EBFM Symposium, October 2012 Montpellier

Spatio-temporal patterns of hooking contacts in pelagic longlining

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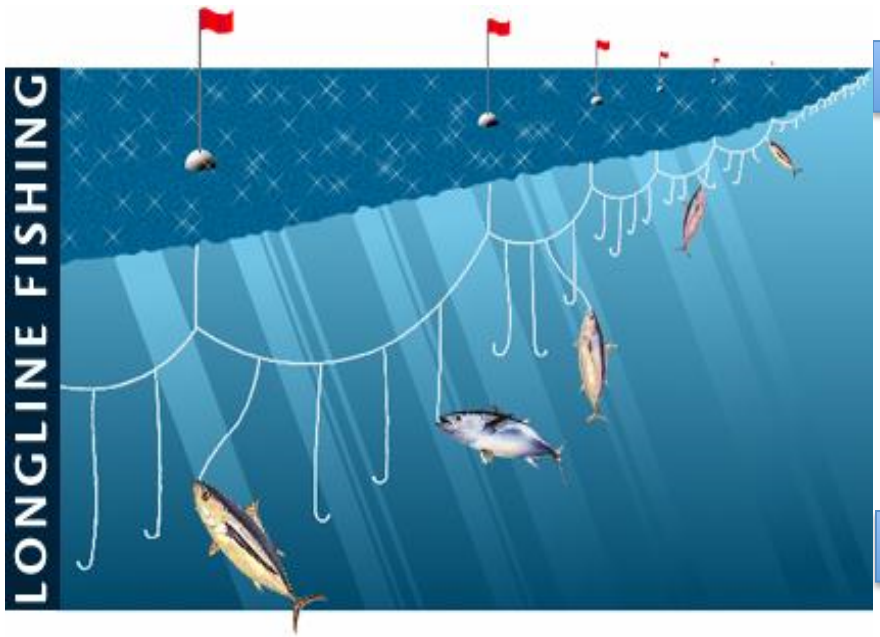
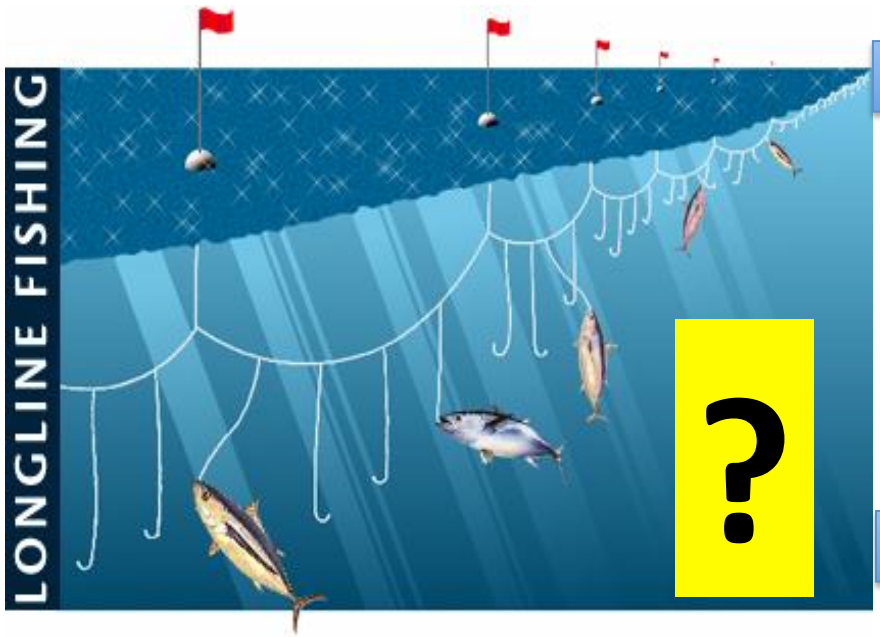
Pelagic LL and fisheries science



Probe for fish abundance (CPUE index)

Probe for the ecology and behavior of fish

Pelagic LL and fisheries science



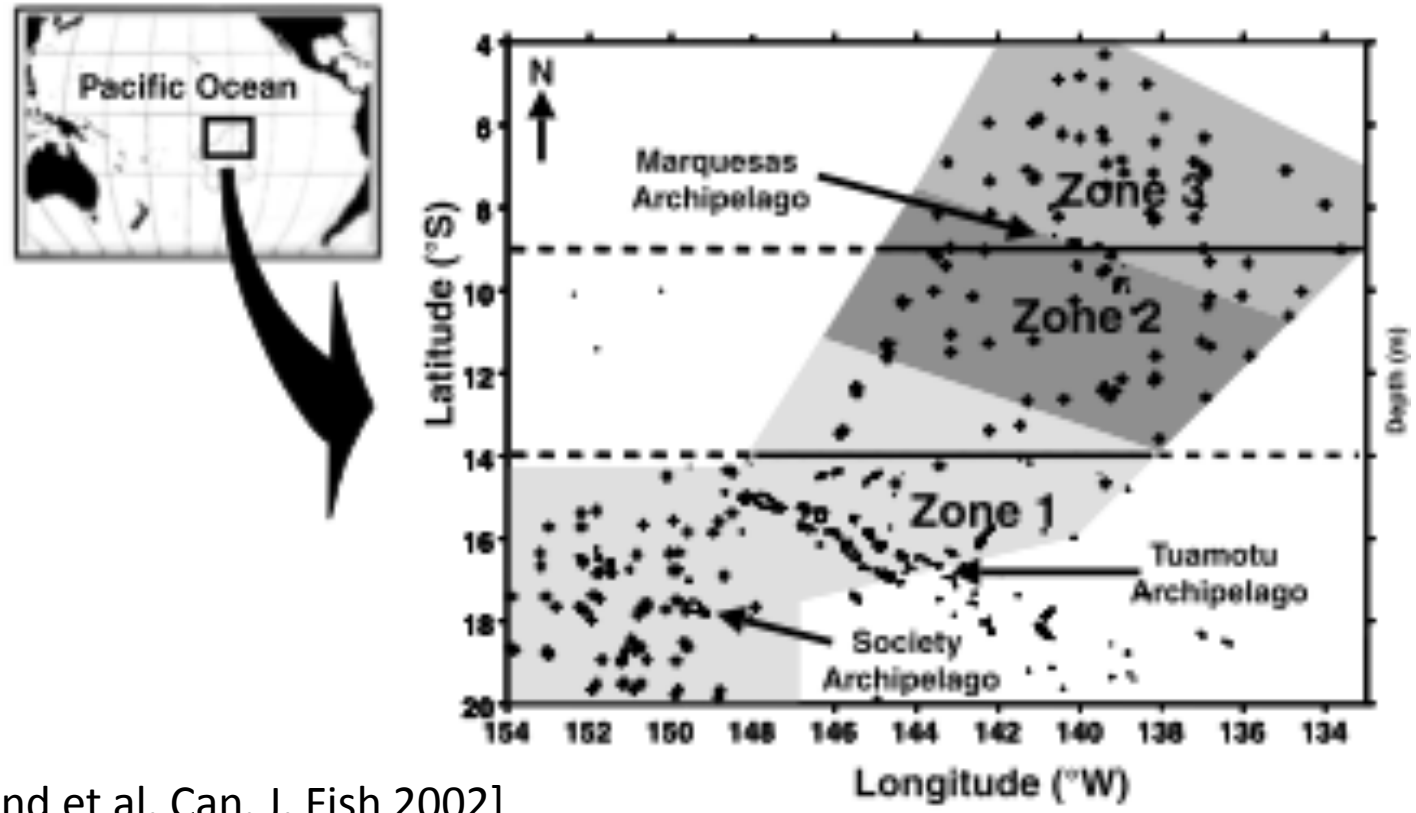
Probe for fish abundance (CPUE index)

Probe for the ecology and behavior of fish

Little is known on the interaction between the large pelagic fish and the longline gear

Experimental data

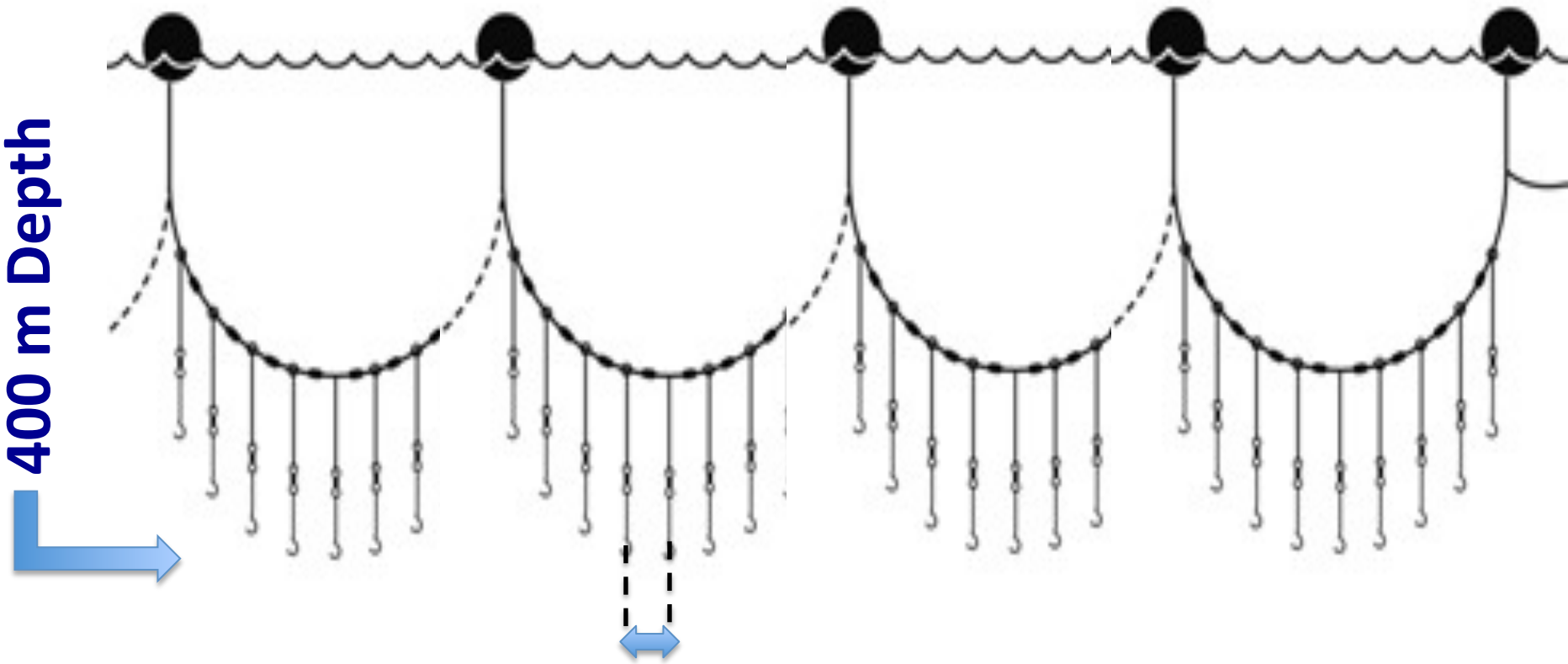
147 Instrumented pelagic longlines
targeting tuna (ALB, YFT,BET)
ECOTAP program, French Polynesia (SCPO)



[Bertrand et al. Can. J. Fish 2002]

LL characteristics

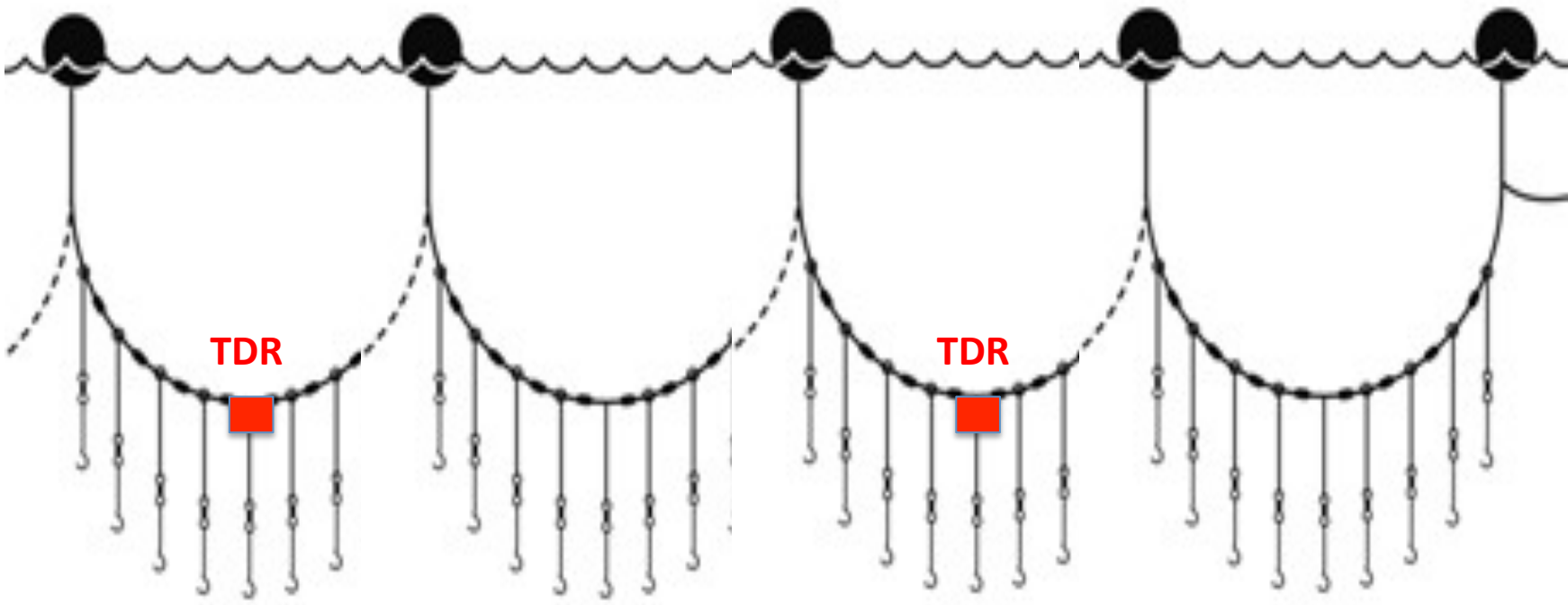
500 hooks per line x **147 lines**



Daytime
6:00-18:00

LL instrumentation

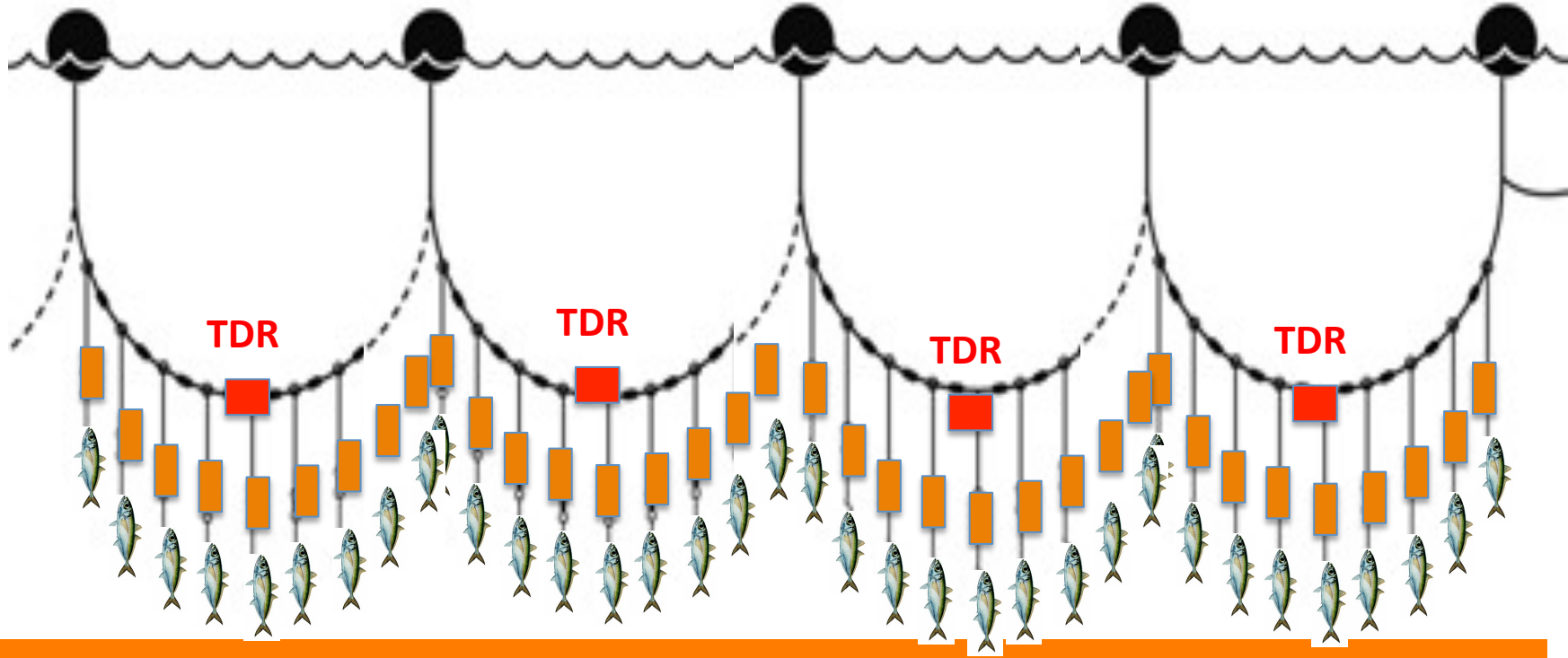
1 TDR each 2 baskets (Temperature Depth recorder)



Depth of the line during fishing time

LL instrumentation

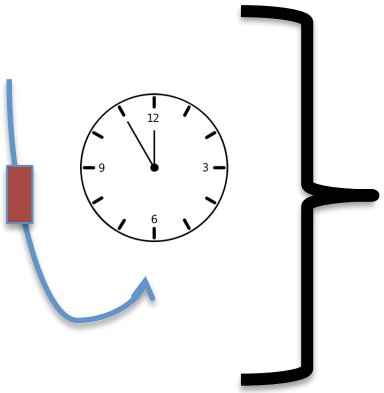
Hook timers



Elapsed time between hooking contact (triggered by fish) and landing on deck.

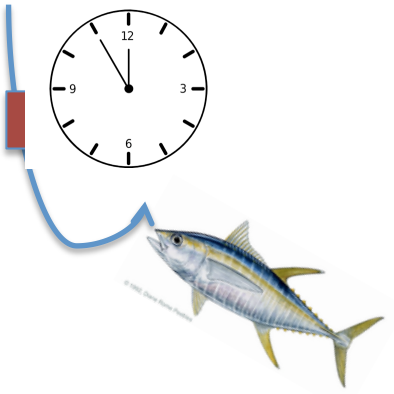
LL data

Hooking contact:



Time of interaction
Horizontal hook position
Hook Depth

Hooking success:



+ Species

Dataset

6009 Hooking Contacts

-> 8% of total hooks deployed

1255 Hooking Success:

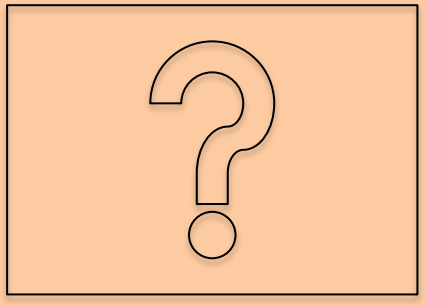
-> 1.7% of total hooks deployed

- **737** target (tuna)
- **517** bycatch(swordfish, sharks,marlin,lancetfish)

Objectives

Assess the interactions of large pelagic fish with the LL gear at a fine scale in:

- **Space** (hook position, 50m spacing)
- **Time** (minutes)



How far are contacts from a random process?

Do spatio-temporal patterns exist?

Objectives

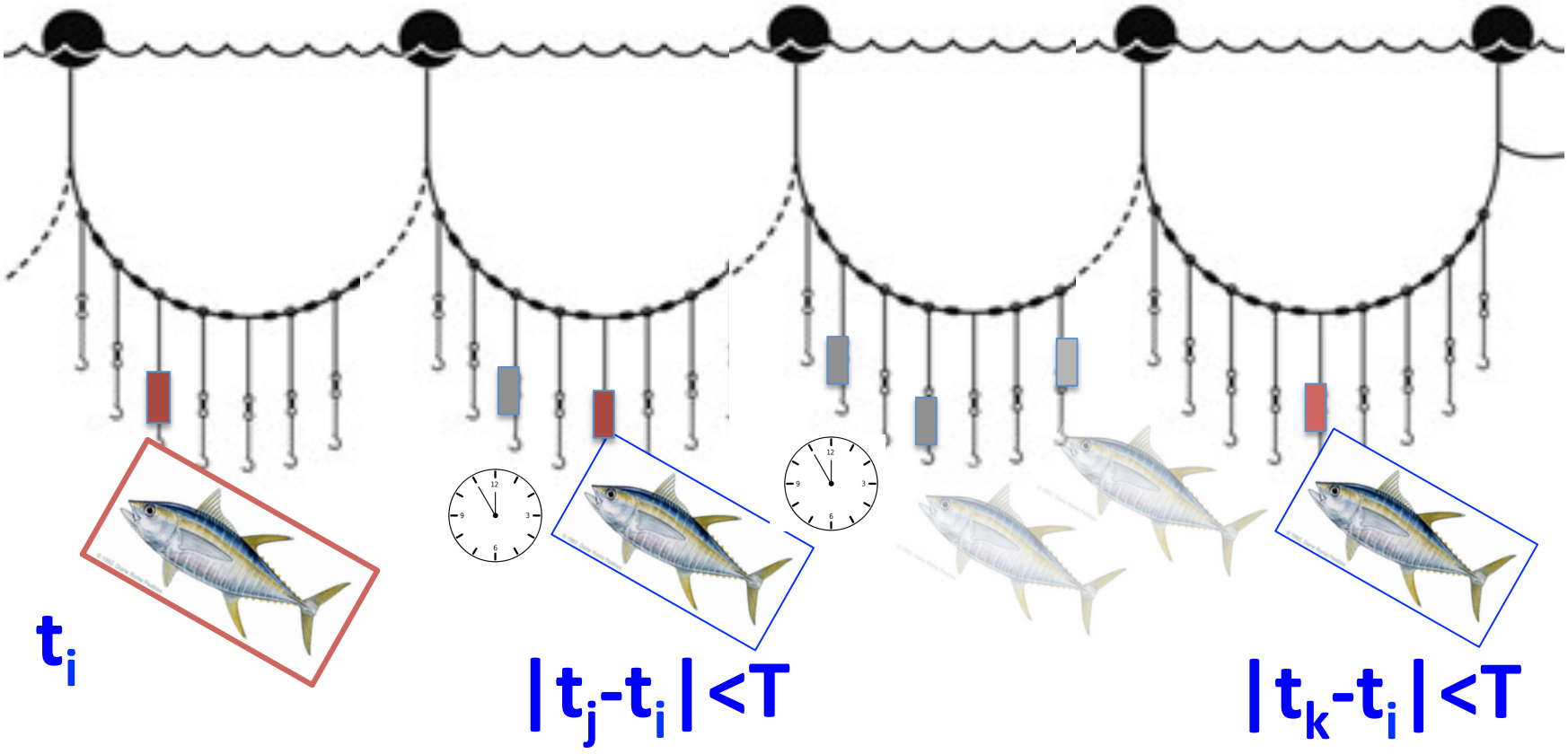
What is the impact of these patterns on:

- Abundance estimates from CPUE
- Bycatch mitigation

Do spatio-temporal patterns exist?

Methods: temporal window

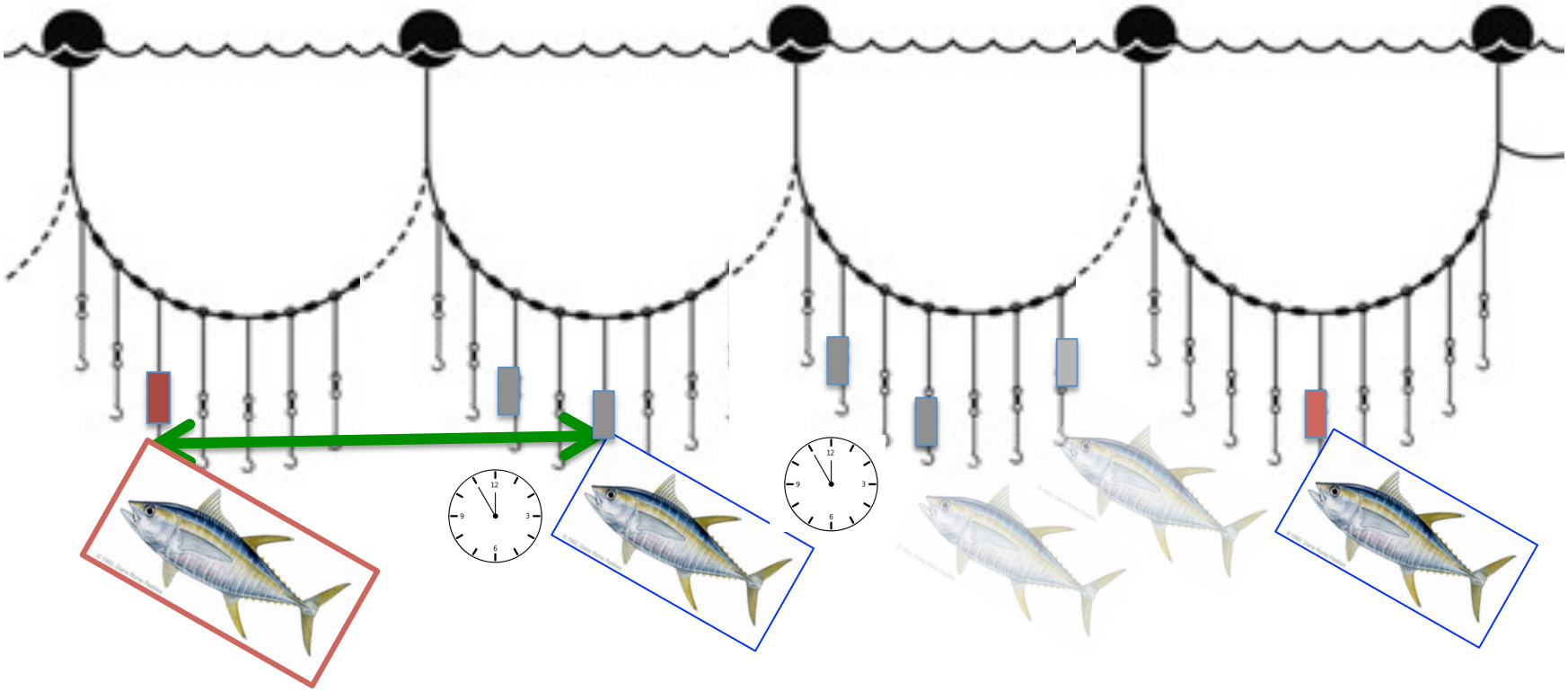
Select synchronous contacts in time:



Consider all contacts within a temporal window **T**

Nearest-neighbor distance

In space, amont synchronous fish:

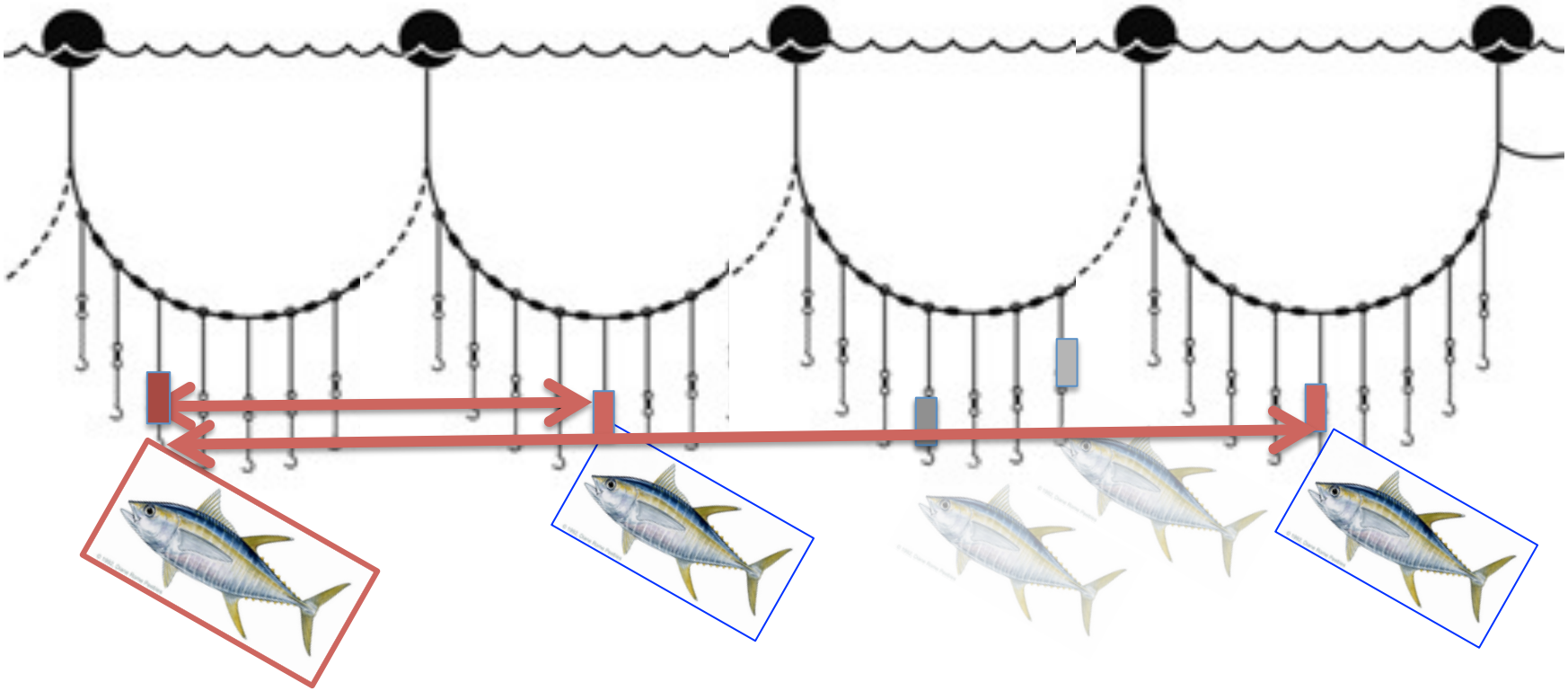


Nearest neighbor distance distribution

-> how far T-synchronous fish are?

Pair correlation

Distribution of distances with all synchronous fish

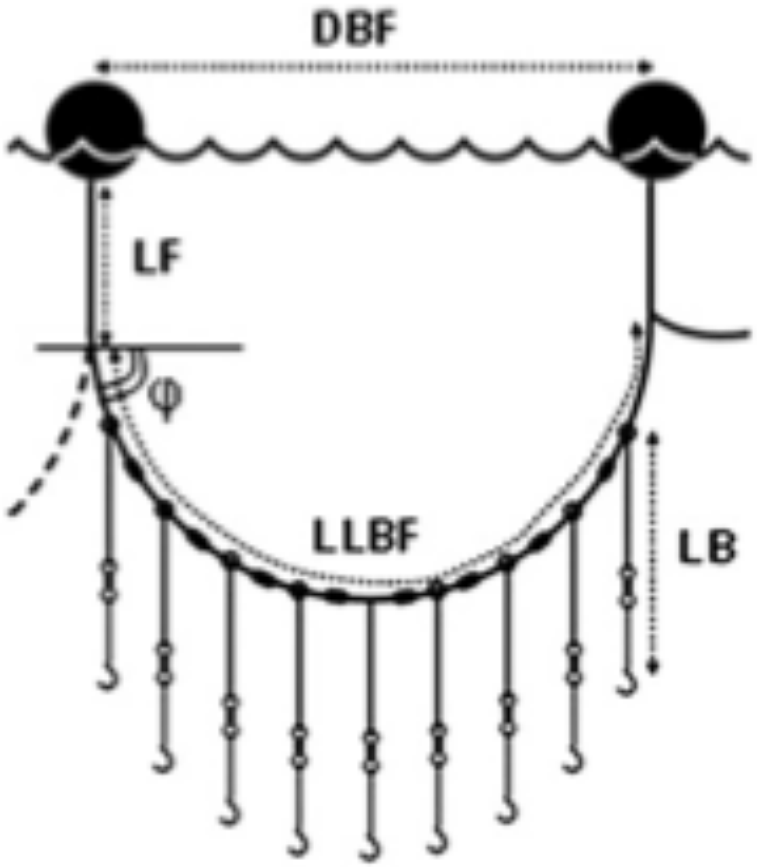


Pair correlation

--> Probability of having two contacts at distance **r** in **T**

Stochastic model

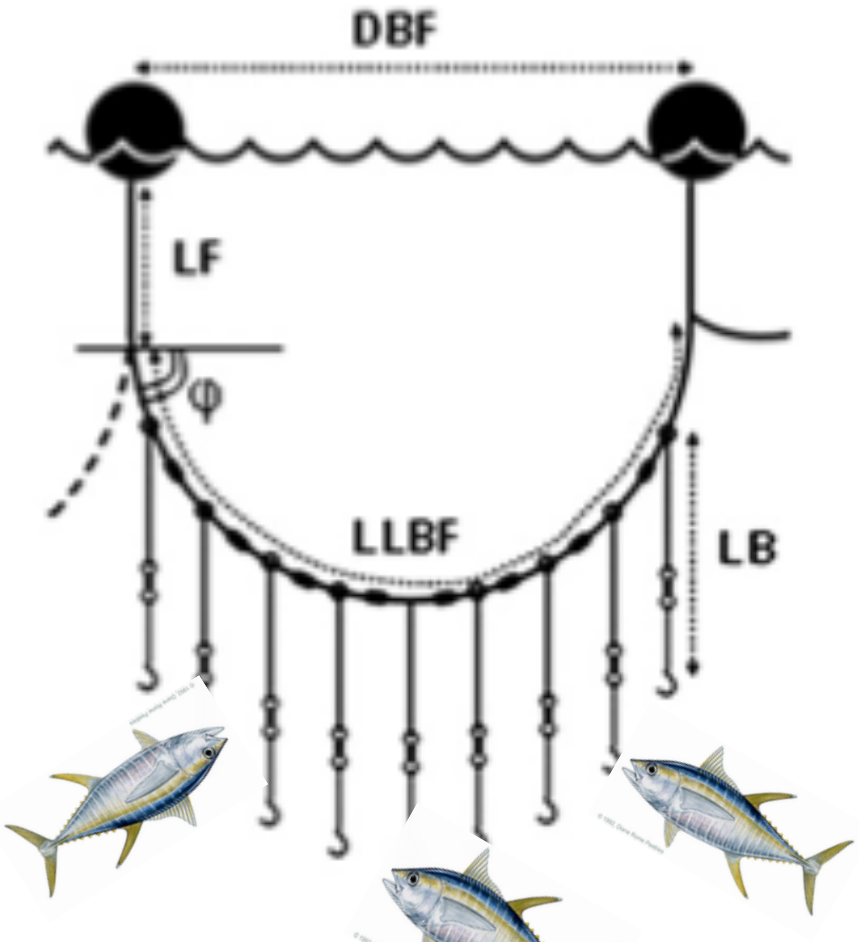
Generate **X** random positions in time and space through Monte Carlo using:



- **Catenary shape LL model [Suzuki 1977]**

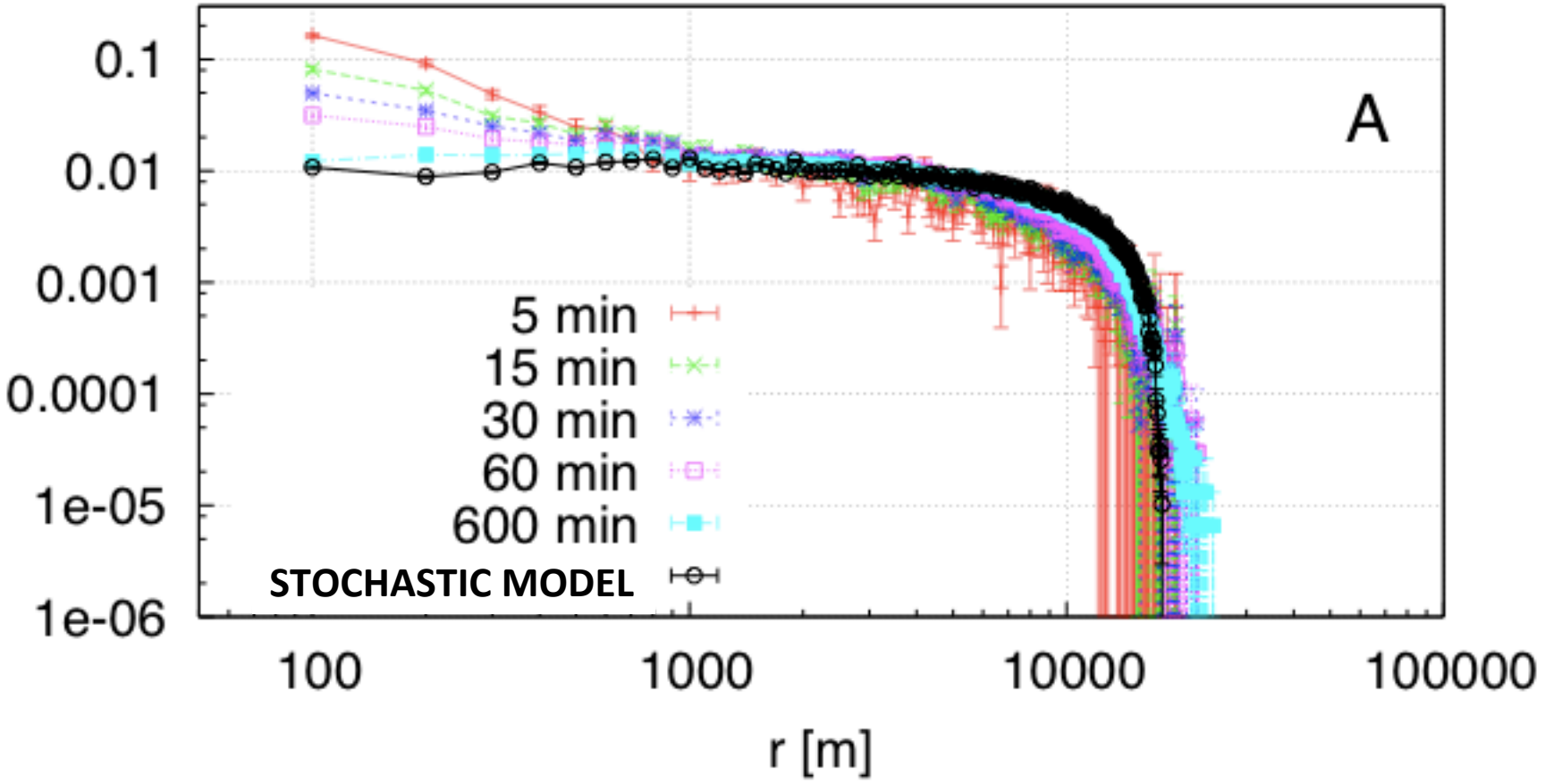
Stochastic model

Generate **X** random positions in time and space through Monte Carlo using:



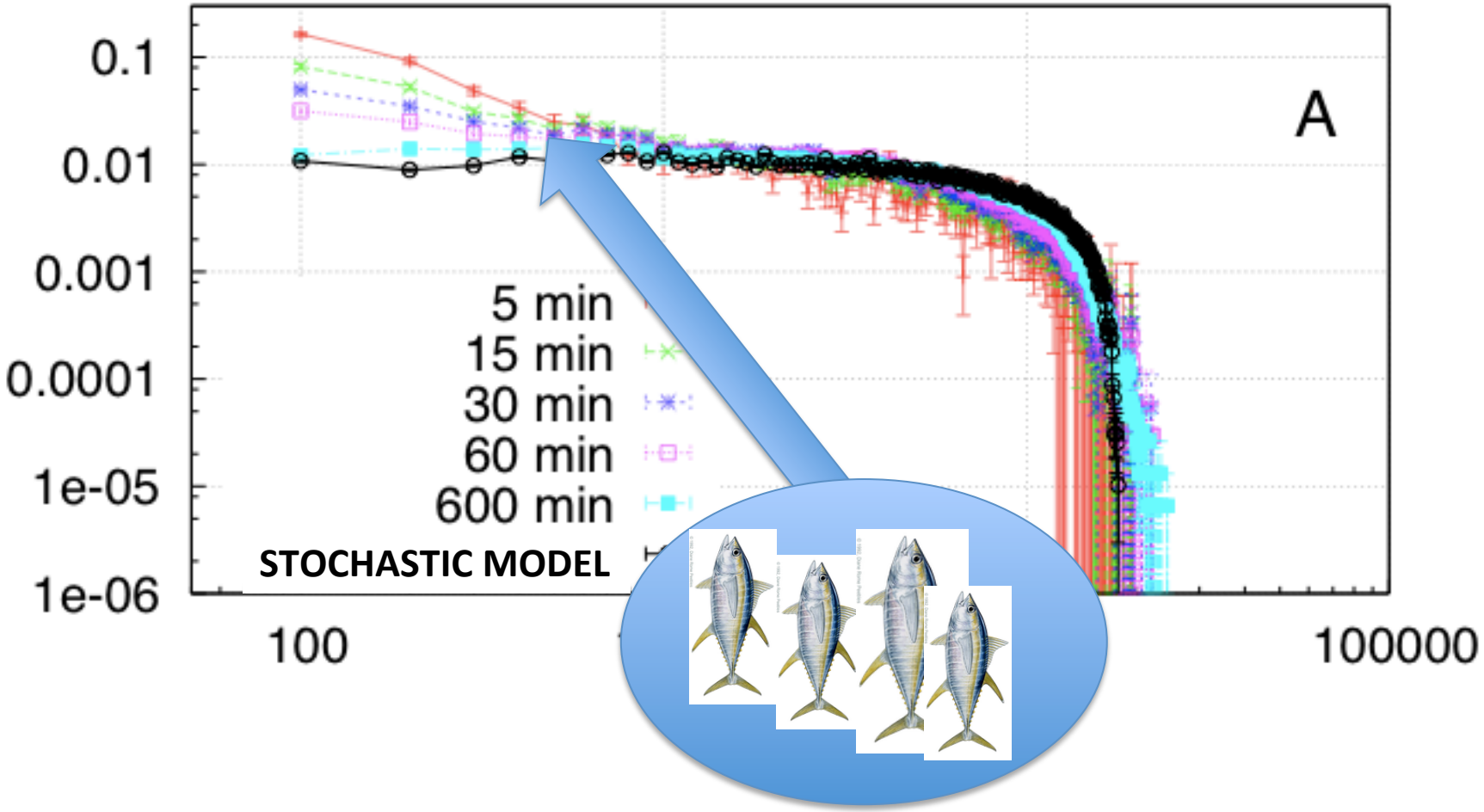
- **Catenary shape LL model [Suzuki 1977]**
- **X from the Experimental distribution of number of Contacts and Catches**

Results: pair correlation



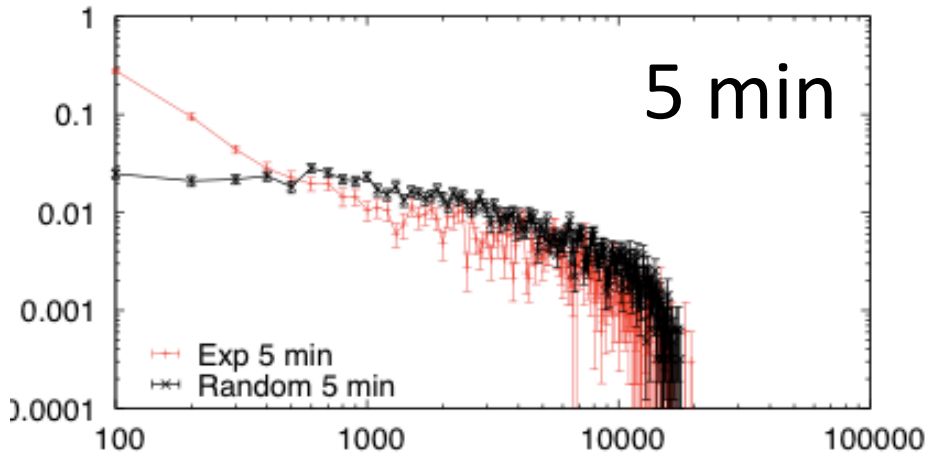
Higher probability for two contacts at small distance at small time windows

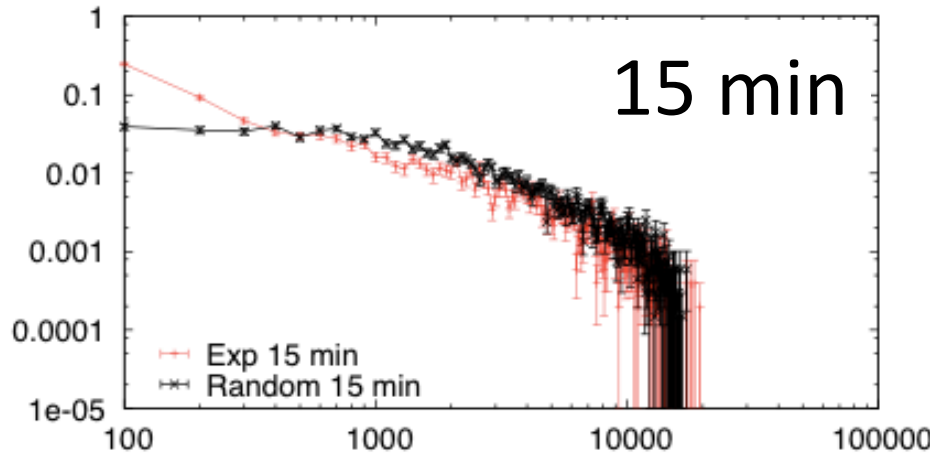
Results: pair correlation

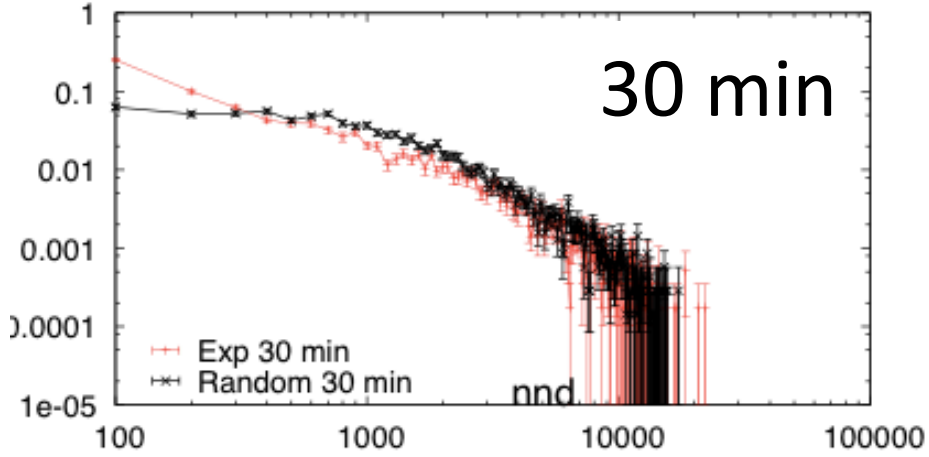


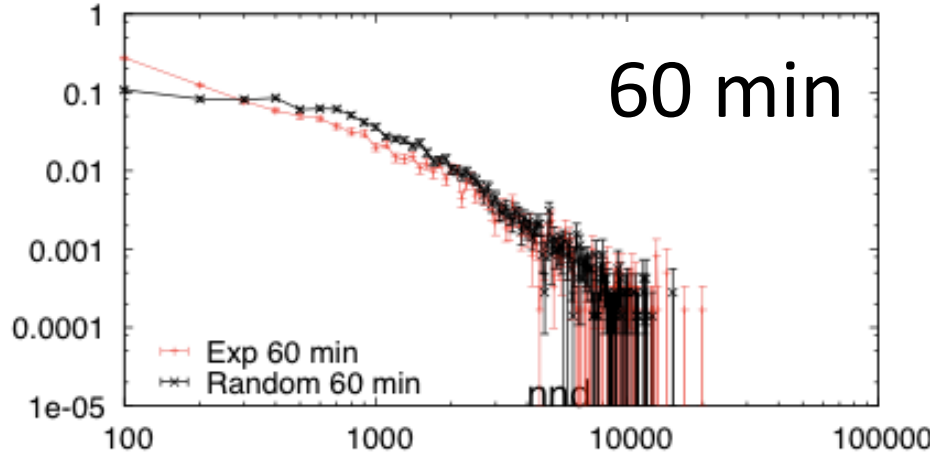
Patch size ~400 -500 m

Results: nearest-neighbor distance



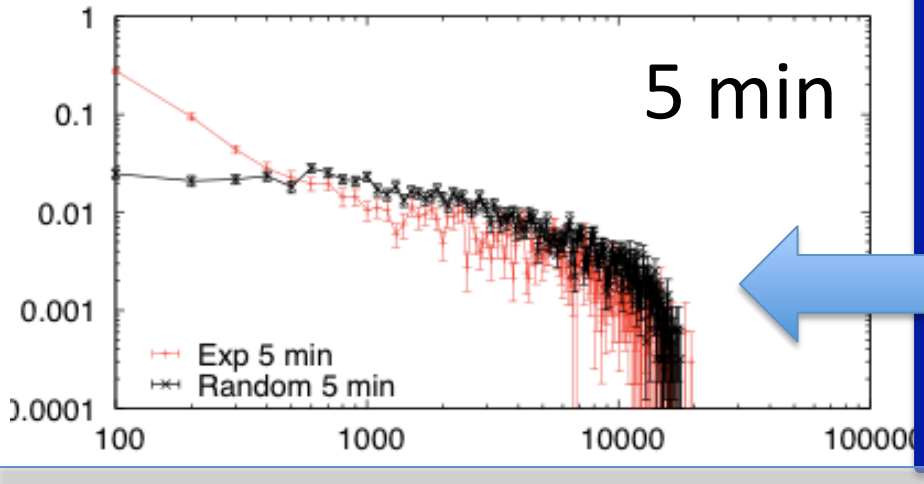


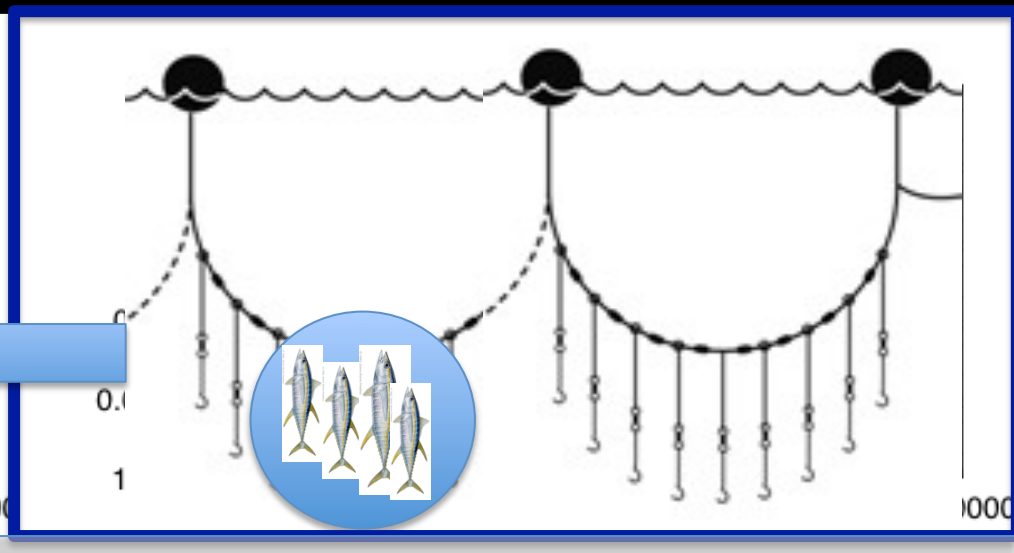


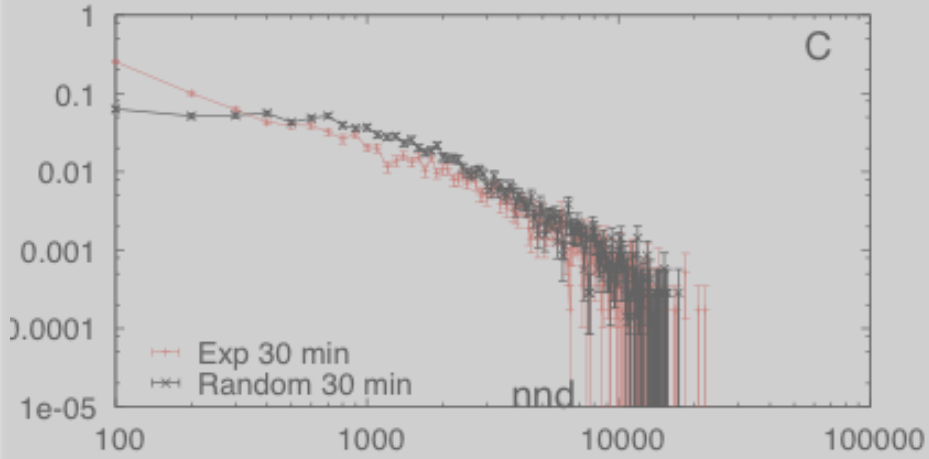


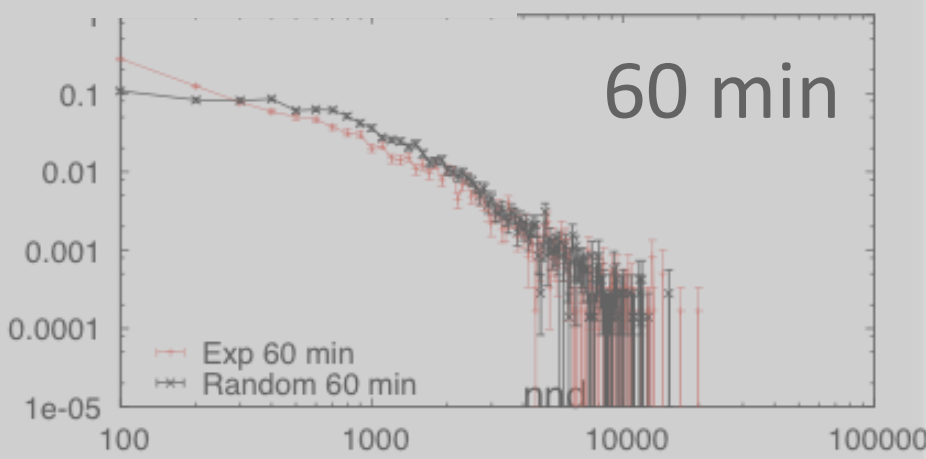
Contacts are closer than the random model for small time windows

Results nnd

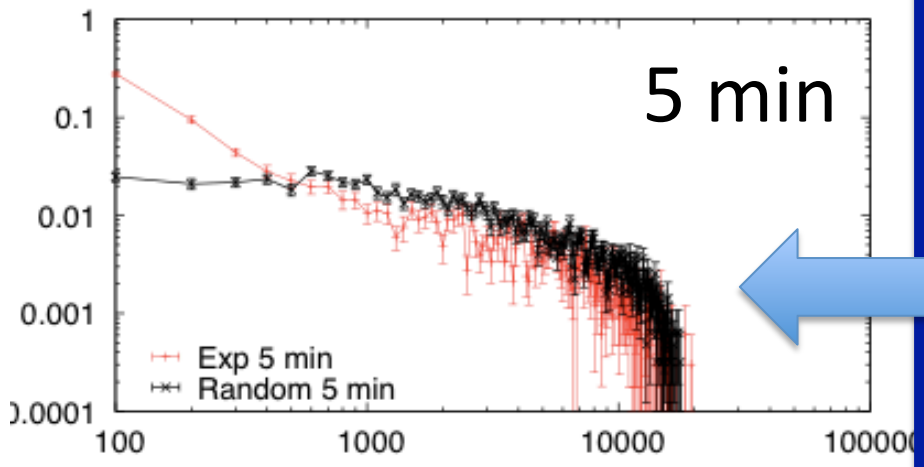

5 min
Exp 5 min
Random 5 min
1
0.1
0.01
0.001
0.0001
100
1000
10000

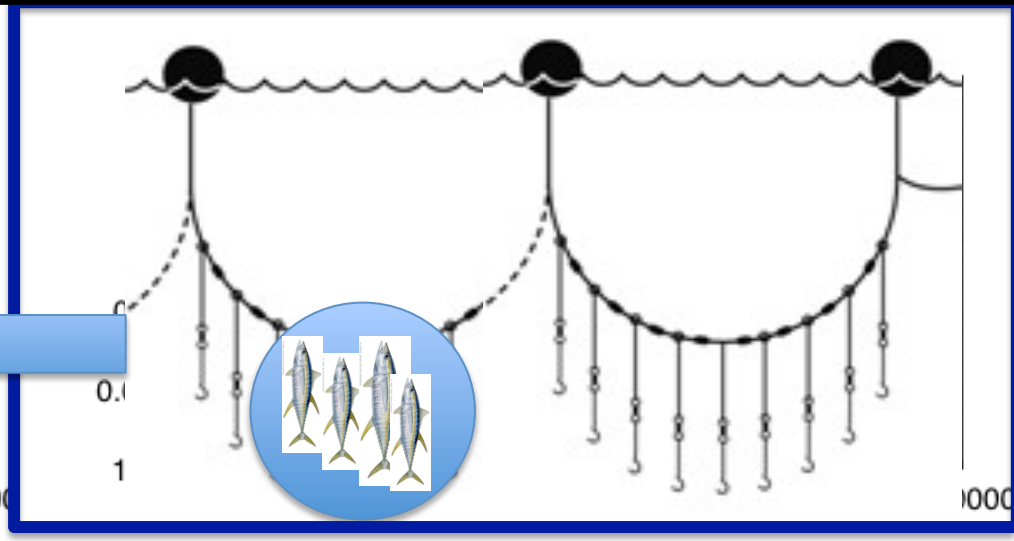


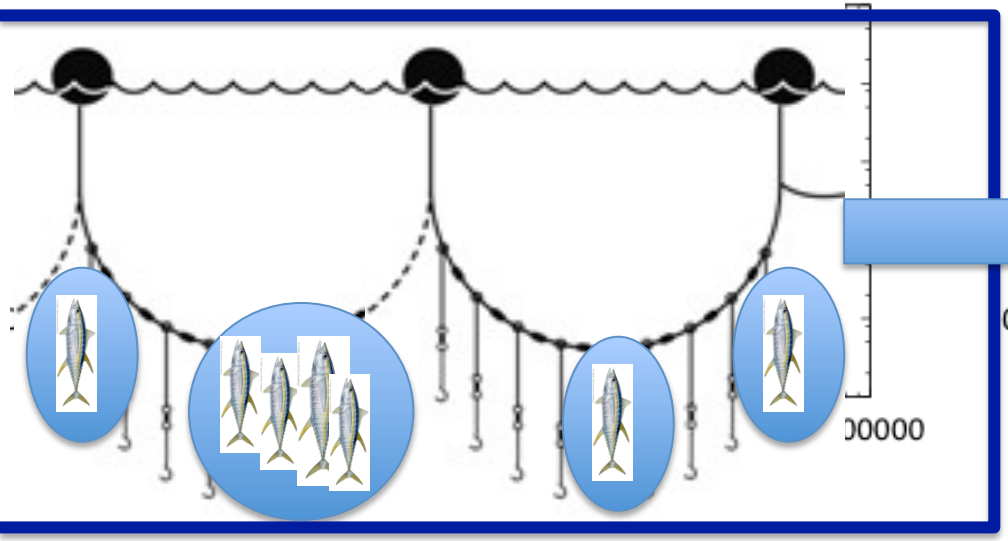

C
Exp 30 min
Random 30 min
nnd
1
0.1
0.01
0.001
0.0001
1e-05
100
1000
10000
100000

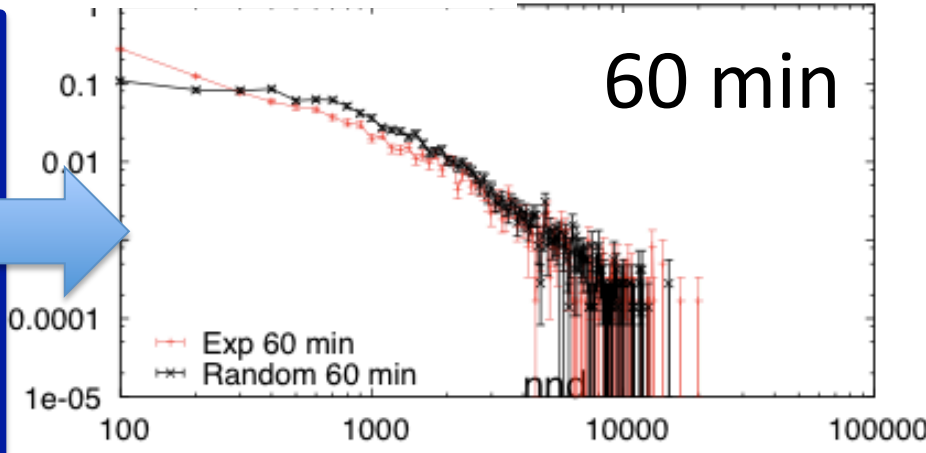

60 min
Exp 60 min
Random 60 min
nnd
0.1
0.01
0.001
0.0001
1e-05
100
1000
10000
100000

Results nnd


5 min
1
0.1
0.01
0.001
0.0001
100
1000
10000
Exp 5 min
Random 5 min

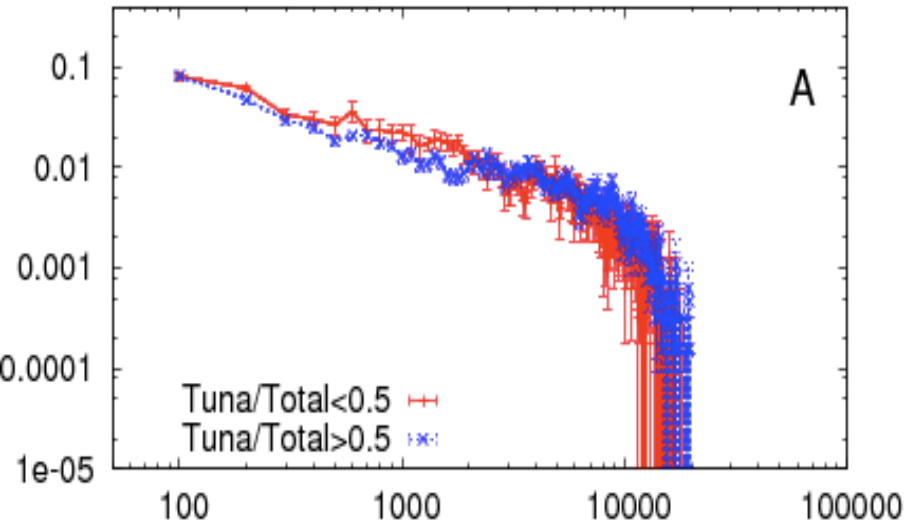




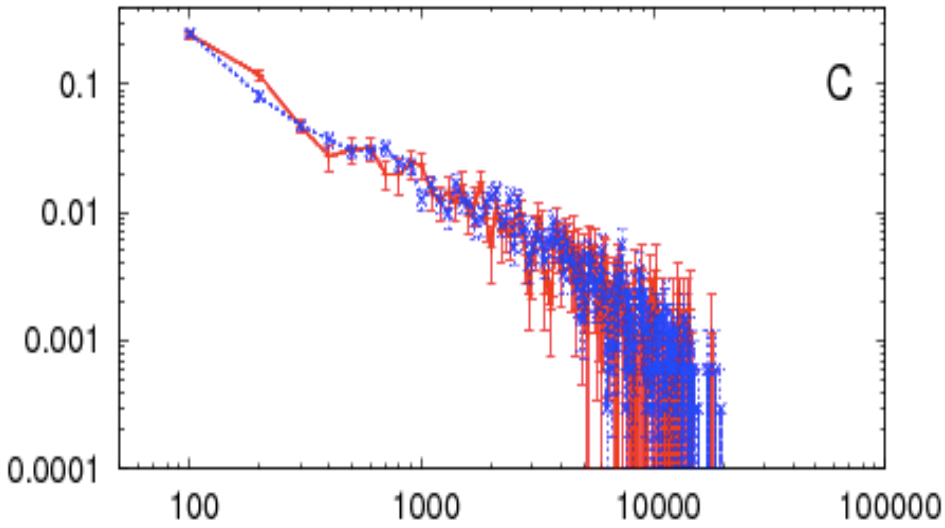

60 min
0.1
0.01
0.0001
1e-05
100
1000
10000
100000
Exp 60 min
Random 60 min
nnd

Role of species: target vs bycatch

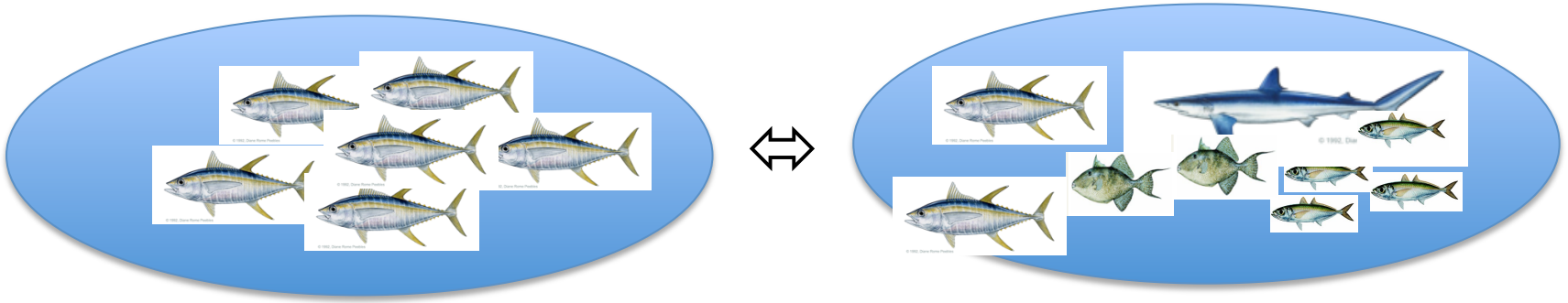
Pair correlation



Nearest neighbor distance



Multispecific patches



Consequences for bycatch mitigation

In the sampled region:

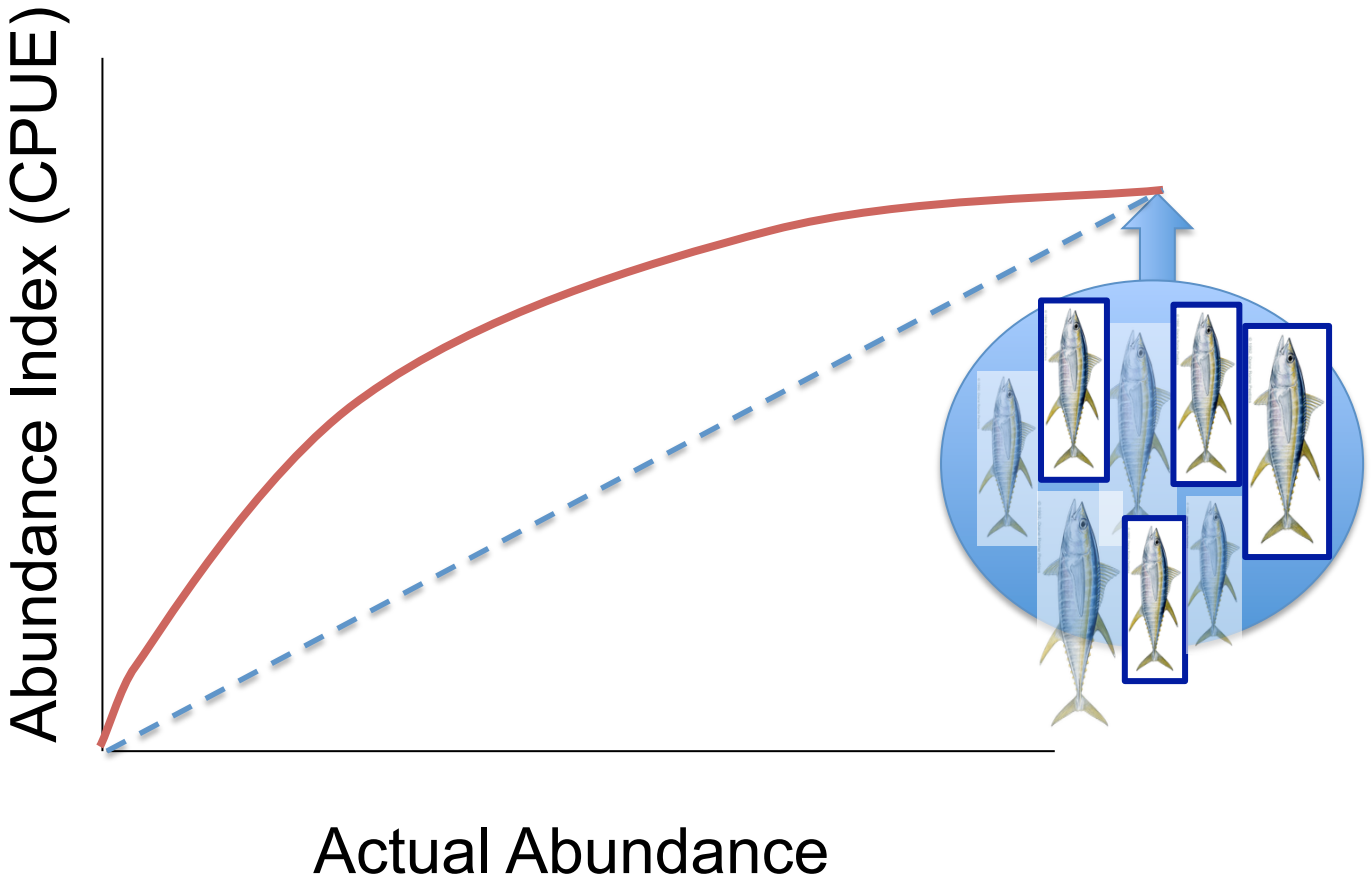
- ❑ Multispecific aggregations interact with the gear
- ❑ Not possible to separate spatio/temporal scales at the patch level

Mitigation measures:

- ◆ Modify catchability of target vs bycatch from the engine (hook type, bait,…)

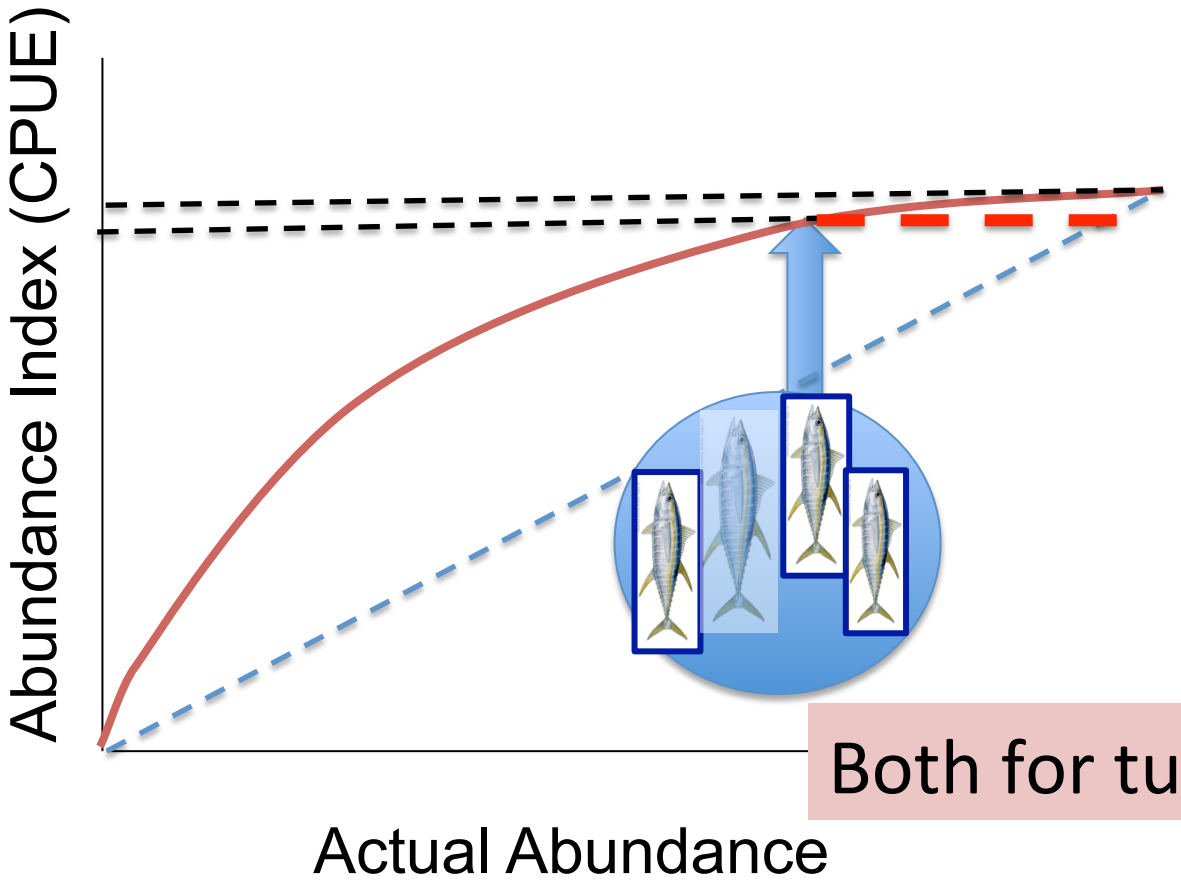
Consequences for CPUE

Local Saturation: Hyper-stability



Consequences for CPUE

Local Saturation: Hyper-stability



Both for tuna and bycatch

Conclusions

Evidence of interaction of patches of pelagic fish with the longline (400-500m)

The patches are multispecific aggregations

Not possible to separate spatial scales for bycatch mitigation

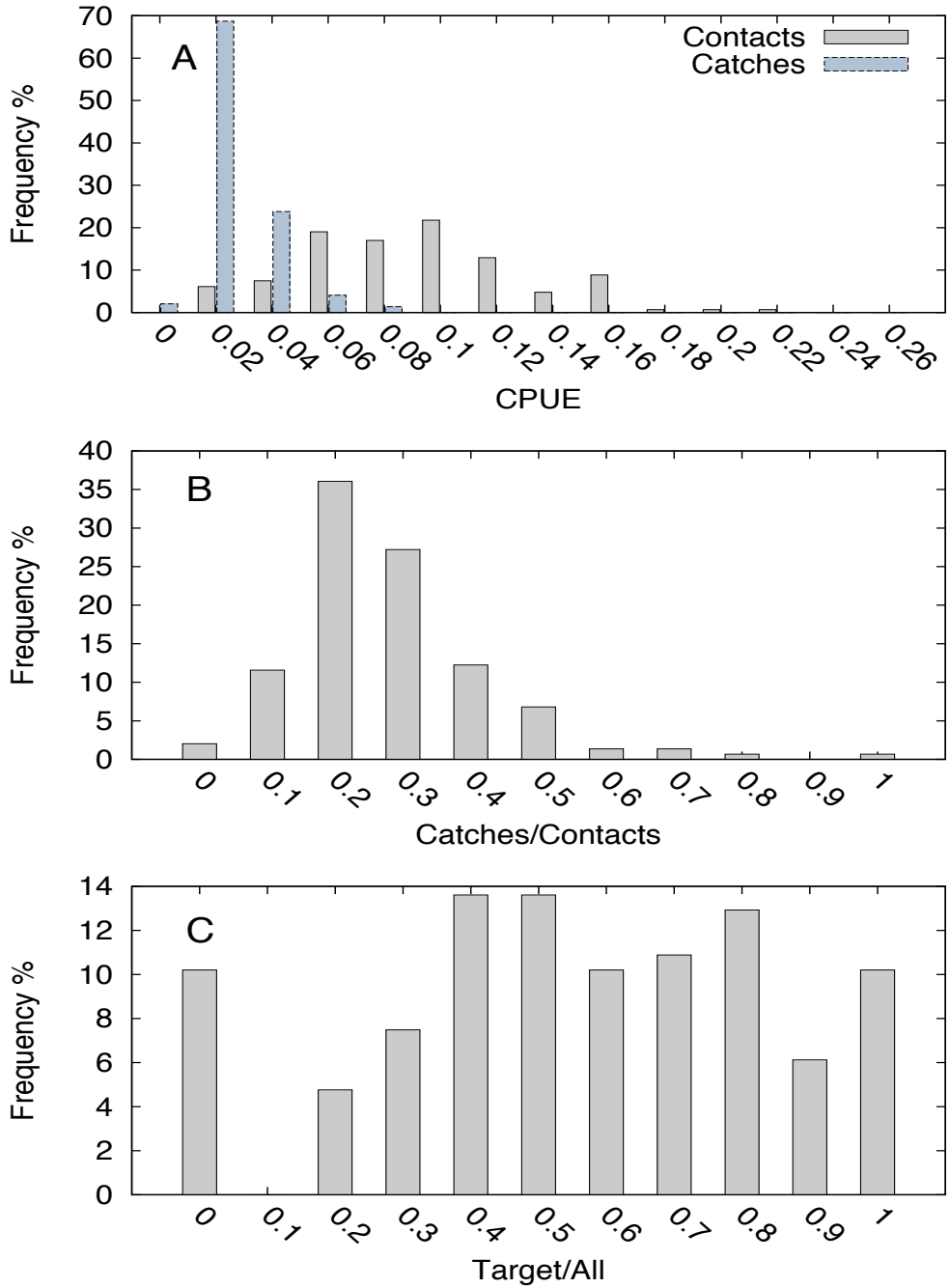
Possible local effects of saturation

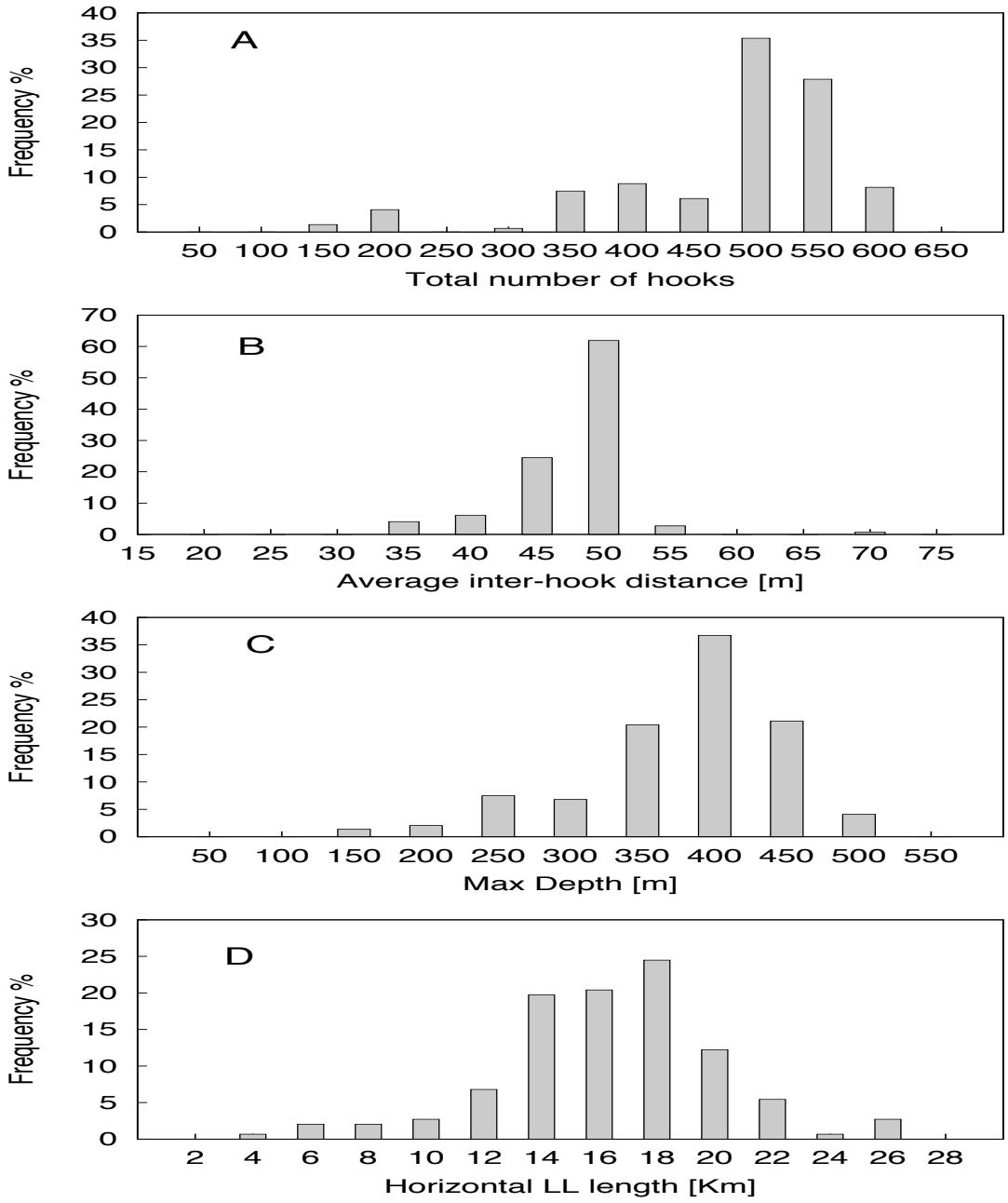
Perspectives

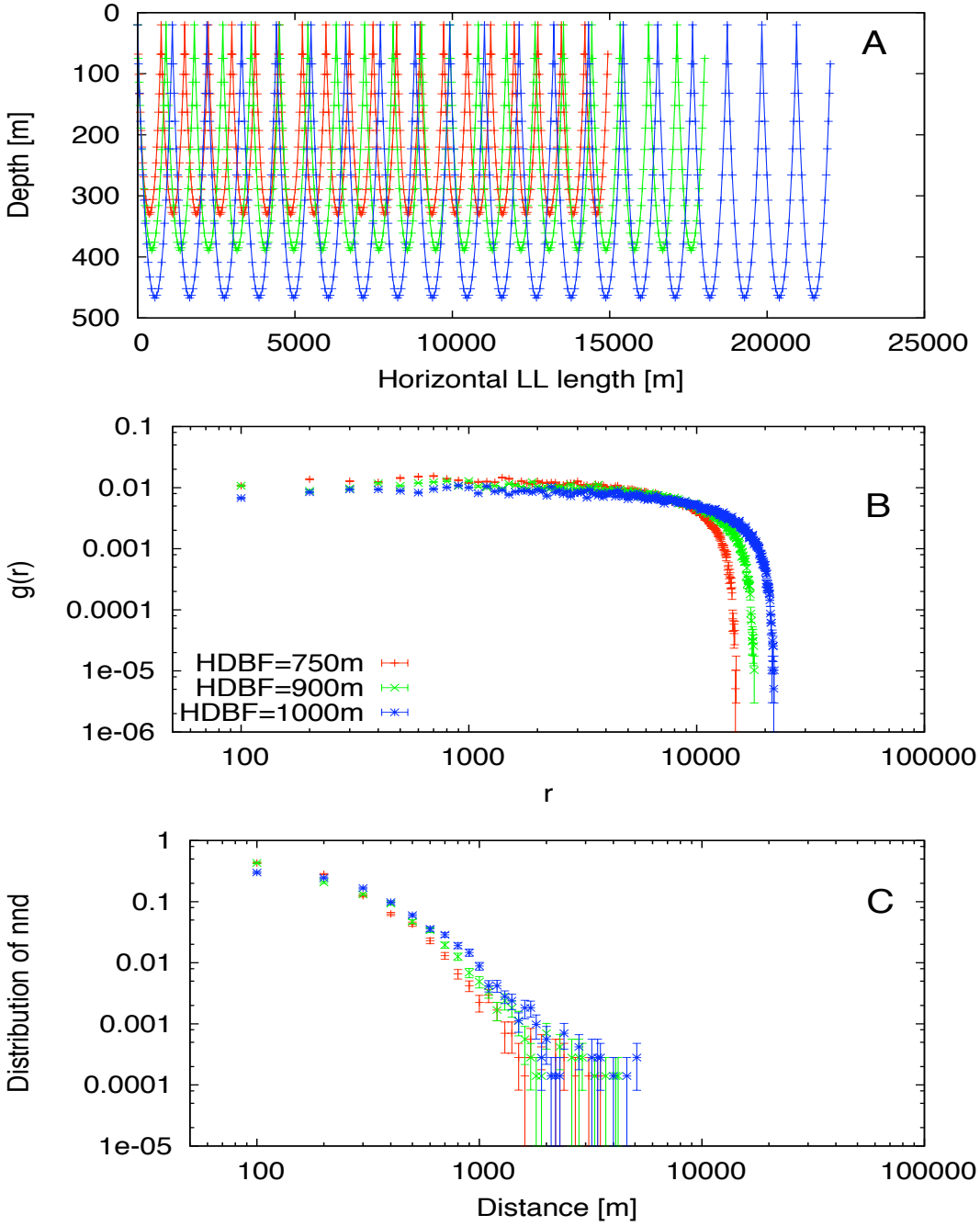
Environmental analysis at a fine scale

Model interaction of patches with the line.

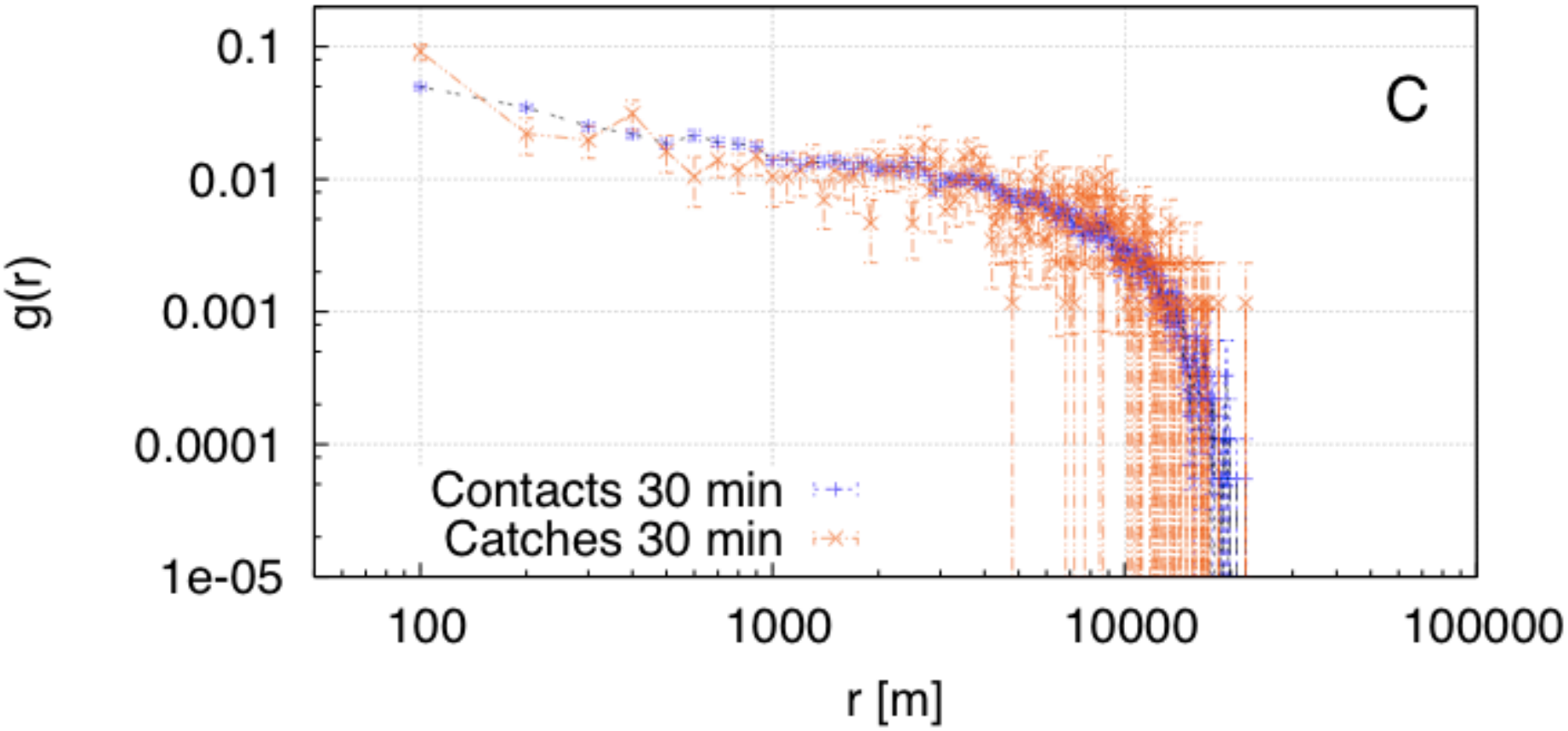
Analyzing stomach content
(number of baits in the stomach) of captures
to estimate catchability and
quantify local saturation effects.


A
Contacts
Catches
Frequency %
70
60
50
40
30
20
10
0
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
0.24
0.26
CPUE
B
Frequency %
40
35
30
25
20
15
10
5
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Catches/Contacts
C
Frequency %
14
12
10
8
6
4
2
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Target/All

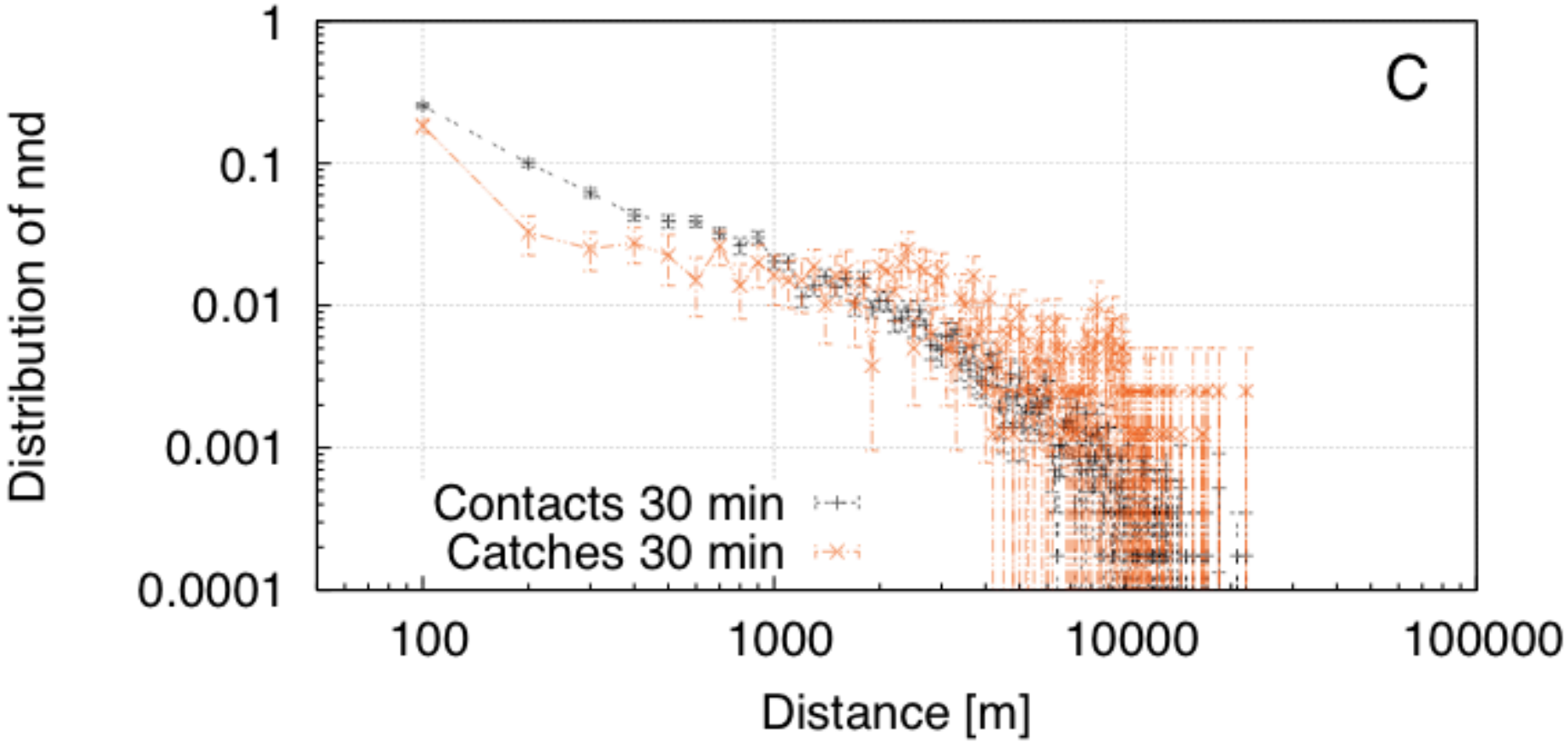

A
Frequency %
Total number of hooks
B
Frequency %
Average inter-hook distance [m]
C
Frequency %
Max Depth [m]
D
Frequency %
Horizontal LL length [Km]


A
Depth [m]
0
100
200
300
400
500
0
5000
10000
15000
20000
25000
Horizontal LL length [m]
B
g(r)
0.1
0.01
0.001
0.0001
1e-05
1e-06
HDBF=750m
HDBF=900m
HDBF=1000m
100
1000
10000
100000
r
C
Distribution of nnd
1
0.1
0.01
0.001
0.0001
1e-05
100
1000
10000
100000
Distance [m]

Captures: pair-correlation



Captures: nnd



Fishing time