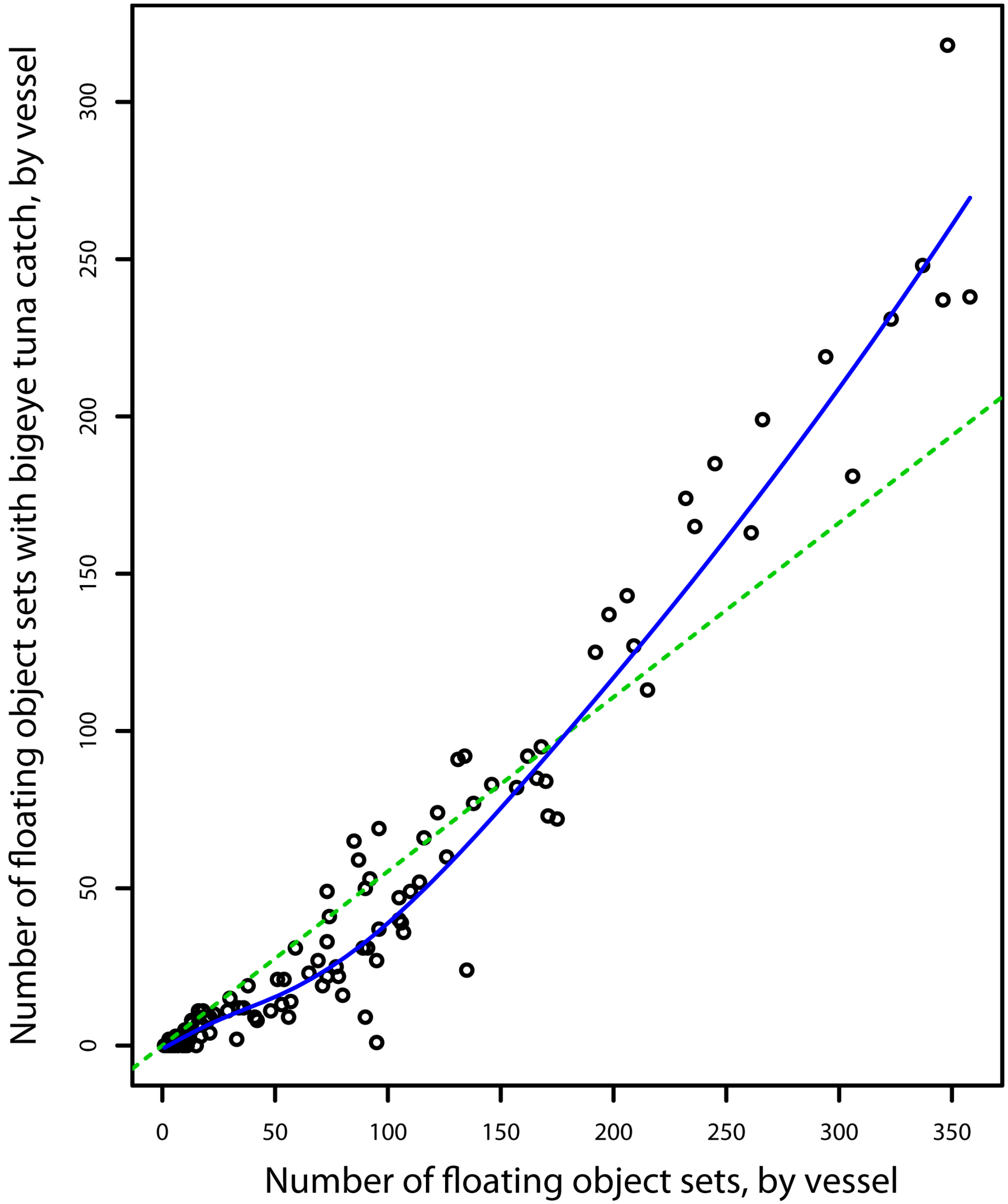
An analysis of gear effects on the presence of bigeye tuna catches in floating object sets

(SAR-8-09c)

Objectives of analysis

To determine:

- how well we can predict the presence of bigeye tuna catch from data on environmental conditions, fishing operations and gear characteristics;
- the importance and structure of gear effects;
- if there exist additional 'vessel effects.'



Number of floating object sets with bigeye tuna catch, by vessel
0
50
100
150
200
250
300
0
50
100
150
200
250
300
350
Number of floating object sets, by vessel

Analytical approach

- How well can we predict the presence of bigeye catch from data on environmental conditions, fishing operations and gear characteristics?
  - build classification algorithm on subset of data
  - compute misclassification error

- What is the importance and structure of gear effects?
  - compute the utility of each variable for predicting the occurrence of bigeye catch
  - estimate the relationship between the probability of catching bigeye tuna and gear characteristics, accounting for the average effects of other predictors

Analytical approach

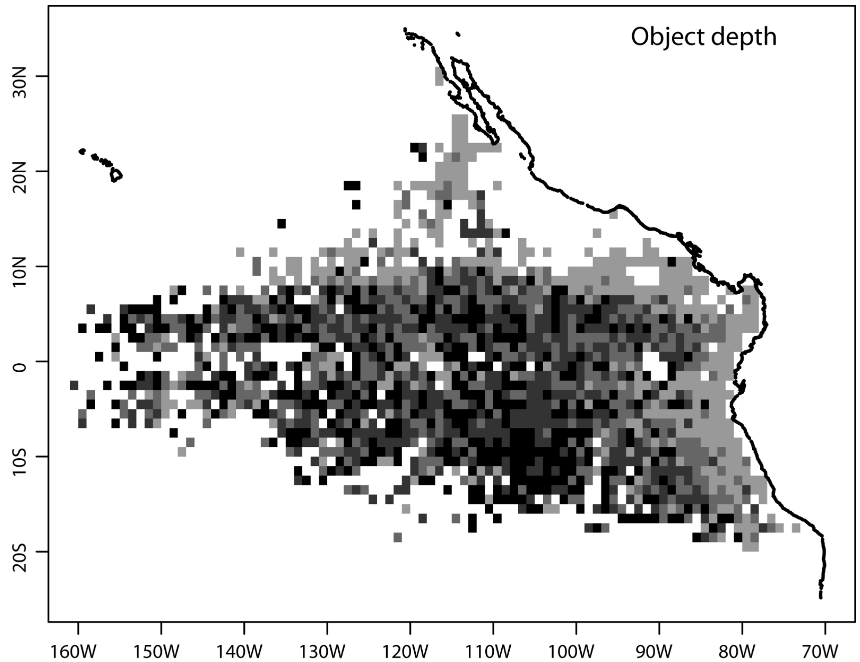
- Do there exist additional ‘vessel effects’?
  - apply classification algorithm to test data and identify sets where bigeye was caught, but none was predicted
  - group sets catching bigeye by vessel
  - compute the probability for each vessel of obtaining *r* or more misclassified sets out of *n* sets catching bigeye tuna (based on binomial distribution)

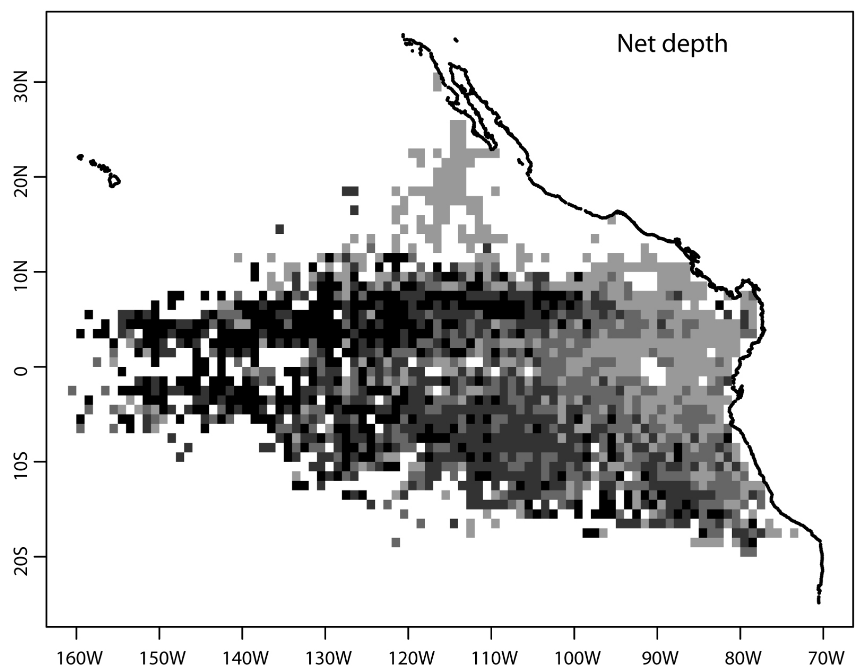
Gear/operational predictors

Vessel capacity (median: 1,089mt; range: 397-2,833mt)
Hanging depth of purse-seine net (median: 120f; range: 72-180f) ('net depth')
Purse-seine mesh size (median: 4.25in; range: 3.5-12.0in)
Presence of dolphin safety panel (~55% of sets)
Maximum object depth below surface (median: 18.1m; range: 0.01-130m) ('object depth')
Percent object covered with fouling organisms (median: 40%; range: 0-100%)
Start time of the set (median: ~06:40; range: 04:45 –19:00)

Environmental/other predictors

Sea surface temperature (SST)
Probability of SST fronts
Mixed layer depth (MLD)
Bathymetry
Presence strong currents
Sea surface height anomaly (SSH)
Slope of SSH
Chlorophyll-a density
Location (latitude, longitude)
Month, Year
Proxy for the size of non-tuna community at the object
Proxy for local object density


Object depth
30N
20N
10N
0
10S
20S
160W
150W
140W
130W
120W
110W
100W
90W
80W
70W


Net depth
30N
20N
10N
0
10S
20S
160W
150W
140W
130W
120W
110W
100W
90W
80W
70W

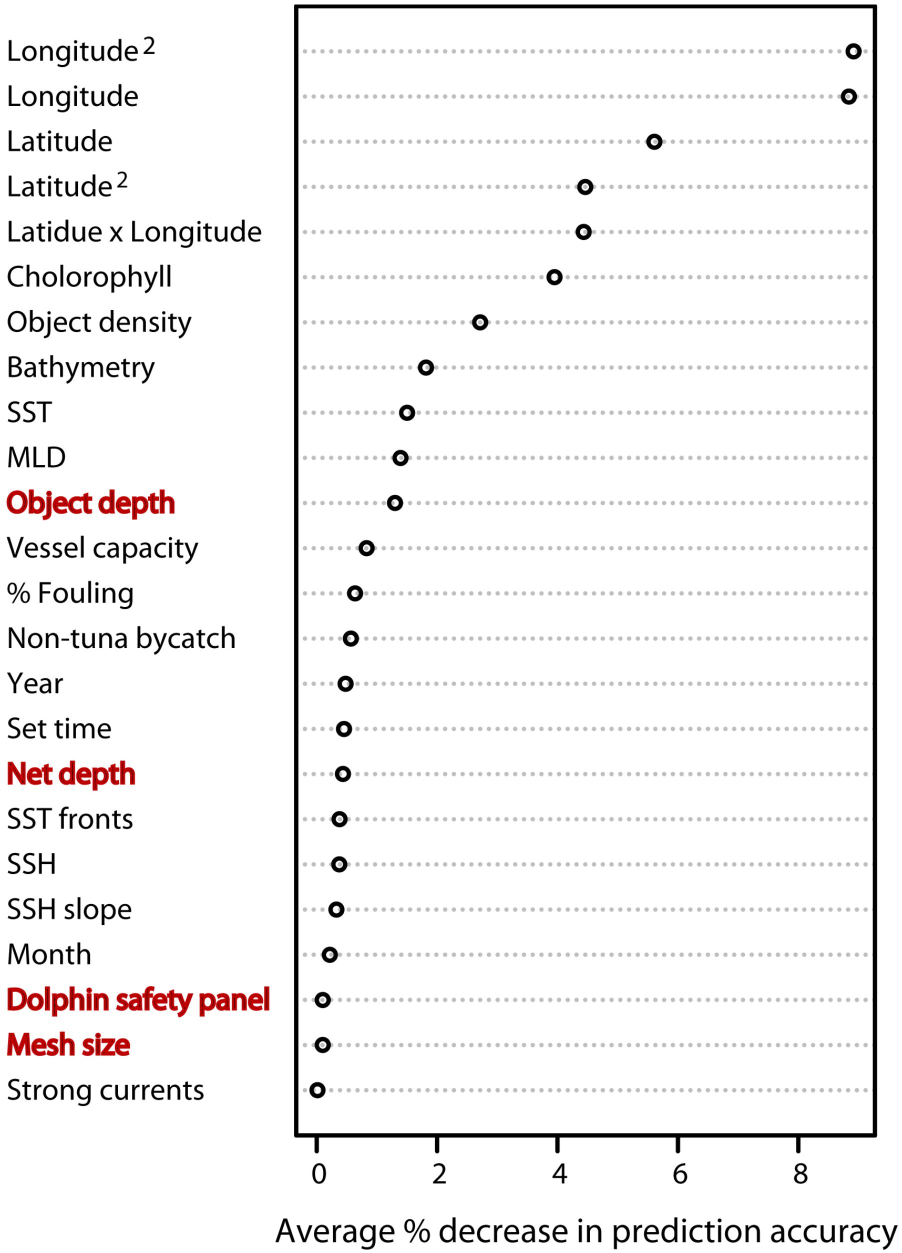
Data

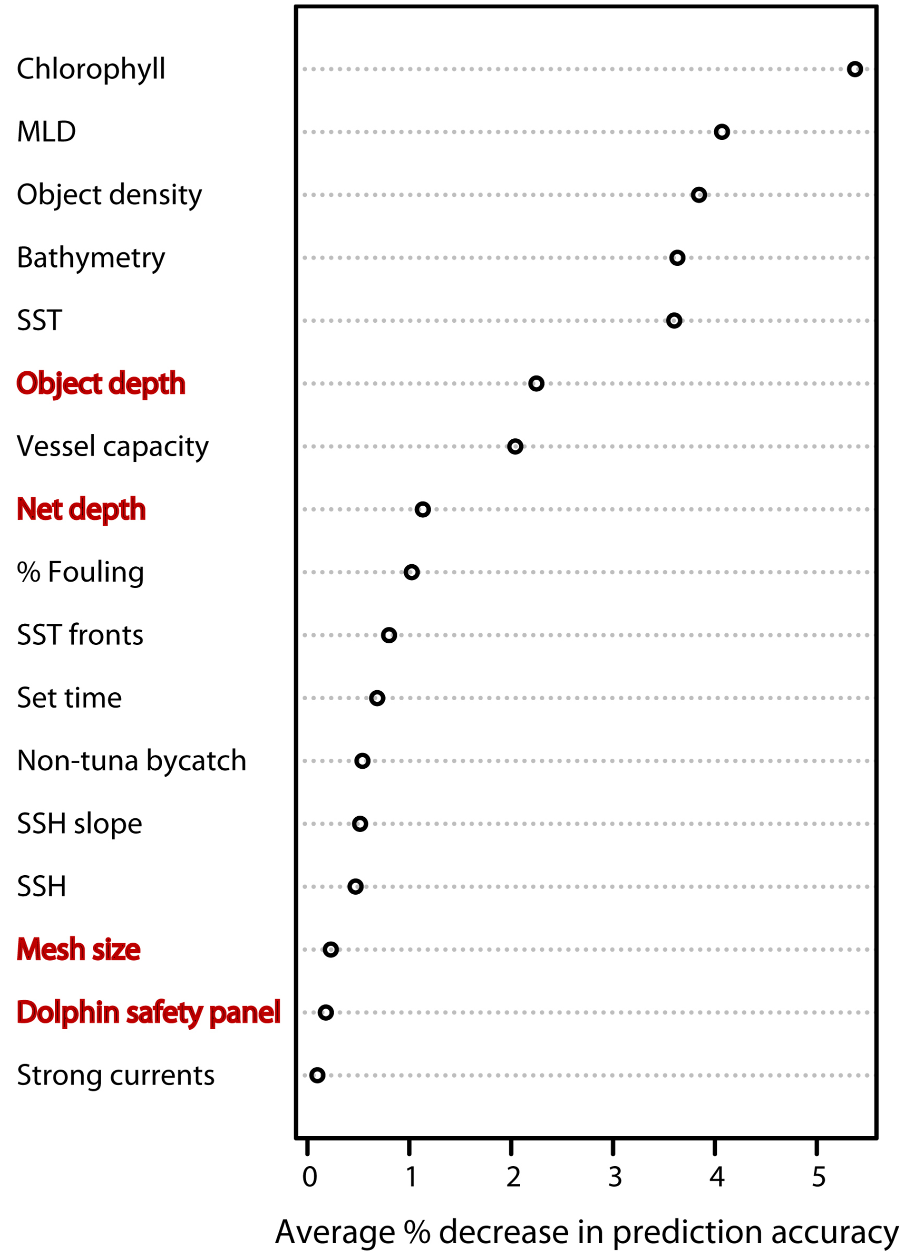
- 10,425 floating objects sets (IATTC observer data), 2001-2005
  - Limited data to first sets with some catch of yellowfin, skipjack or bigeye.
  - Split data into a training set (5,212 sets) and a test set (5,213 sets).
- 21 predictors
- Response variable: presence/absence of any amount bigeye tuna catch

Misclassification errors

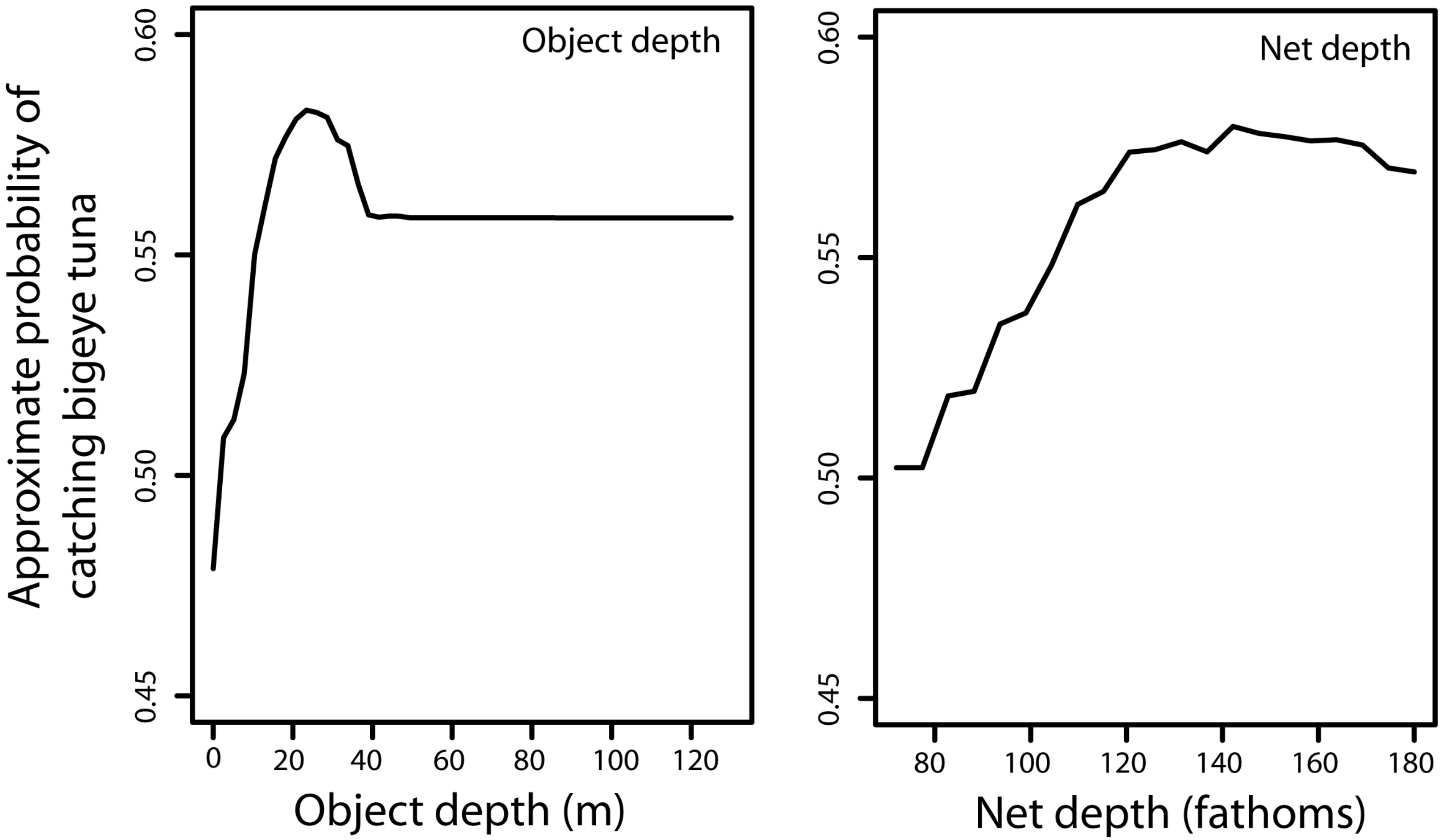
	Observed class	Predicted class		Misclassification error
		0 (no bigeye)	1 (bigeye)	
(a)	0 (no bigeye)	1952	433	0.182
	1 (bigeye)	430	2397	0.152
(b)	0 (no bigeye)	1745	640	0.268
	1 (bigeye)	213	2614	0.075

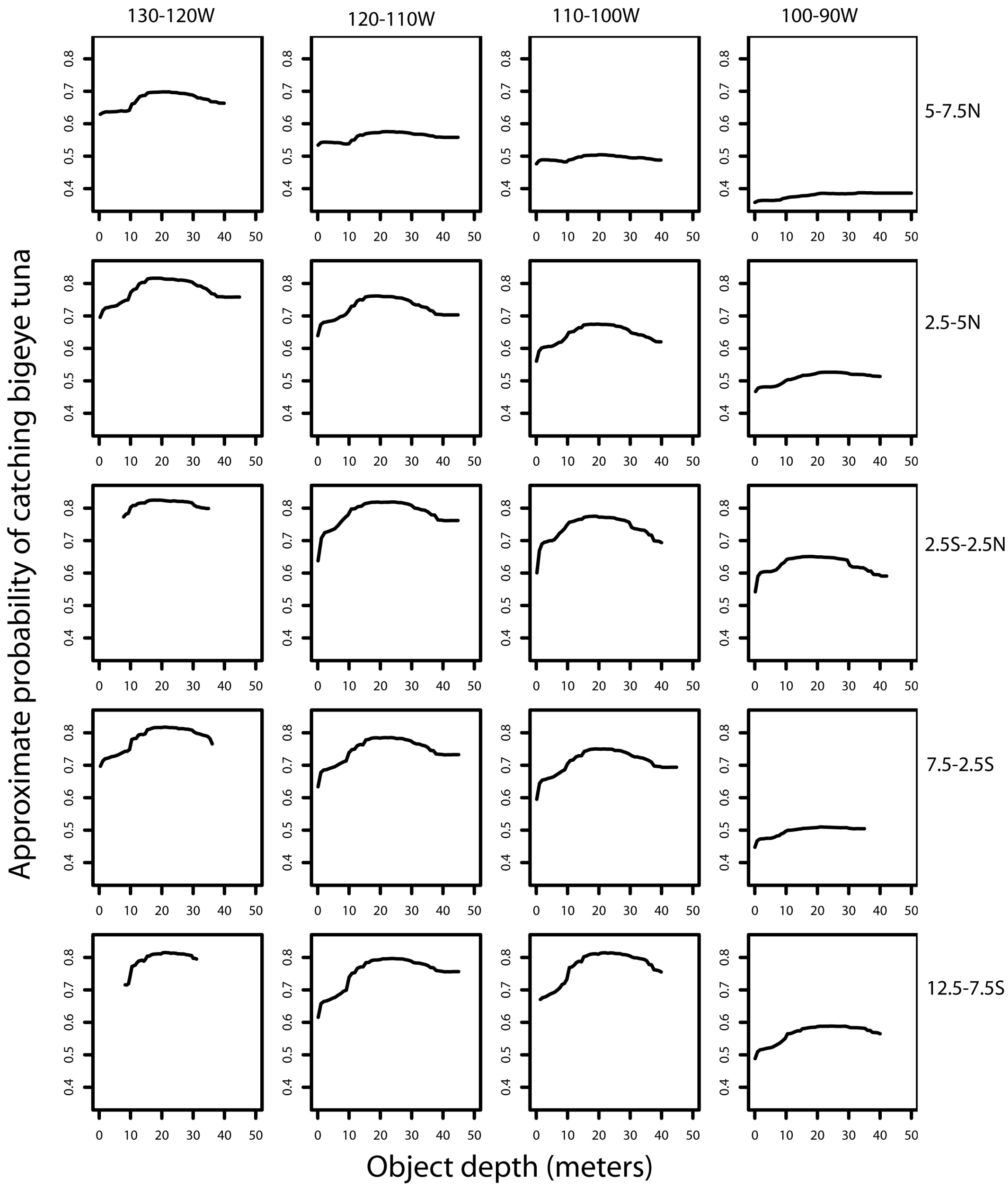
Predictor importance for presence of bigeye

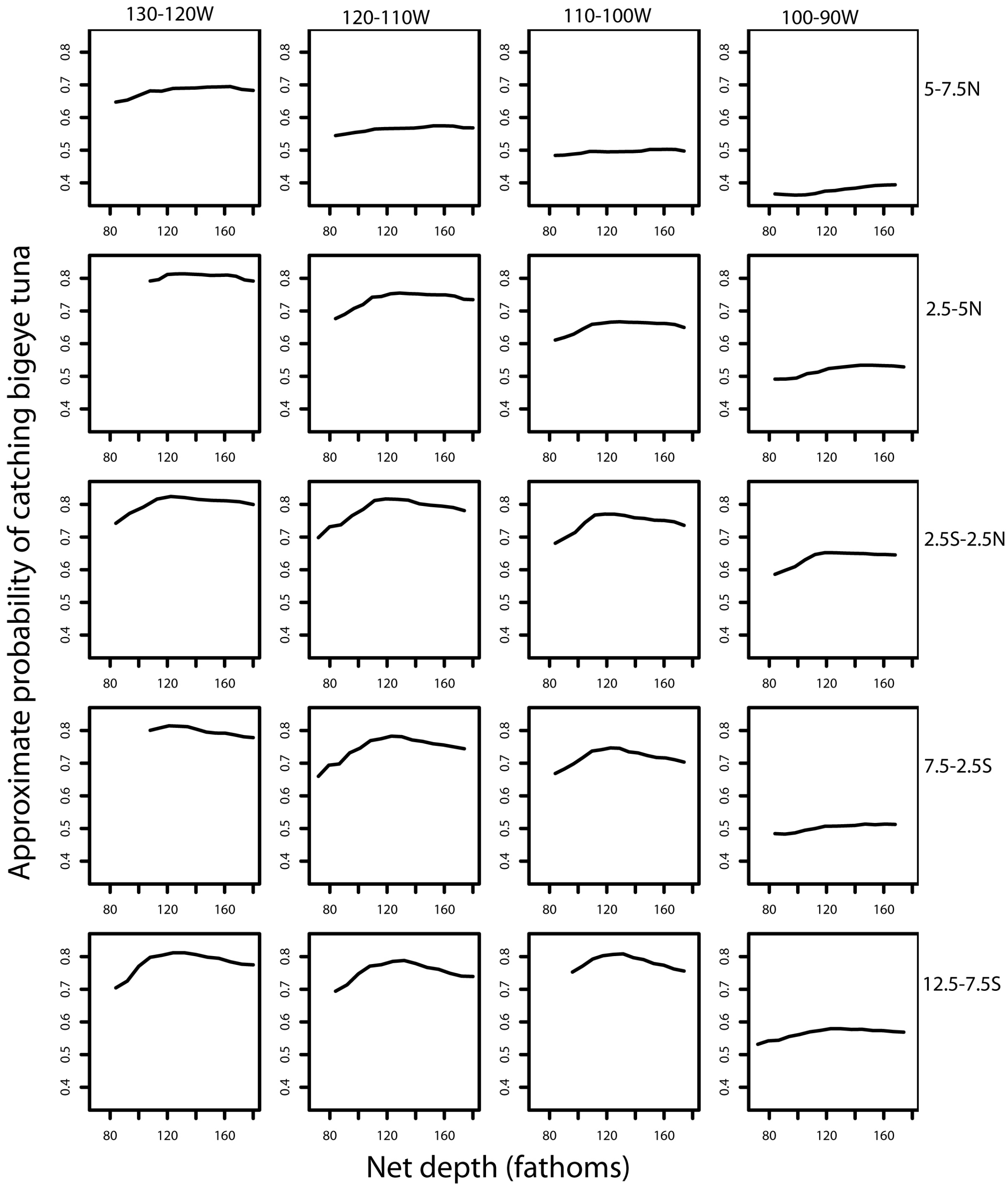




Probability of bigeye catch versus gear

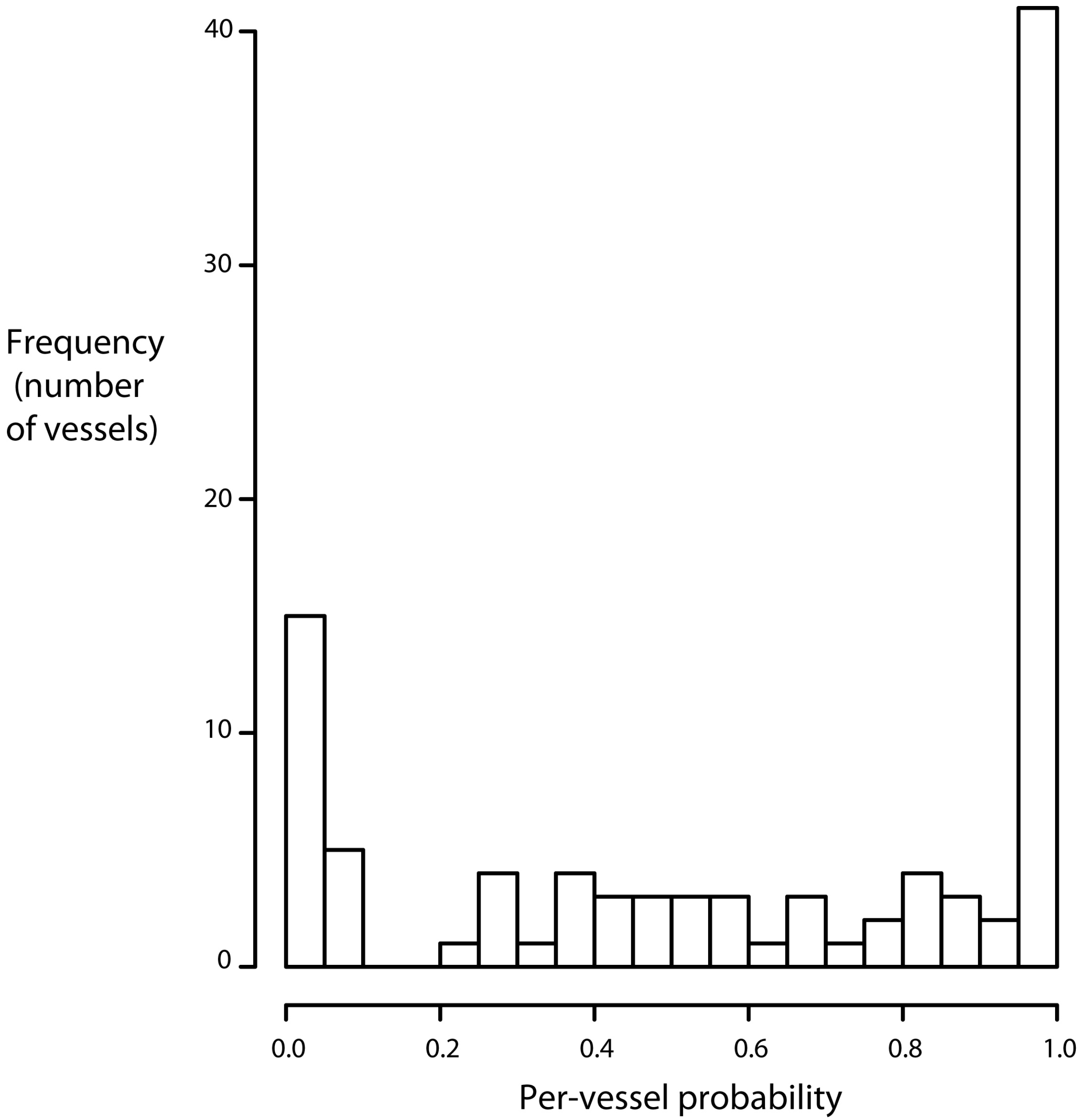



130-120W
120-110W
110-100W
100-90W
5-7.5N
2.5-5N
2.5S-2.5N
7.5-2.5S
12.5-7.5S
Approximate probability of catching bigeye tuna
Object depth (meters)
0.4 0.5 0.6 0.7 0.8
0 10 20 30 40 50



130-120W
120-110W
110-100W
100-90W
5-7.5N
2.5-5N
2.5S-2.5N
7.5-2.5S
12.5-7.5S
0.4
0.5
0.6
0.7
0.8
80
120
160
Approximate probability of catching bigeye tuna
Net depth (fathoms)

Per-vessel probabilities



Summary

- The occurrence of bigeye tuna catch in floating object sets is consistent with some level of fishermen control:
  - 46% of floating object sets and 29% of vessels making floating object sets caught no bigeye tuna;
  - the presence of bigeye tuna was reasonably predicted from set location, environmental conditions, and gear/operational characteristics;
  - some important features of the classification algorithm:
    - set location was the most important predictor
    - object depth effects varied spatially
  - failure to predict the presence of bigeye tuna was concentrated within certain vessels, possibly indicating additional ‘vessel effects.’

Implications

- Fishermen have options for avoiding catching bigeye tuna, including:
  - in certain areas, changing the in-water depth of the floating object and fishing depth of the purse-seine net;
  - changing their fishing location.