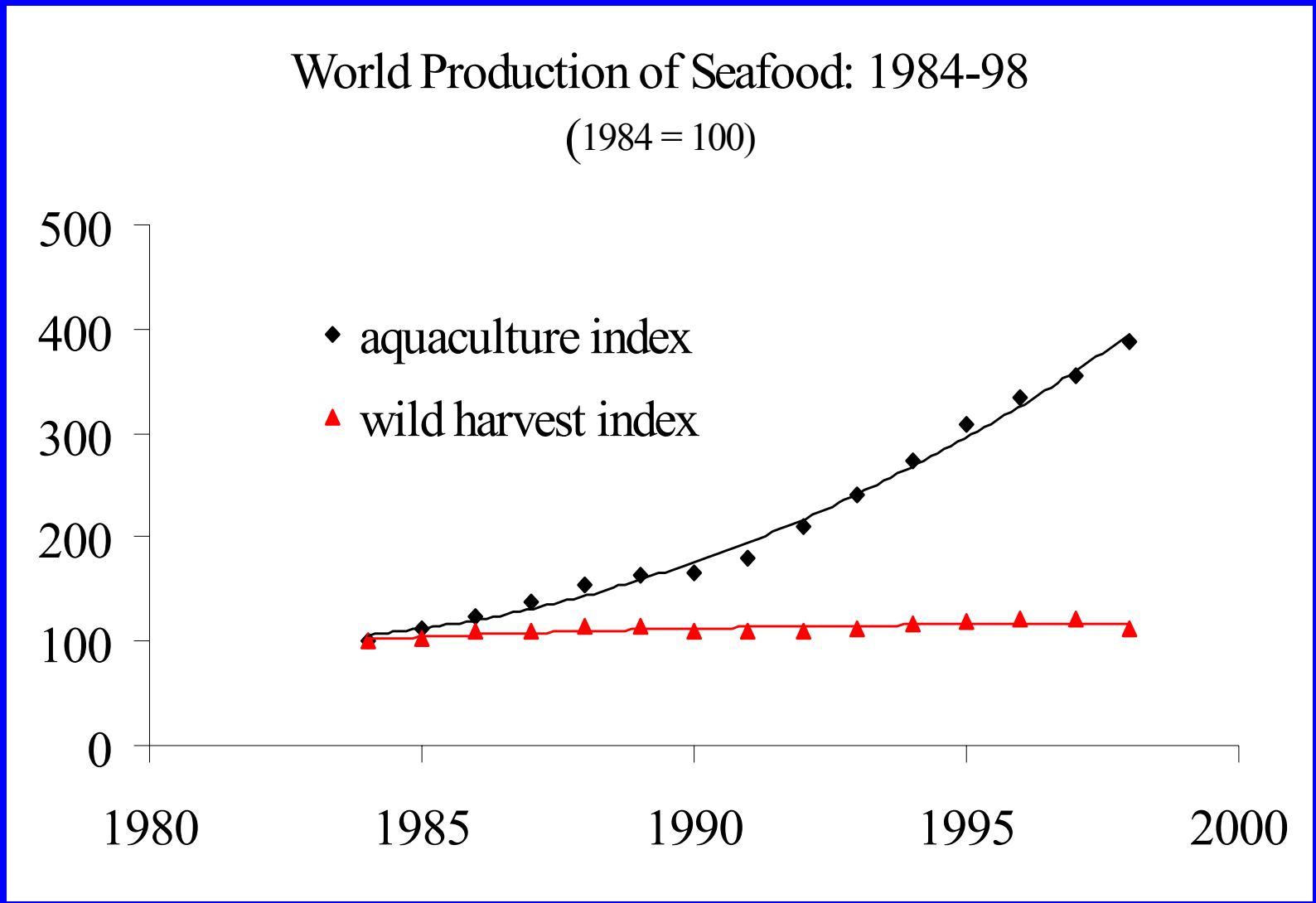
Capture Fisheries – Do they still make sense?

- The concept
- Fisheries management
- Safety

- So: yes, but…

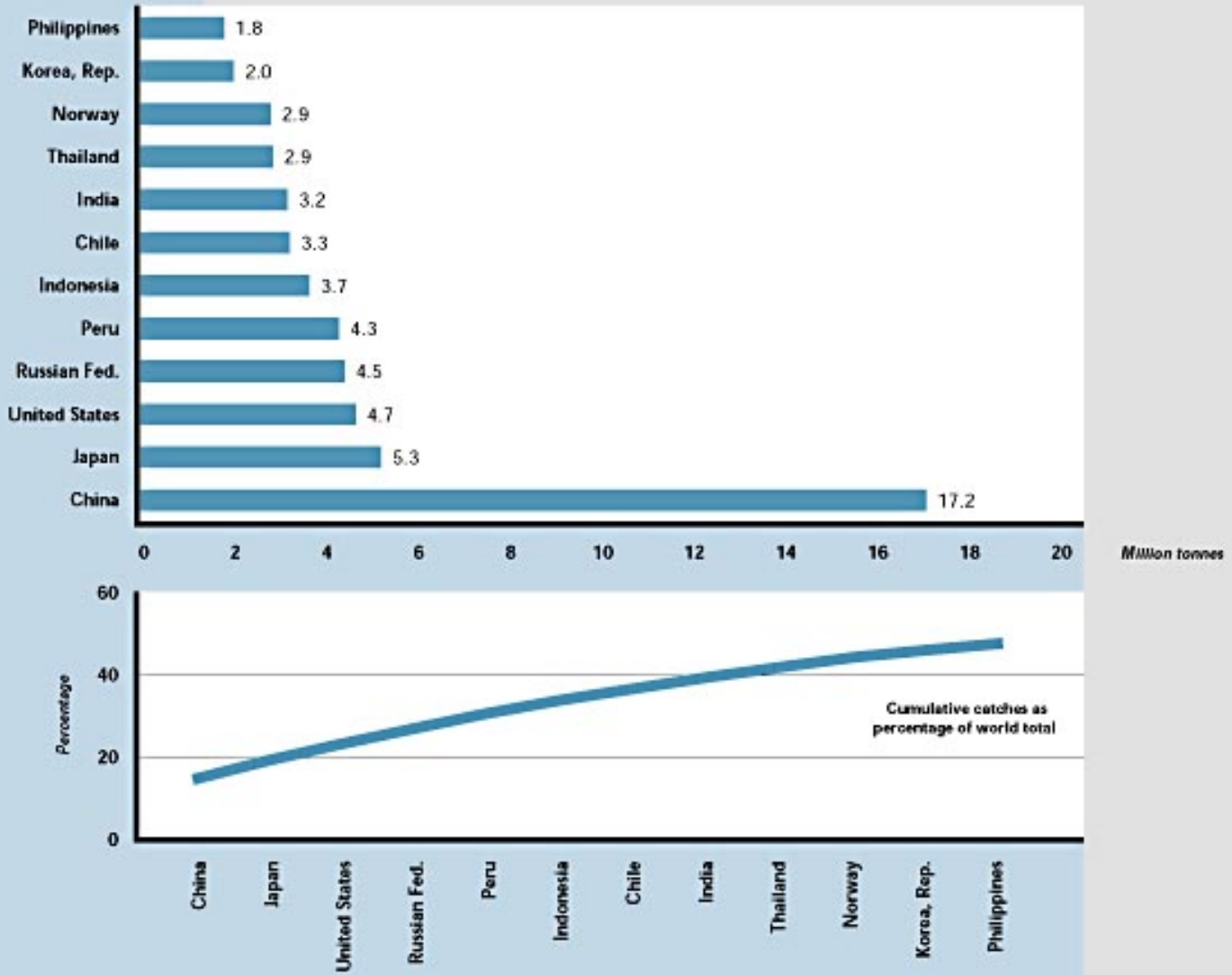

Million tonnes
FIGURE 1
World capture fisheries and aquaculture production
140
120
100
80
60
40
20
0
1950
1954
1958
1962
1966
1970
1974
1978
1982
1986
1990
1994
1998
Aquaculture
Capture fisheries
Note: Aquaculture quantities prior to 1984 are estimates
Source: FAO


World Production of Seafood: 1984-98
(1984 = 100)
500
400
300
200
100
0
aquaculture index
wild harvest index
1980
1985
1990
1995
2000

World Fish Production

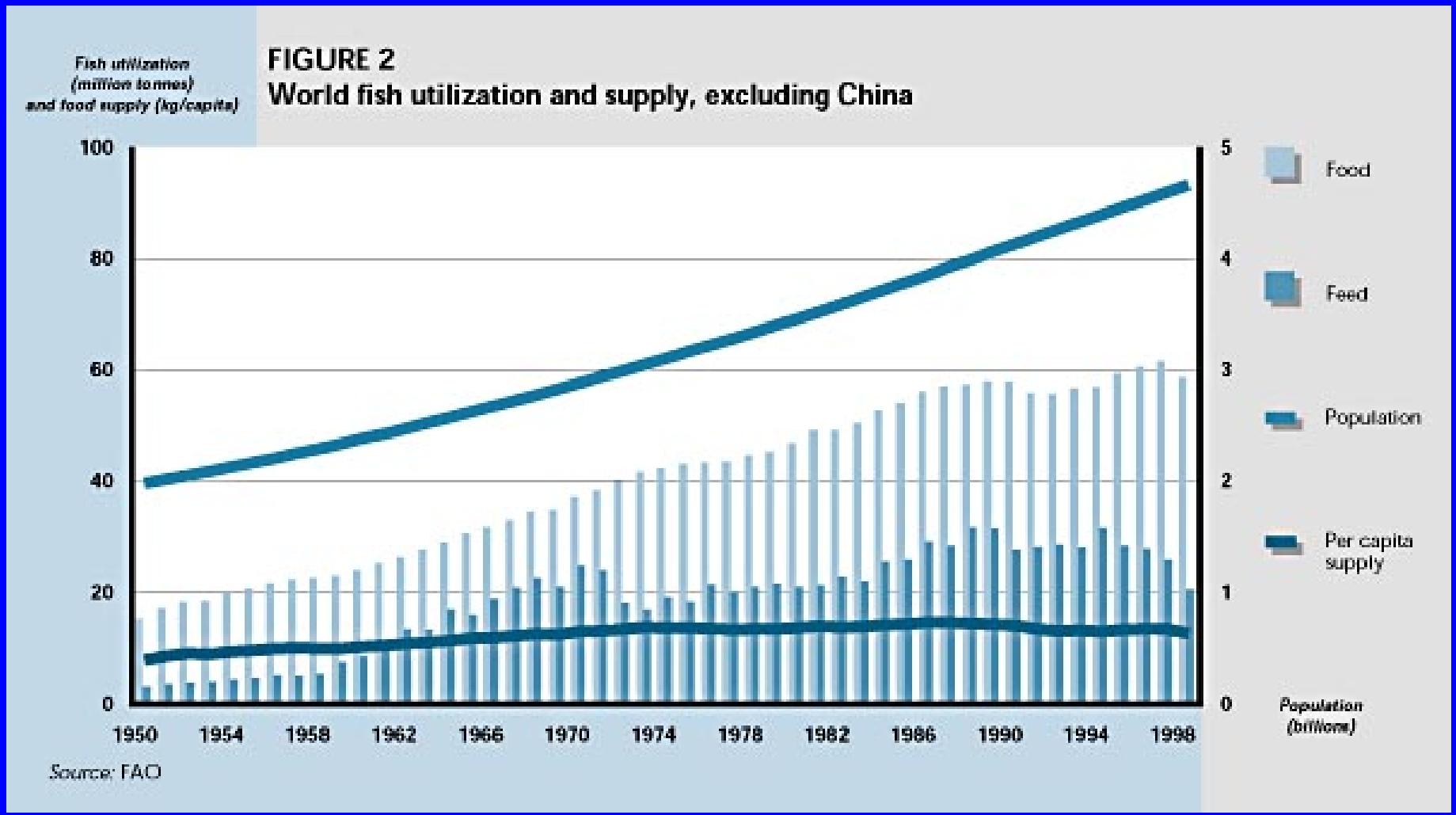
- Capture fisheries
  - 6% growth per year 1950s, 60s
  - 2% growth per year 1970s, 80s
  - No growth in 1990s
  - 80 million tons/year marine, 10 mt fresh water
  - $76 billion
- Aquaculture
  - Dramatic growth in 1980s, 90s
  - 20 million tons/year fresh, 13 mt marine
  - Approx. $50 billion

FIGURE 5
Marine and inland capture fisheries production: top producer countries in 1998



Note: For statistical purposes, data for China do not include Taiwan Province and Hong Kong Special Administrative Region

Source: FAO


Fish utilization (million tonnes) and food supply (kg/capita)
FIGURE 2
World fish utilization and supply, excluding China
100
80
60
40
20
0
5
4
3
2
1
0
1950
1954
1958
1962
1966
1970
1974
1978
1982
1986
1990
1994
1998
Food
Feed
Population
Per capita supply
Population (billions)
Source: FAO

Utilization, 1999

- 93 million tons for human consumption
- 30 million tons for fishmeal and oil
- World per capita food fish supply: 15.4 kg per year
- Animal protein contribution in human diet: 15%

World Aquaculture Today

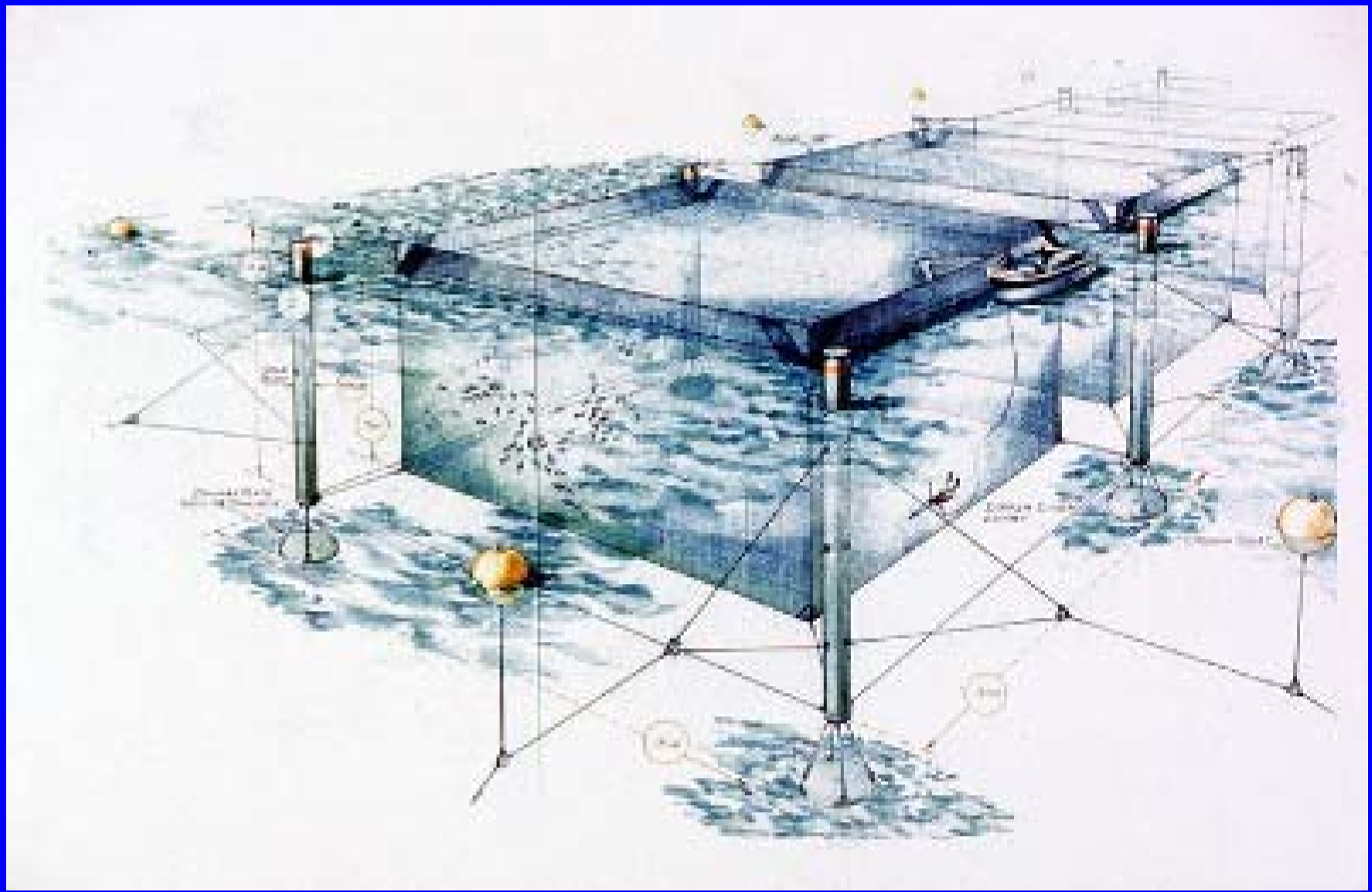
- Freshwater: finfish (carp)
- Brackish water: shrimp (tiger prawn)
- Marine: seaweeds and molluscs (oysters); salmon

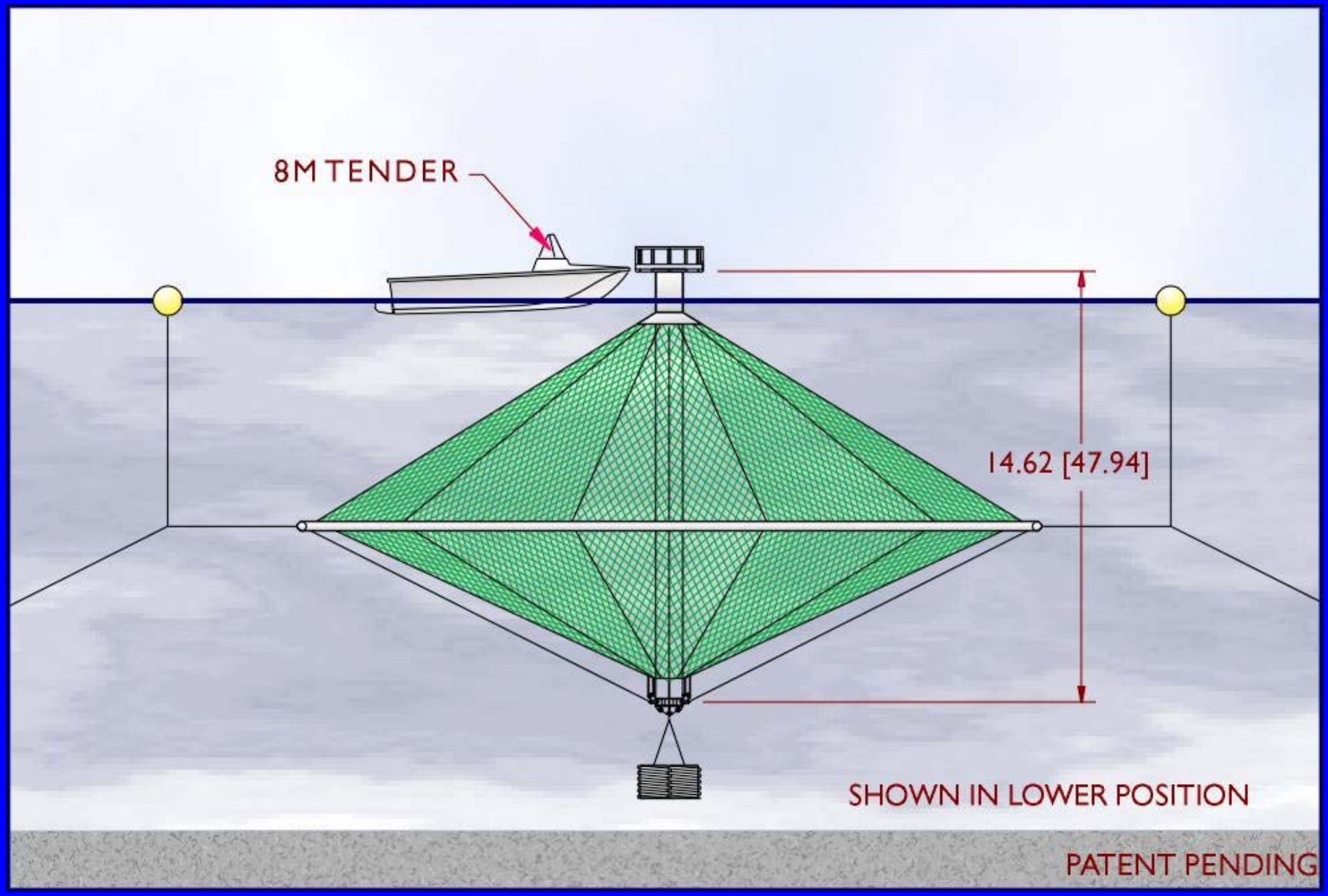
- China accounts for more than half of all aquaculture production

Aquaculture Techniques

- Extensive ponds (carp, tilapia)
- Semi-intensive ponds (shrimp)
- Cage culture (mariculture; salmon)
- Intensive onshore systems (finfish)

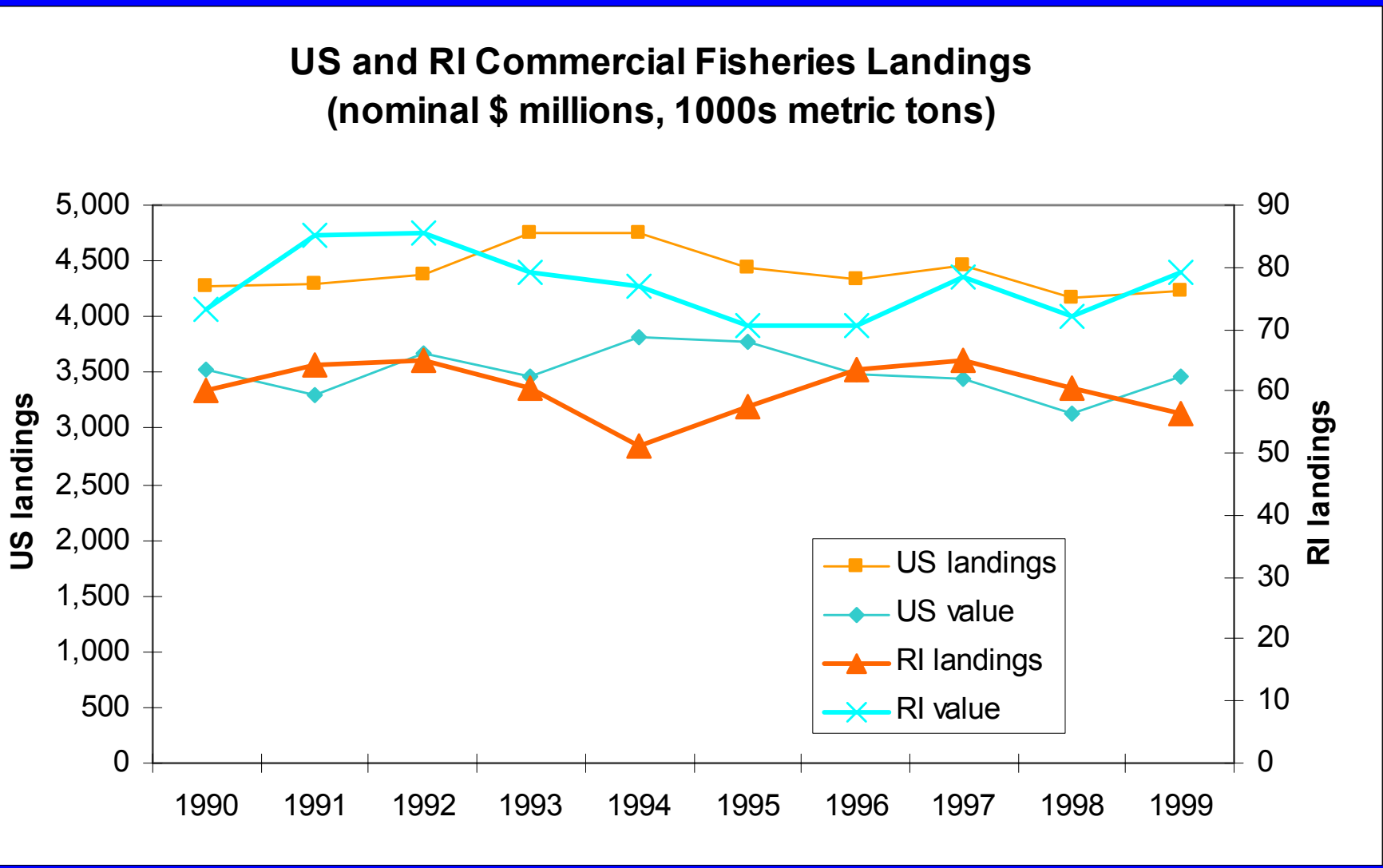
- Others: seaweed, shellfish beds, tuna…

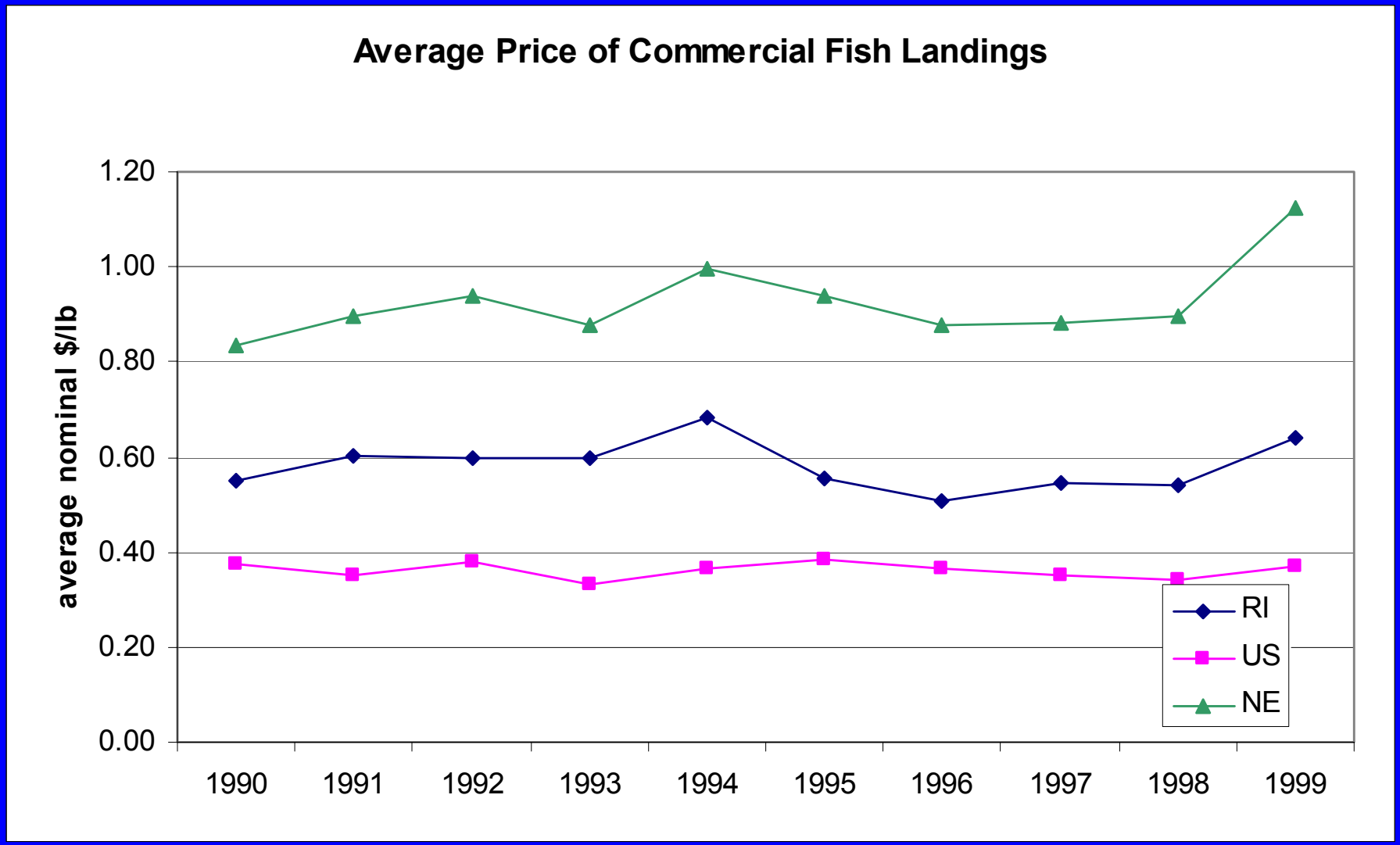



8M TENDER
14.62 [47.94]
SHOWN IN LOWER POSITION
PATENT PENDING

US Aquaculture: Context

- Production less than $1 billion/year
- Marine capture fisheries: $3.5 billion/year; imports are about 50% of consumption
- Recreational fisheries: over $1 billion in expenditures/year in Massachusetts alone
- US aquaculture species: catfish, salmon, oysters, …


US and RI Commercial Fisheries Landings
(nominal $ millions, 1000s metric tons)
US landings
RI landings
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
90
80
70
60
50
40
30
20
10
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
US landings
US value
RI landings
RI value


Average Price of Commercial Fish Landings
average nominal $/lb
1.20
1.00
0.80
0.60
0.40
0.20
0.00
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
RI
US
NE

New England

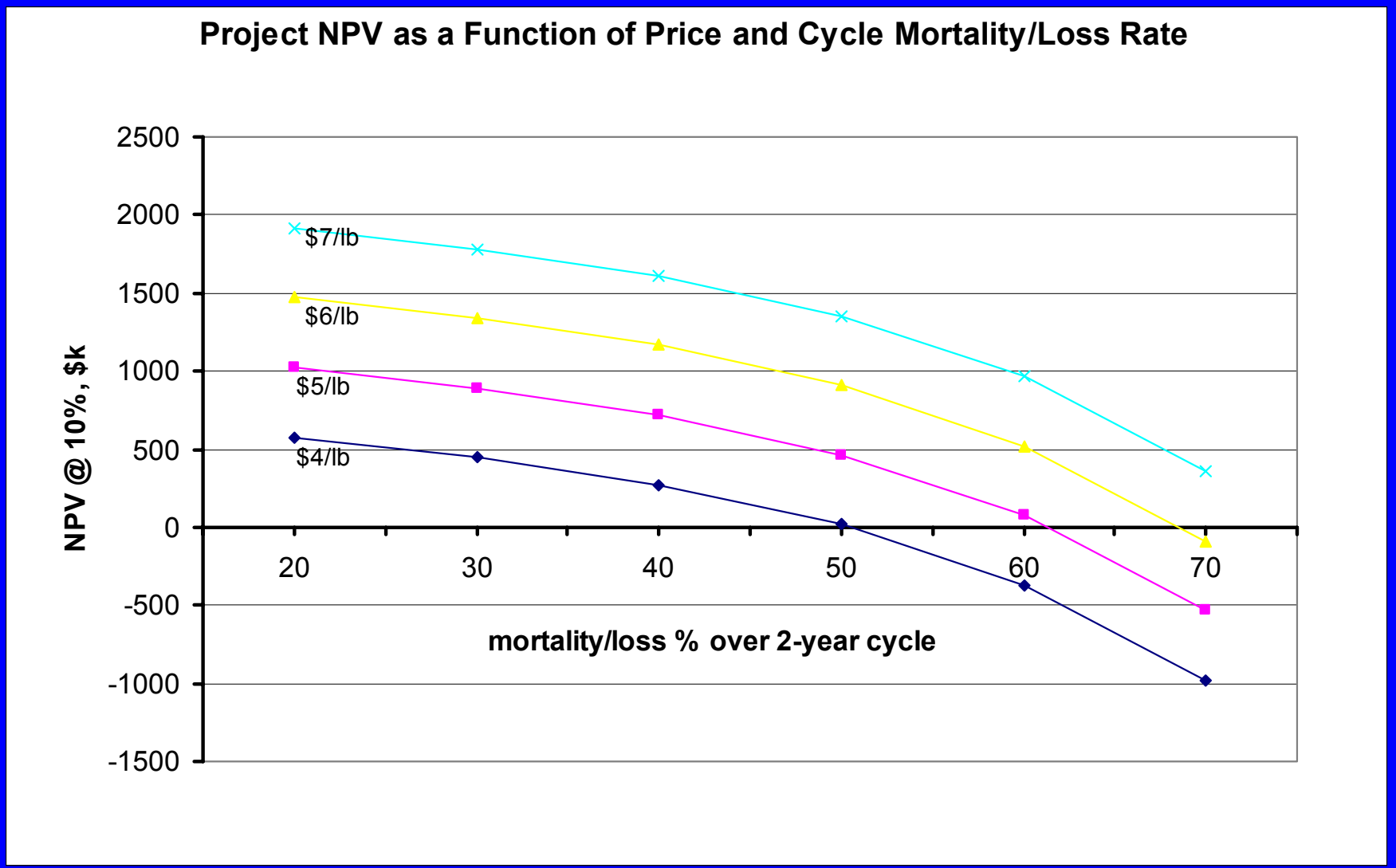
- Gulf of Maine: commercial fish landings $700 million/year; aquaculture $90 million
- Salmon (ME), quahogs and oysters (MA), lots of oysters (CT)
- Challenges to growth:
  - Labor costs
  - Space (MA coastal tourism expenditures: $5 billion/year)

Challenges: US Aquaculture

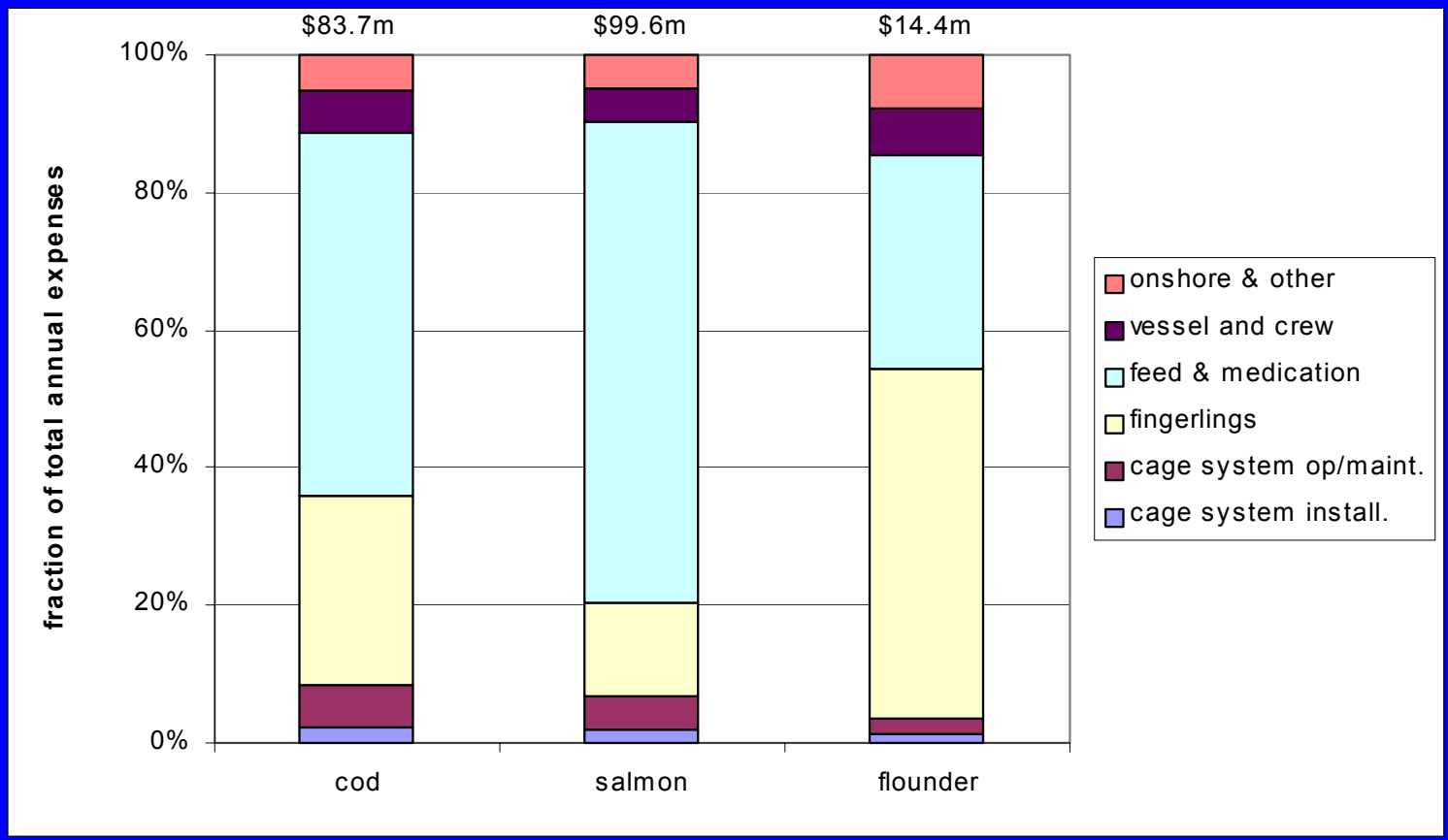
- Onshore intensive systems or open ocean?
- Efficiency through automation
- Species for local fresh markets
- Environmental and ecological issues
  - Nutrient loading (ponds, open water)
  - Genetics
  - Disease management
  - Reproduction

Recent WHOI Work

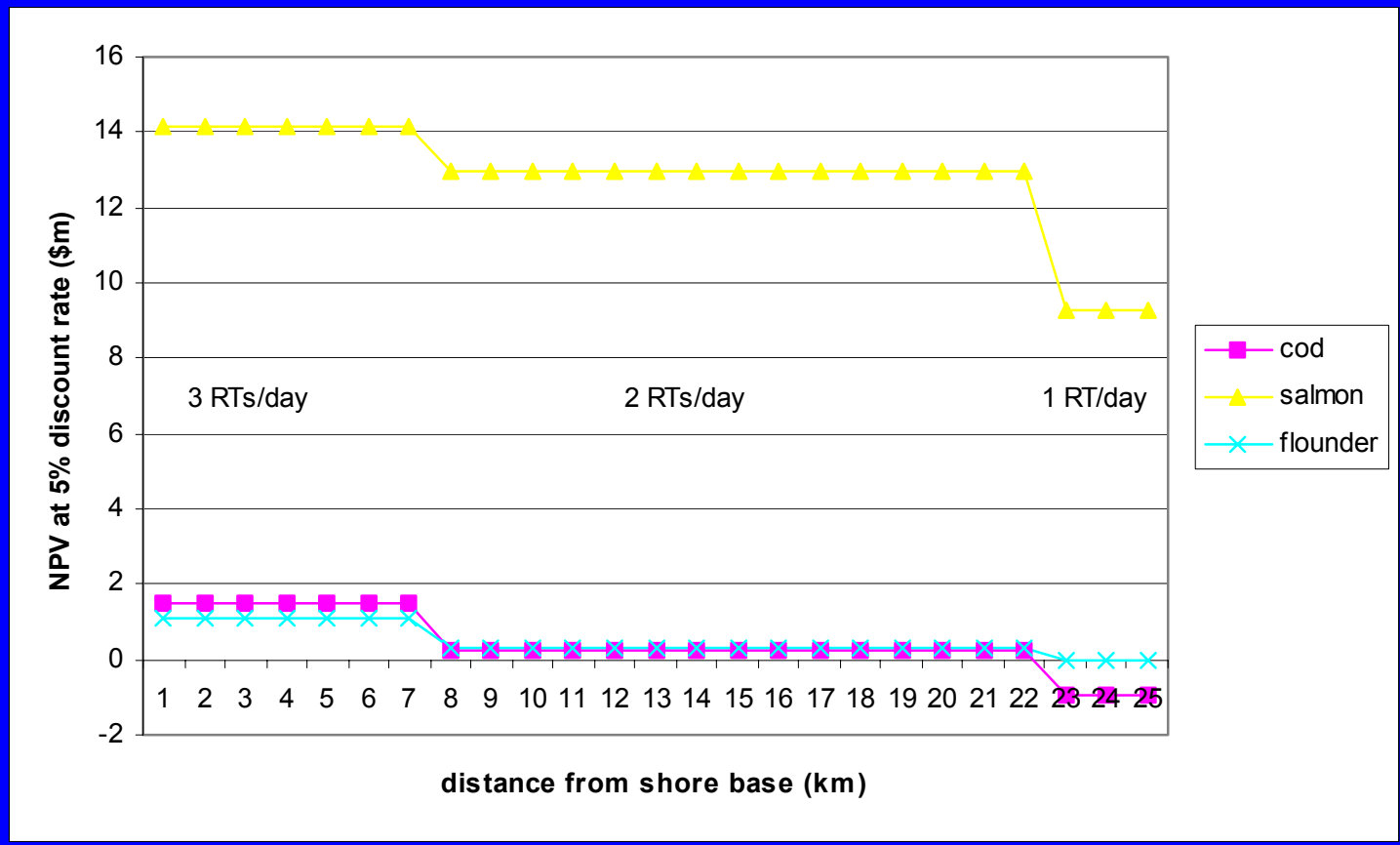
- "access system" for federal waters
  - grants of "tenure" for ocean aquaculture operations
- economics and optimization of open ocean growout of finfish and shellfish
  - blue mussels, scallops
  - cod, flounder, salmon


Project NPV as a Function of Price and Cycle Mortality/Loss Rate
NPV @ 10%, $k
2500
2000
1500
1000
500
0
-500
-1000
-1500
$7/lb
$6/lb
$5/lb
$4/lb
20
30
40
50
60
70
mortality/loss % over 2-year cycle

Cost Components



Effect on NPV of Distance from Shore Base



Polyculture

- Utilize waste, excess nutrients
- Finfish -> shellfish -> algae
- Both high intensity tank systems and low intensity ponds

Detour: 3rd World

- Similar problems, but a very different context
- Seafood protein is more important – few substitutes available
- Severe overfishing
- Limited infrastructure and economic resources

Africa


North Atlantic Ocean
South Atlantic Ocean
Indian Ocean
Indian Ocean
Mediterranean Sea
Arabian Sea
Tropic of Cancer
Tropic of Capricorn
Equator
Gulf of Guinea
Mozambique Channel
Street of Gibraltar
RUSSIA
KAZAKHSTAN
BELARUS
UKRAINE
POLAND
GERMANY
FRANCE
SPAIN
PORTUGAL
ITALY
GREECE
TURKEY
CYPRUS
IRAQ
IRAN
SYRIA
LEB.
ISRAEL
JORDAN
KUWAIT
SAUDI ARABIA
QATAR
U.A.E.
OMAN
YEMEN
EGYPT
LIBYA
ALGERIA
TUNISIA
MOROCCO
MAURITANIA
MALI
NIGER
CHAD
SUDAN
ERITREA
ETHIOPIA
SOMALIA
DJIBOUTI
SENEGAL
THE GAMBIA
GUINEA-BISSAU
GUINEA
SIERRA LEONE
LIBERIA
CÔTE D'IVOIRE
BURKINA FASO
GHANA
TOGO
BENIN
NIGERIA
CAMEROON
CENTRAL AFRICAN REPUBLIC
EQUATORIAL GUINEA
GABON
REP. OF THE CONGO
DEM. REP. OF THE CONGO
RWANDA
BURUNDI
UGANDA
KENYA
TANZANIA
SEYCHELLES
ANGOLA
ZAMBIA
MALAWI
MOZAMBIQUE
ZIMBABWE
BOTSWANA
NAMIBIA
SOUTH AFRICA
SWAZILAND
LESOTHO
MADAGASCAR
Scale 1:51,400,000
Azimuthal Equal-Area Projection
0 800 Kilometers
0 800 Miles
Boundary representation is not necessarily authoritative.

Zanzibar Background

- Importance of seafood to diet
- Fisheries in decline
- Sensitivity to environmental degradation (tourism potential)
- Seaweed farming
- Little technological infrastructure

Wrapping Up

- Aquaculture is the future of seafood production
- Room for growth is US; economic constraints
- Environmental and ecological challenges

- Think about where your seafood comes from