

Designing to optimize costs and minimize environmental effects



Anton Edwards

University of the Highlands and Islands

&

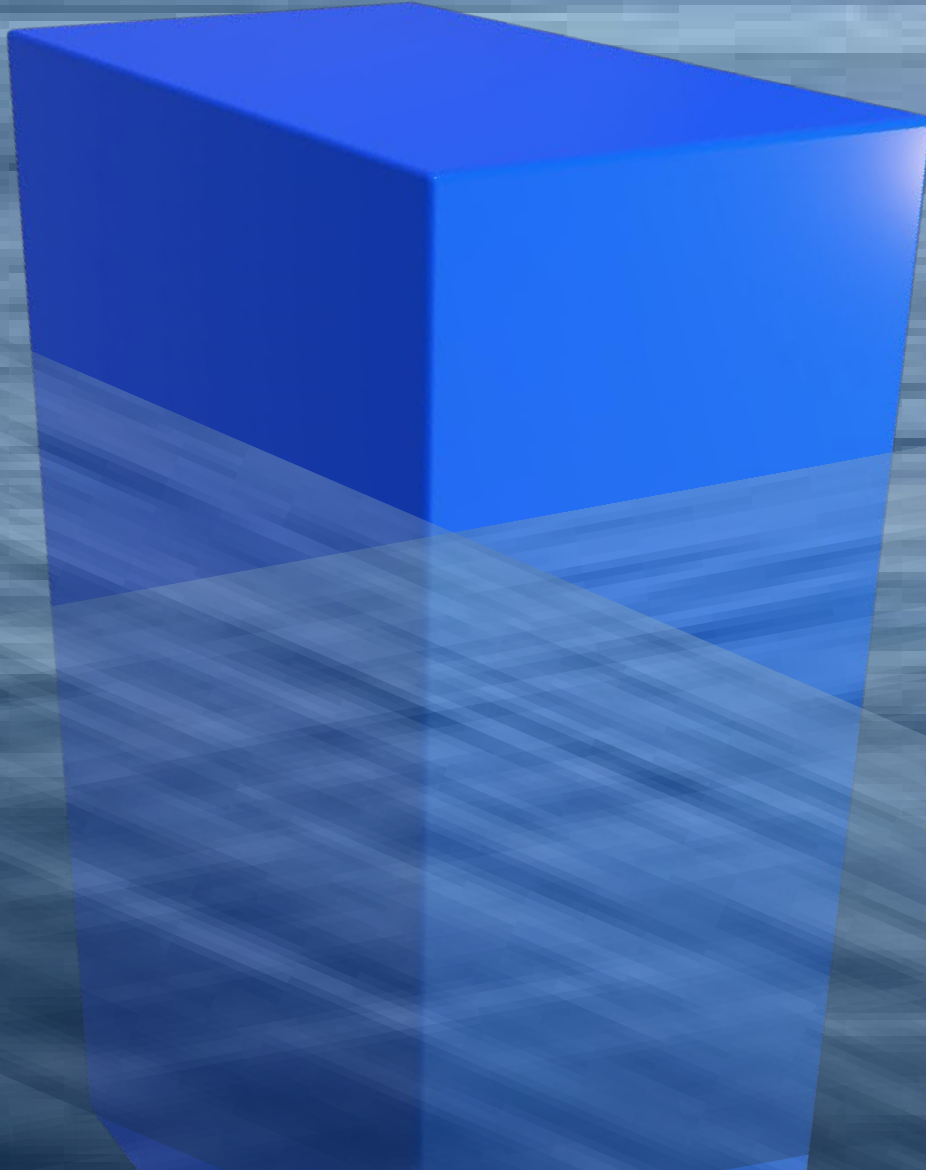
Colin Griffiths

SAMS

Structures in the Sea



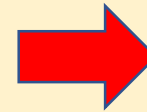
Structures in the Sea



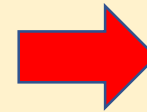
Over-Engineered

£££ High Capital Cost

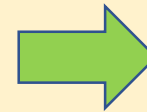
£££ High Running Cost



High environmental
effect of running

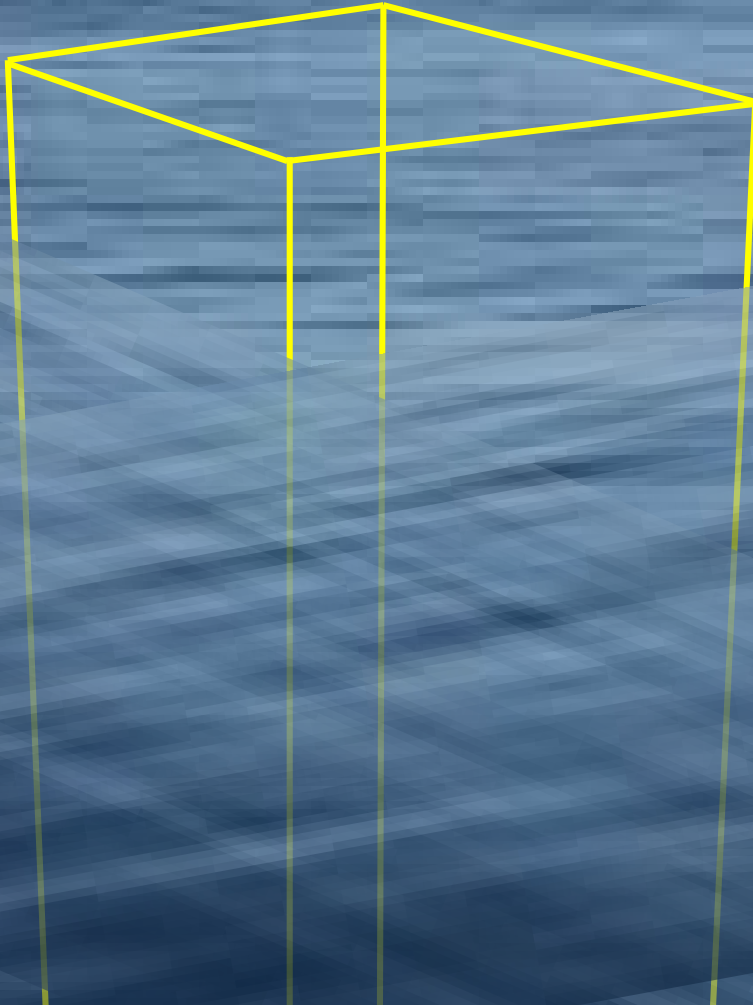


High environmental
effect of manufacture



Low Risk of
catastrophic environmental
effect

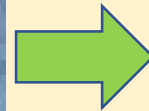
Structures in the Sea



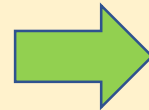
Under-Engineered

£ Low Capital

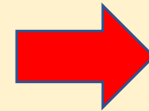
£ Low Running



Low environmental
effect of running



Low environmental
effect of manufacture



High Risk of
catastrophic environmental
effect

Structures in the Sea

**Optimally
Engineered?**

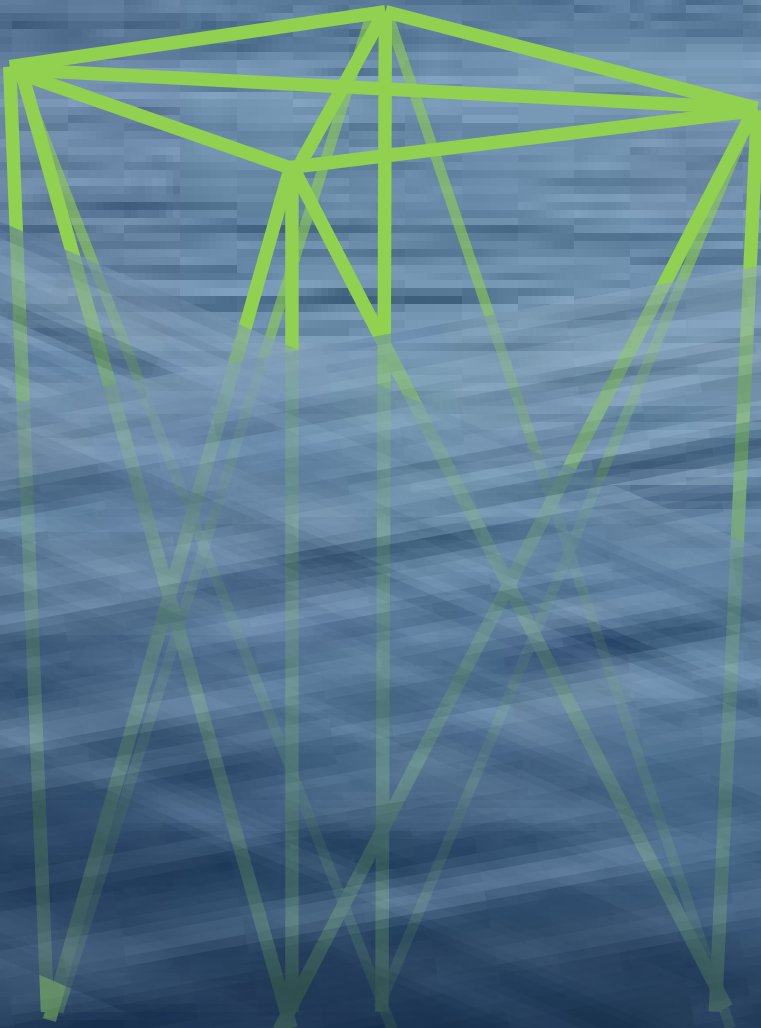
££ Modest Capital

££ Modest Running

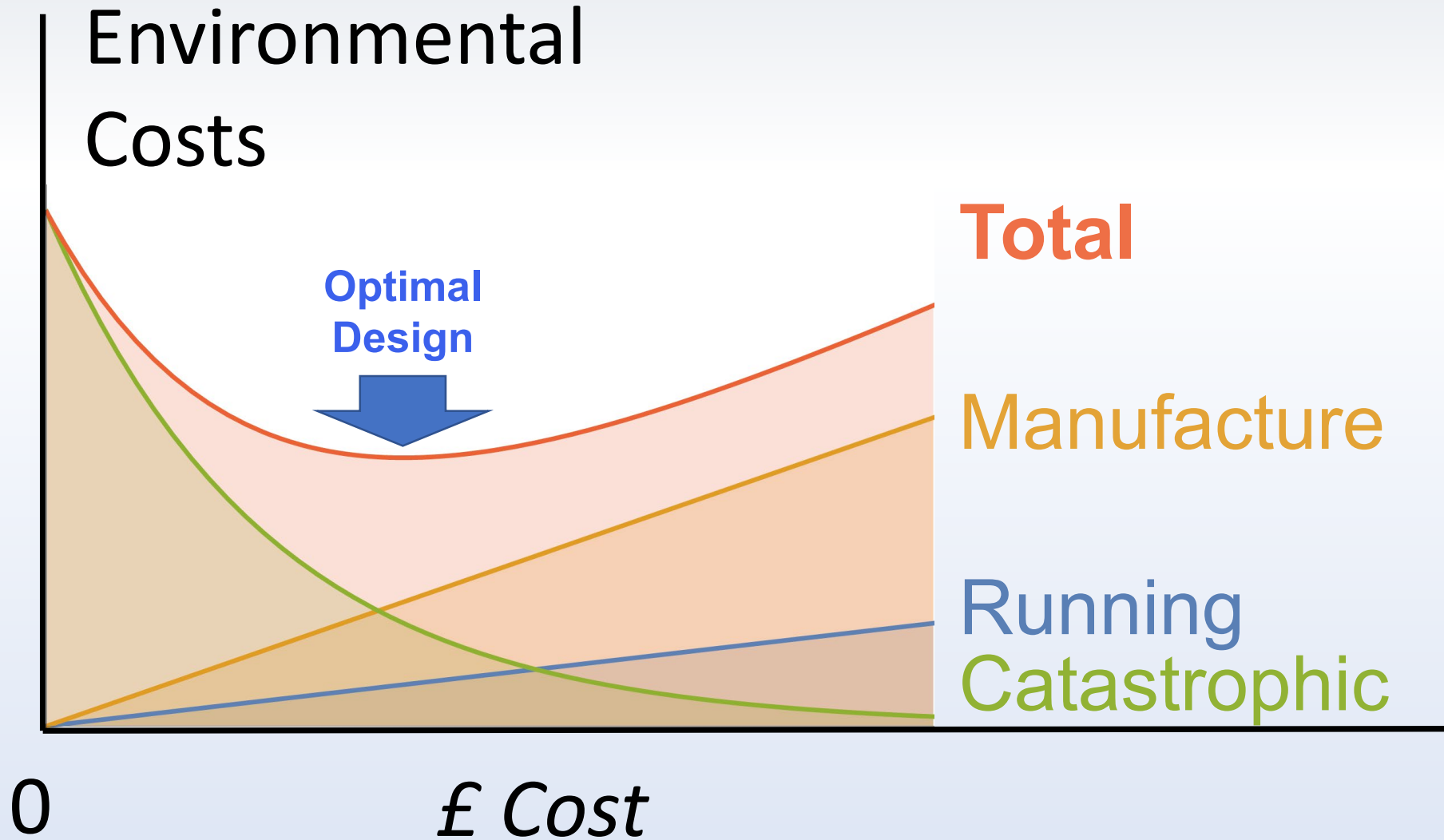
➡ Modest environmental
effect of running

➡ Modest environmental
effect of manufacture

➡ Low Risk of
catastrophic environmental
effect



Three Types of Environmental Costs



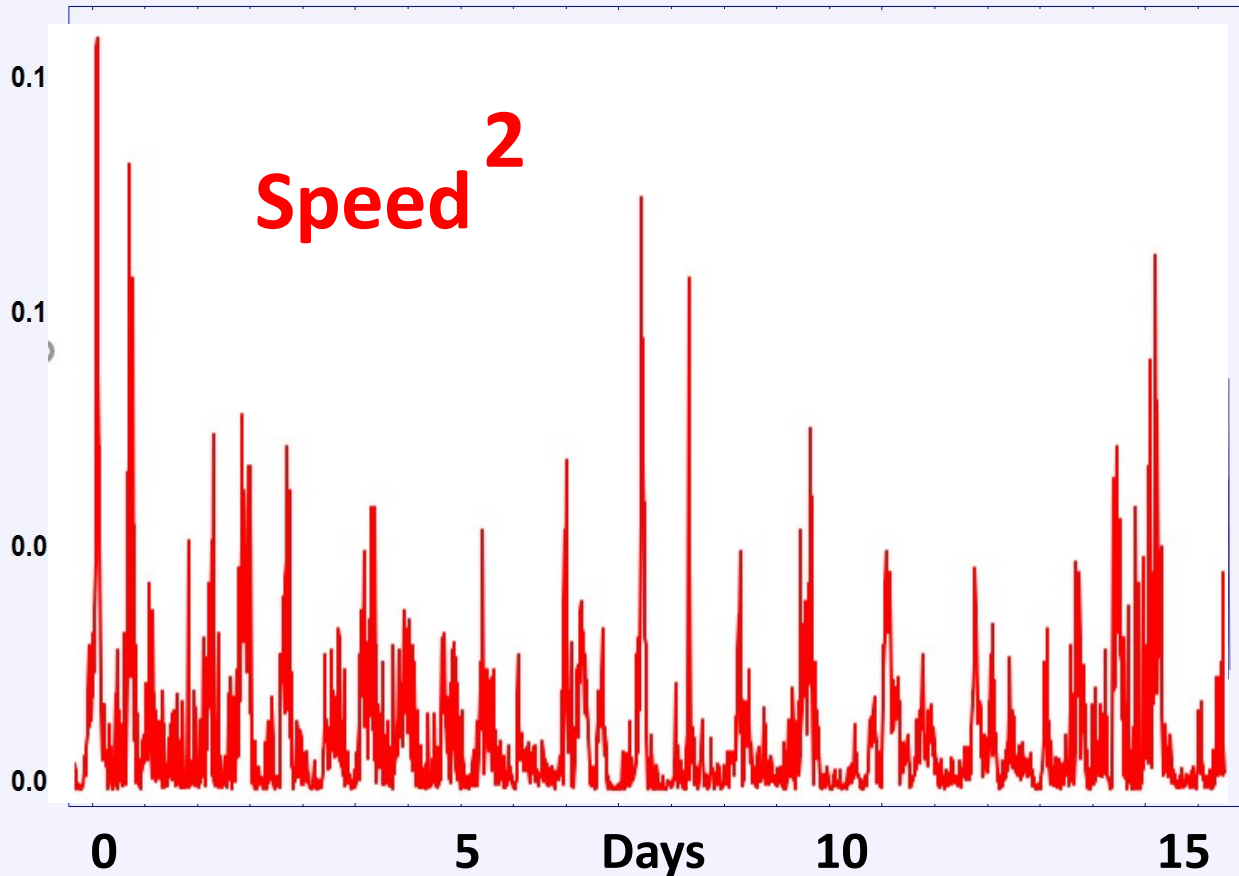
Searching for the Optimum among

Waves,

Tides,

& Currents

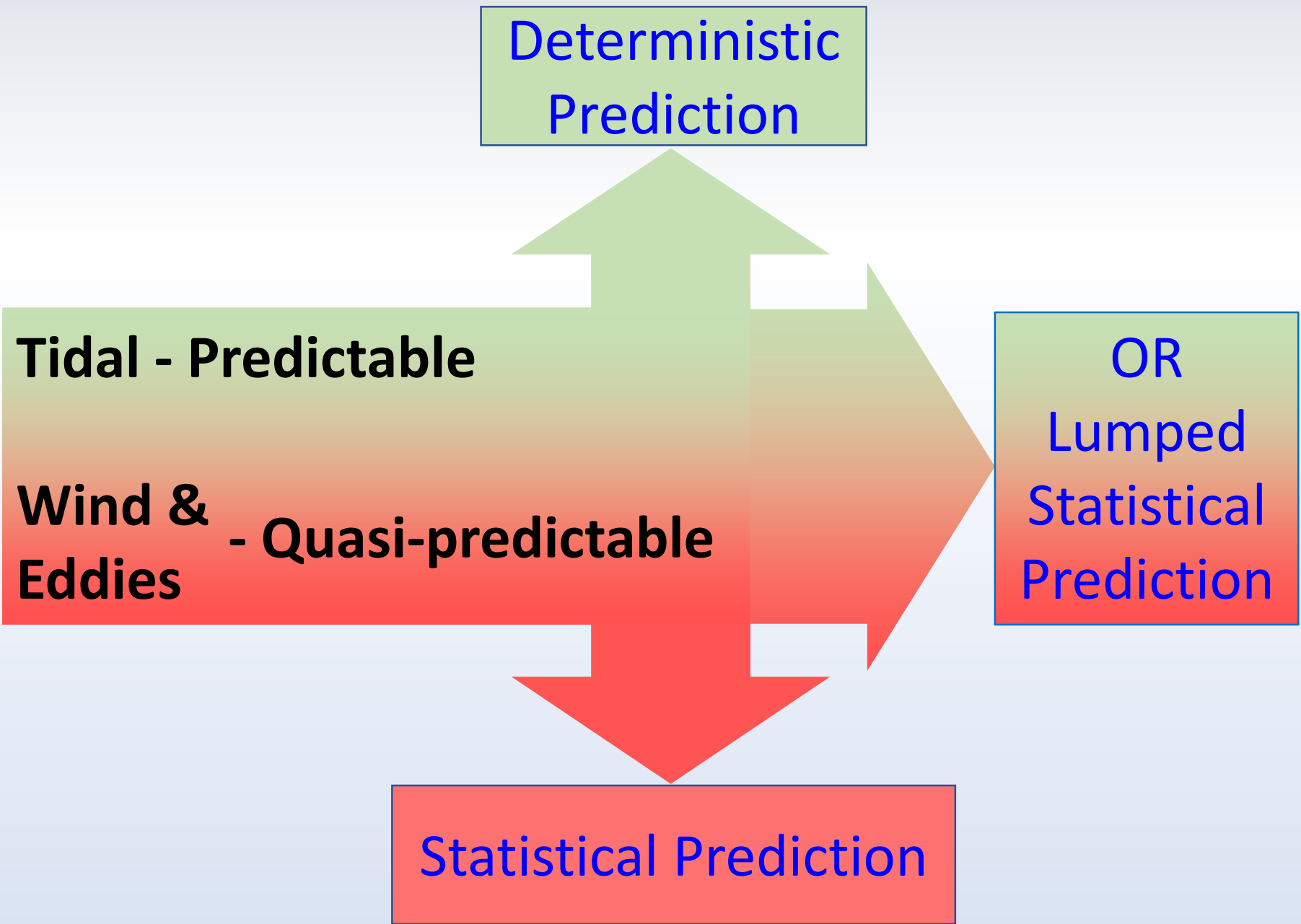
Mooring Forces Associated with Currents²



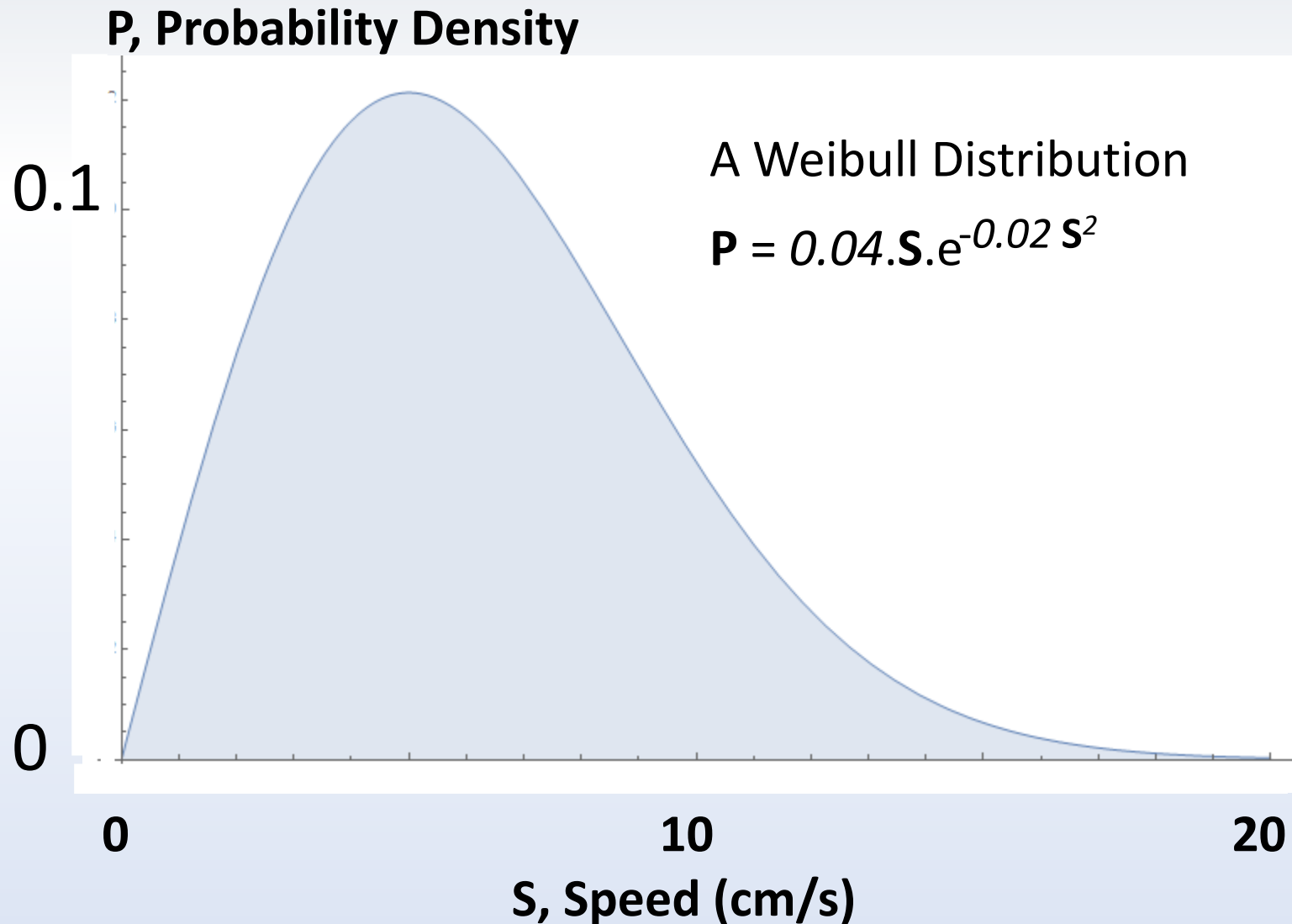
**Currents
are:**

- Tidal
- Wind
- Turbulent

Modelling Extreme Currents

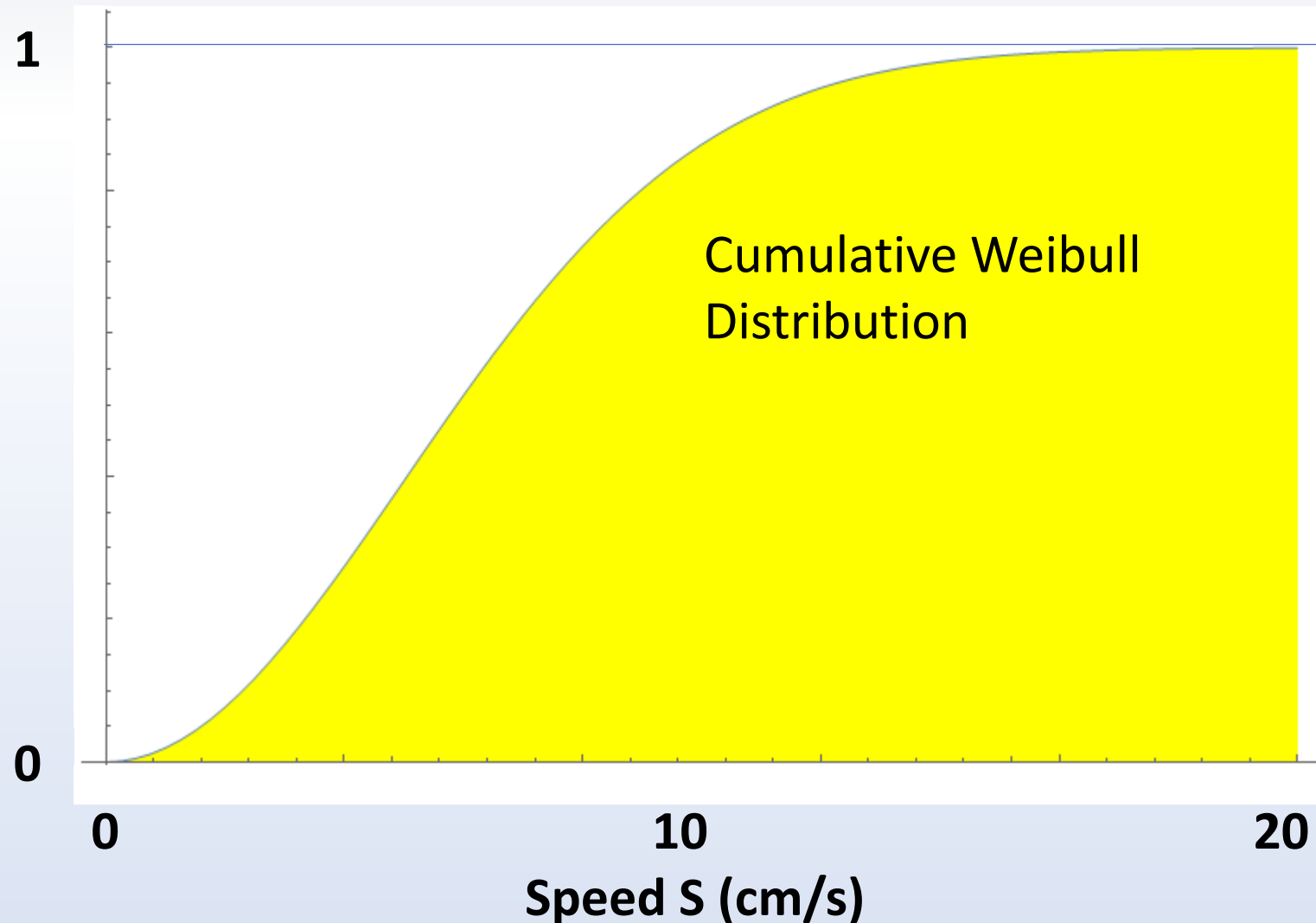


Statistical Distribution of Lumped Speeds (30,000 measurements from Sound of Sleat)

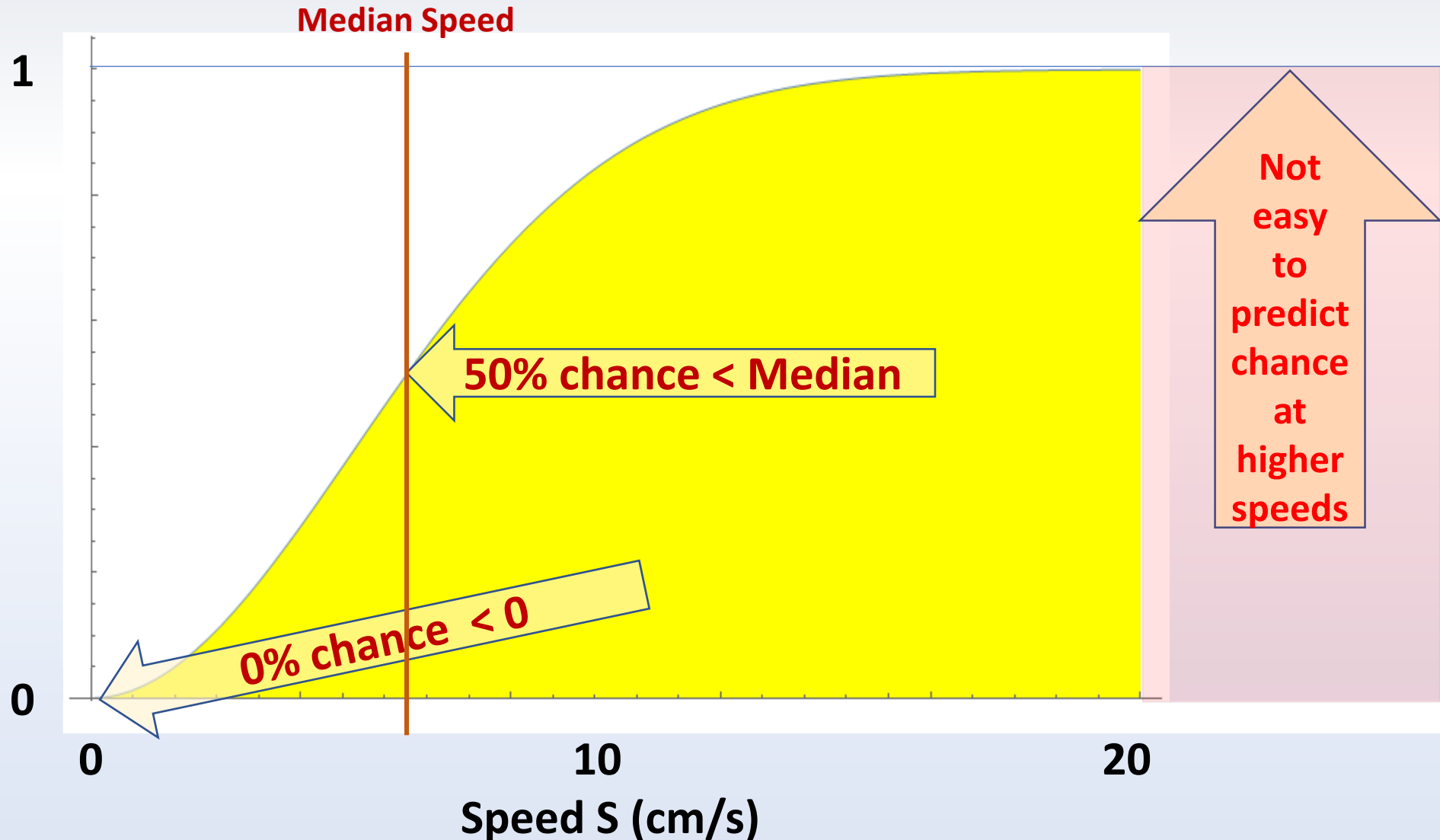


Statistical Distribution of Lumped Speeds (30,000 measurements from Sound of Sleat)

Probability of Speed S or less

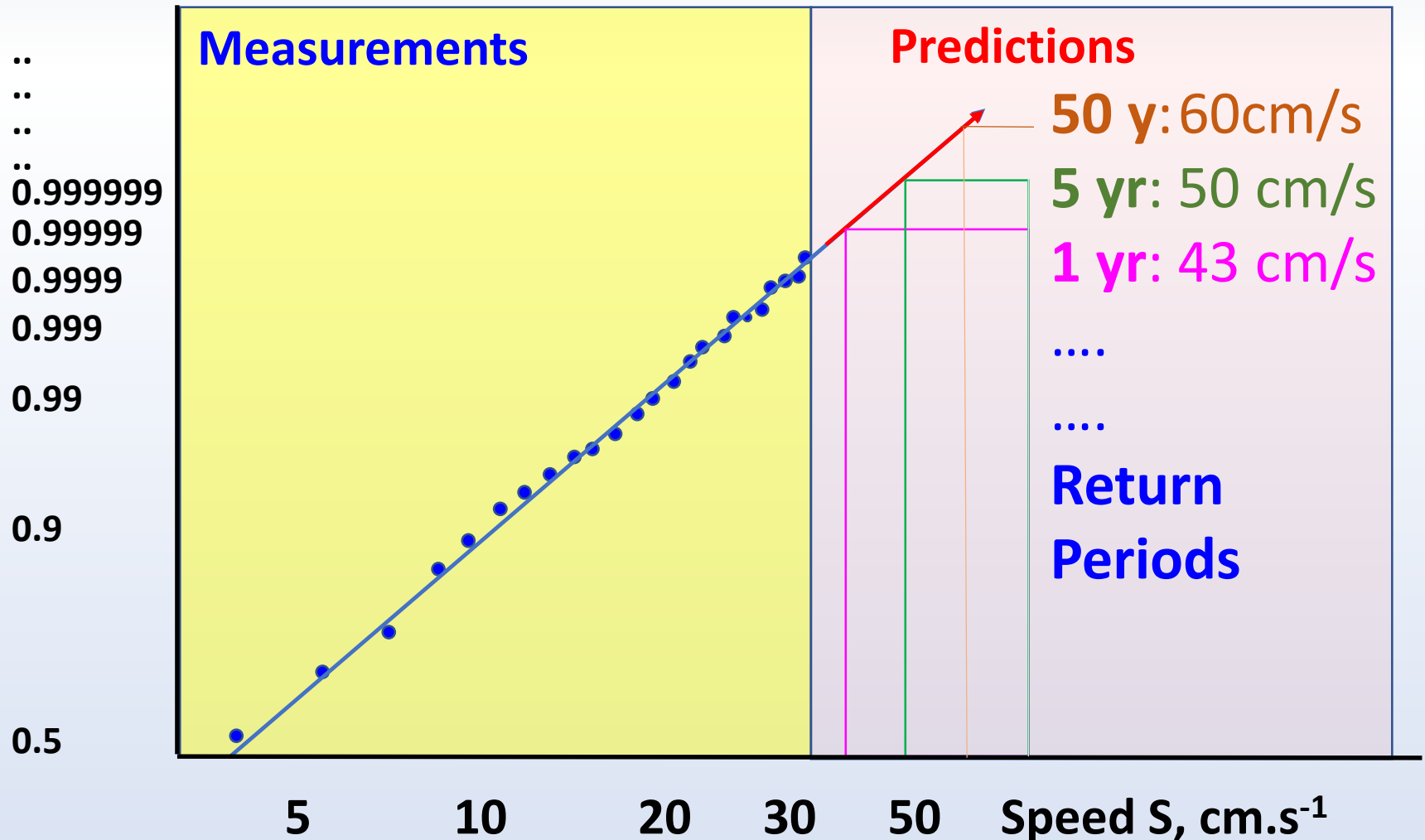


The Chance of less than a Particular Speed



The Chance of less than a Particular Speed (after a bit of fancy log-log manipulation!)

Chance of less than Speed S (Gareloch, 13000 x 10 minute data)

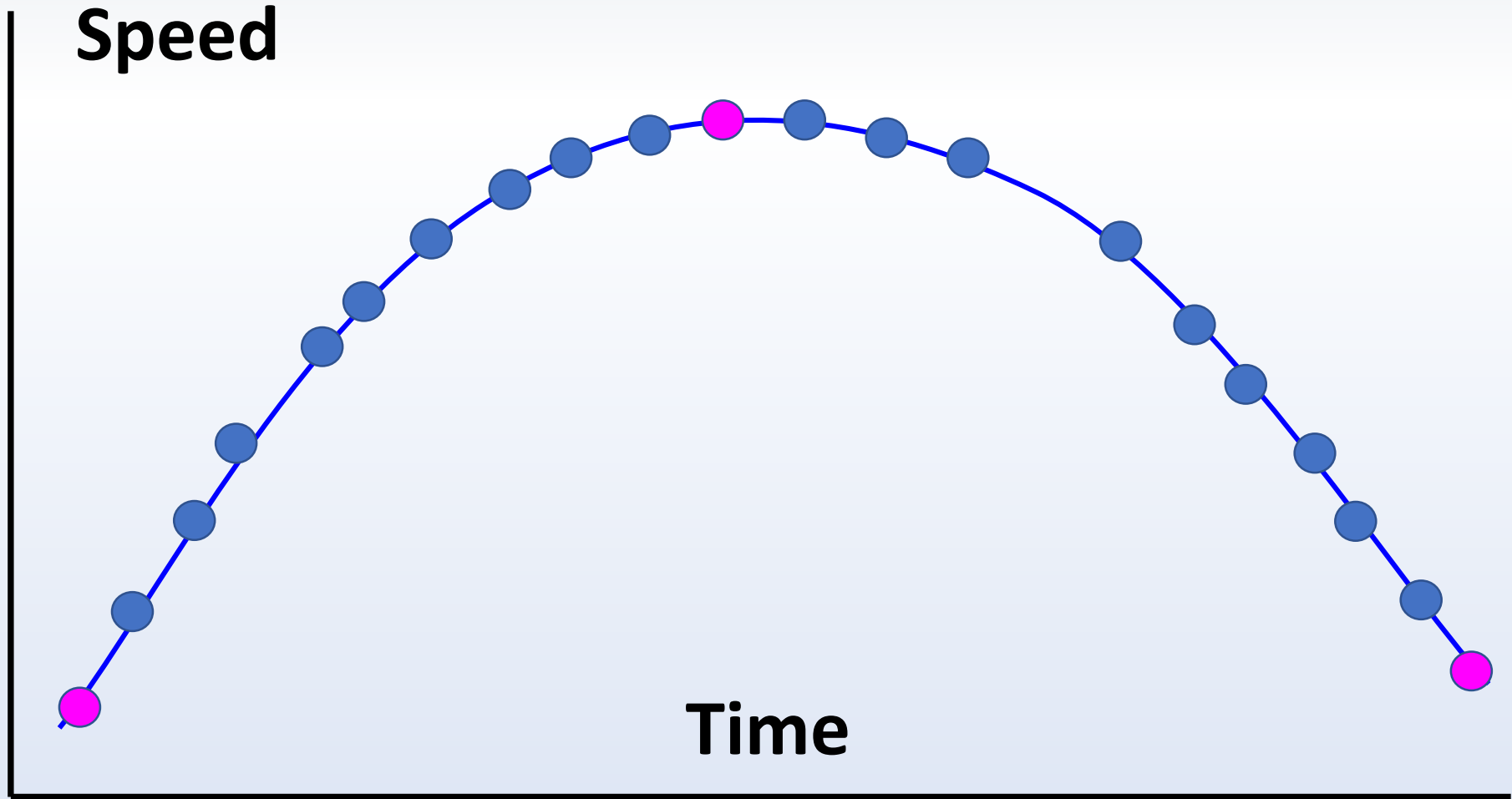


Return Periods in the Gareloch

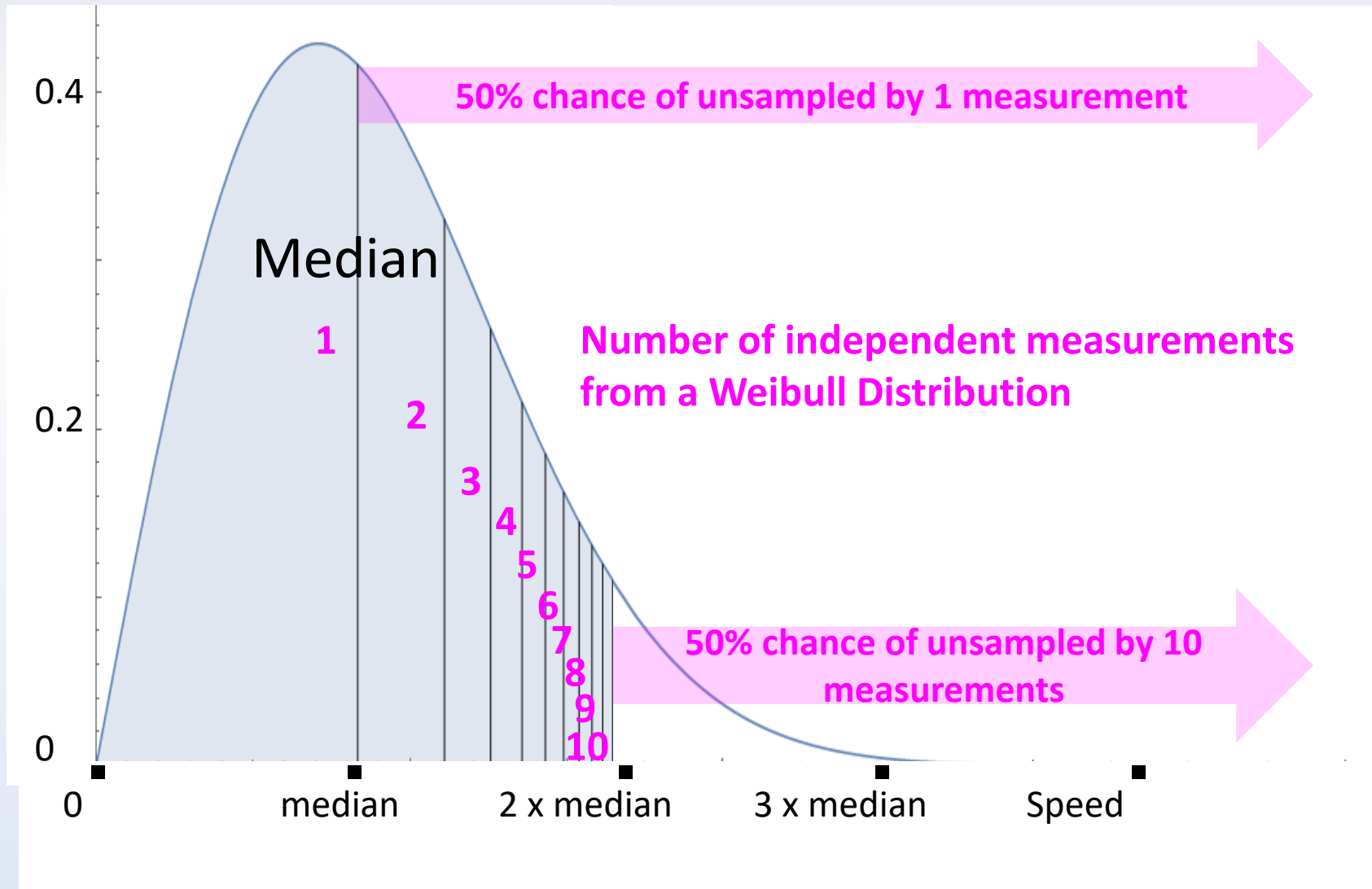
	Years	> Speed cm/s	Factor above measured maximum
Measured	0.25	35	1
Predicted	1	43	1.2
	5	50	1.7
	50	60	1.8

Caution!

Are Measurements Independent?

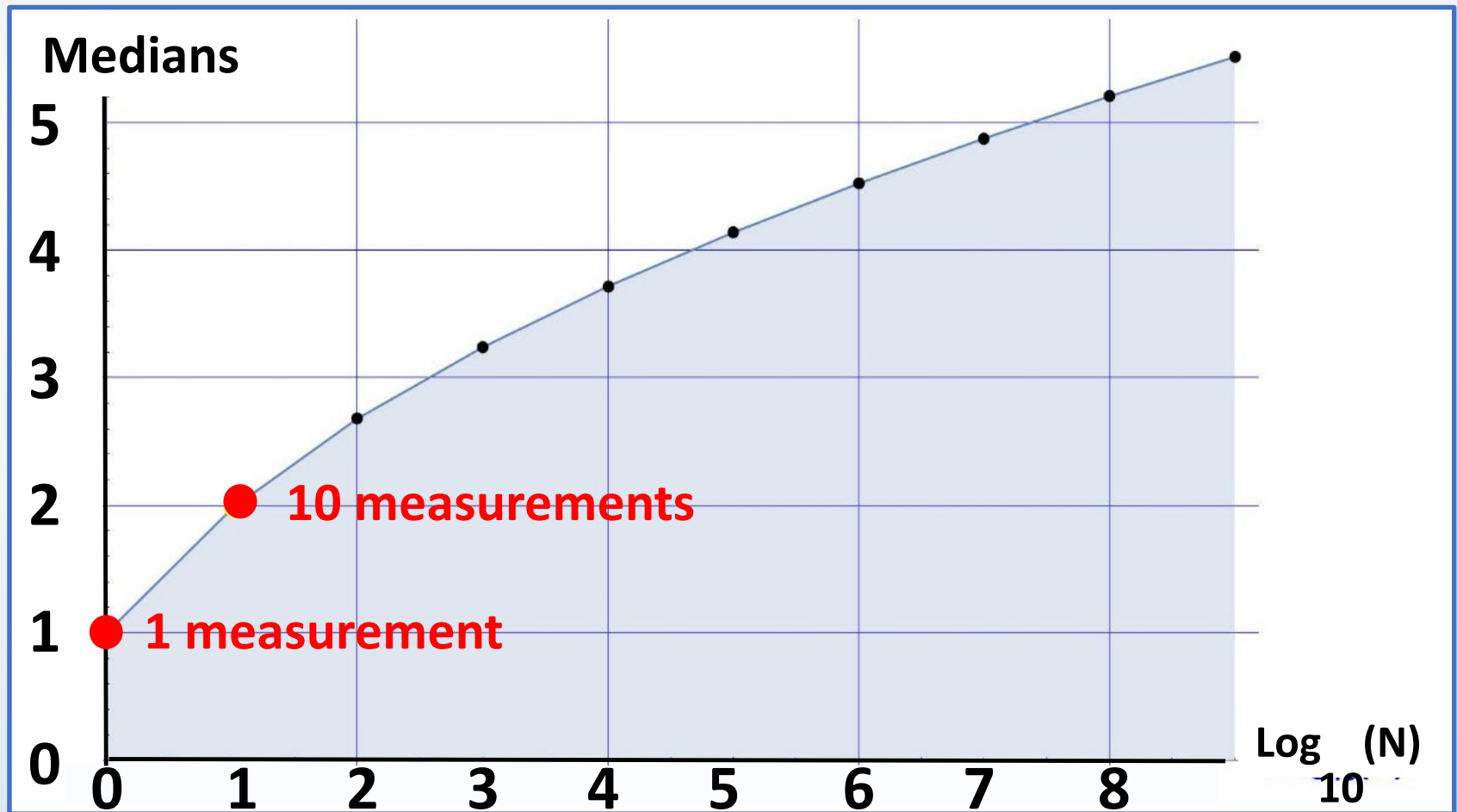


How many independent measurements?



How many independent measurements?

Weibull (2,2): Number of measurements needed for 50% chance of sampling the tail at speeds above the median



=> Diminishing returns from longer sampling

Reservations and Cautions

- Weibull parameters need estimation
- Check independence of measurements
- Tidal and Random: separate or together?
- Spring-neap cycles
- Seasonal effects

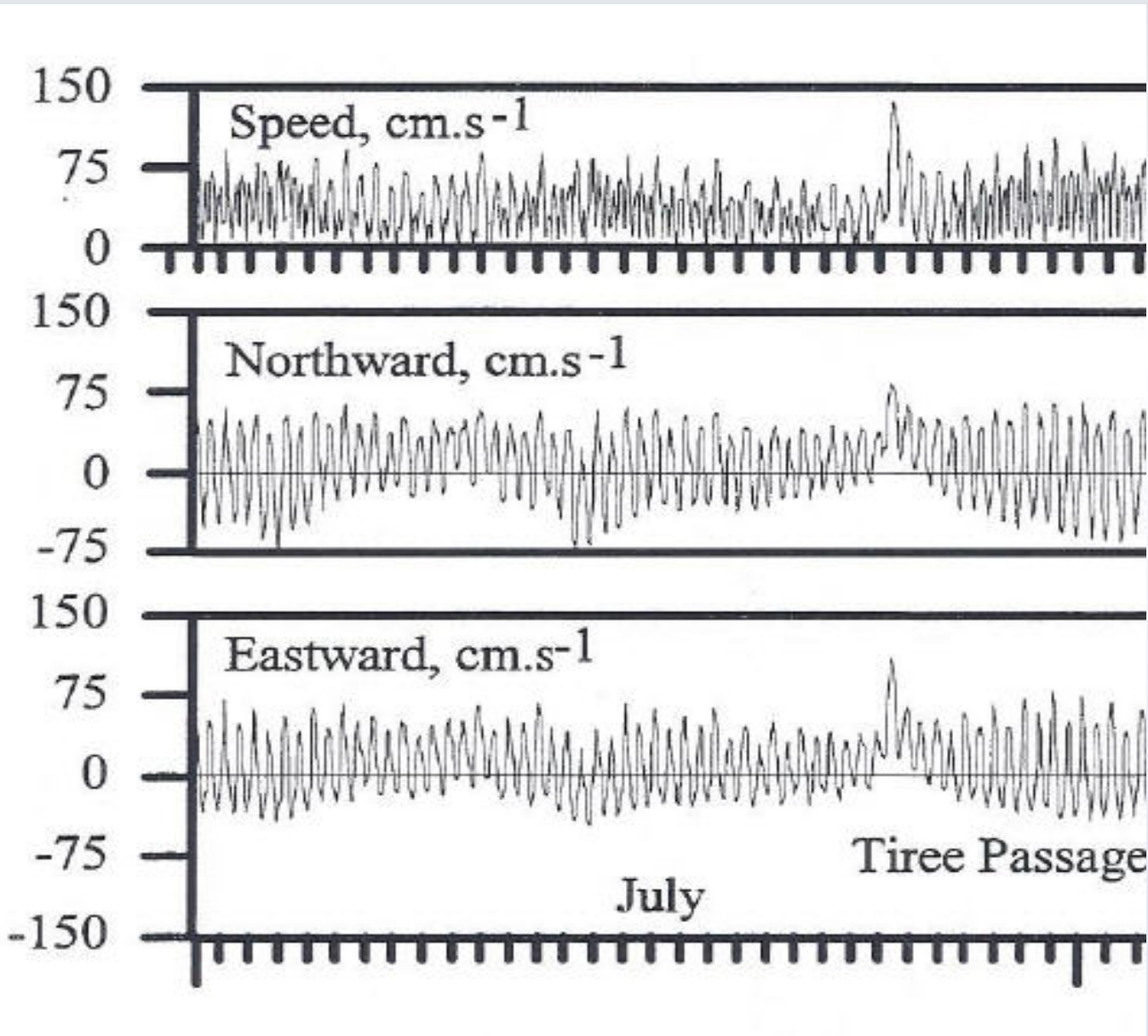
Thank you



A Technical Standard for Scottish Finfish Aquaculture. Marine Scotland.
ISBN: 978-1-78544-372-5 pp 66-921

www.gov.scot/publications/technical-standard-scottish-finish-aquaculture/

Mooring Forces Associated with Currents

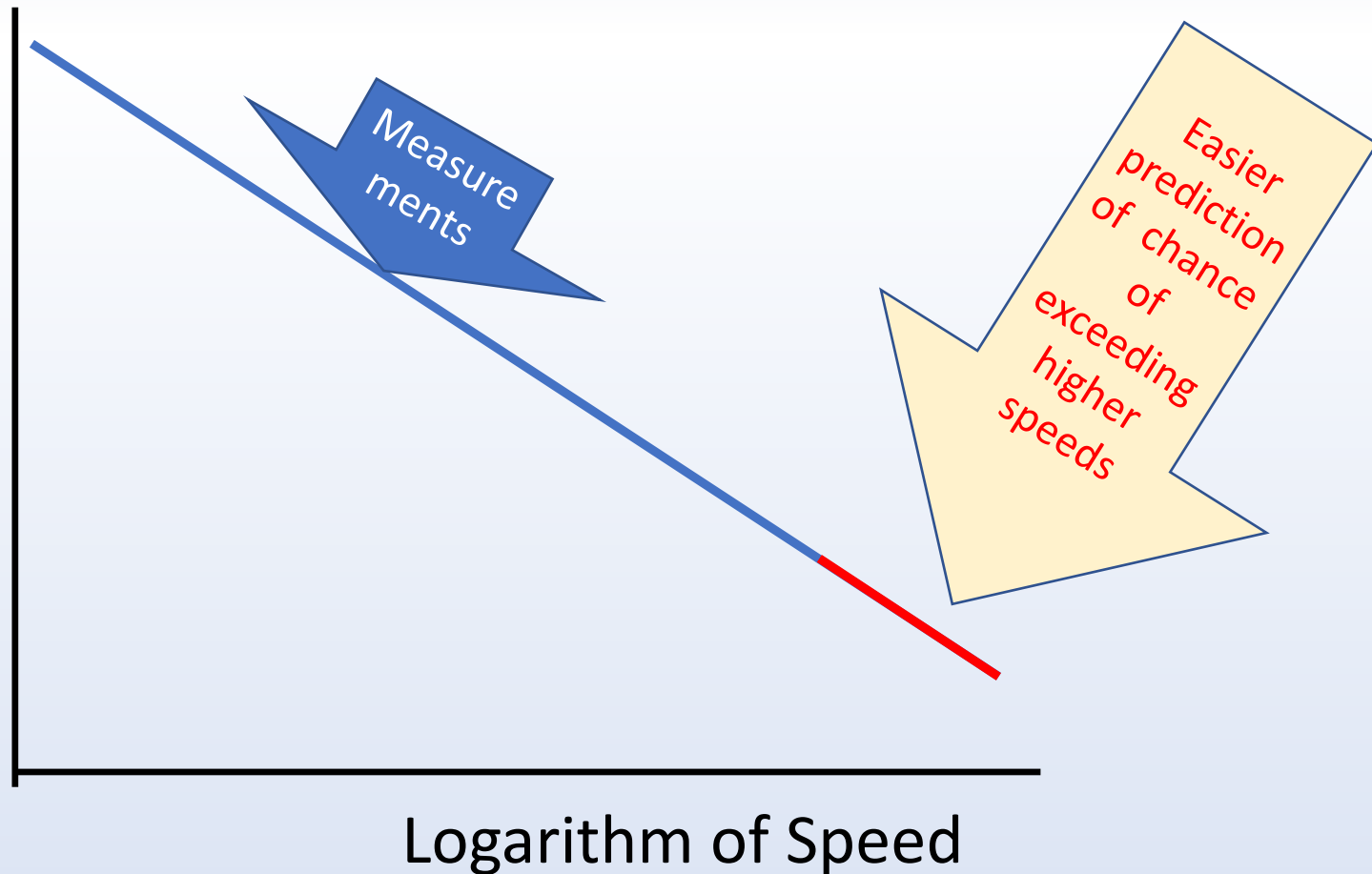


Currents are:

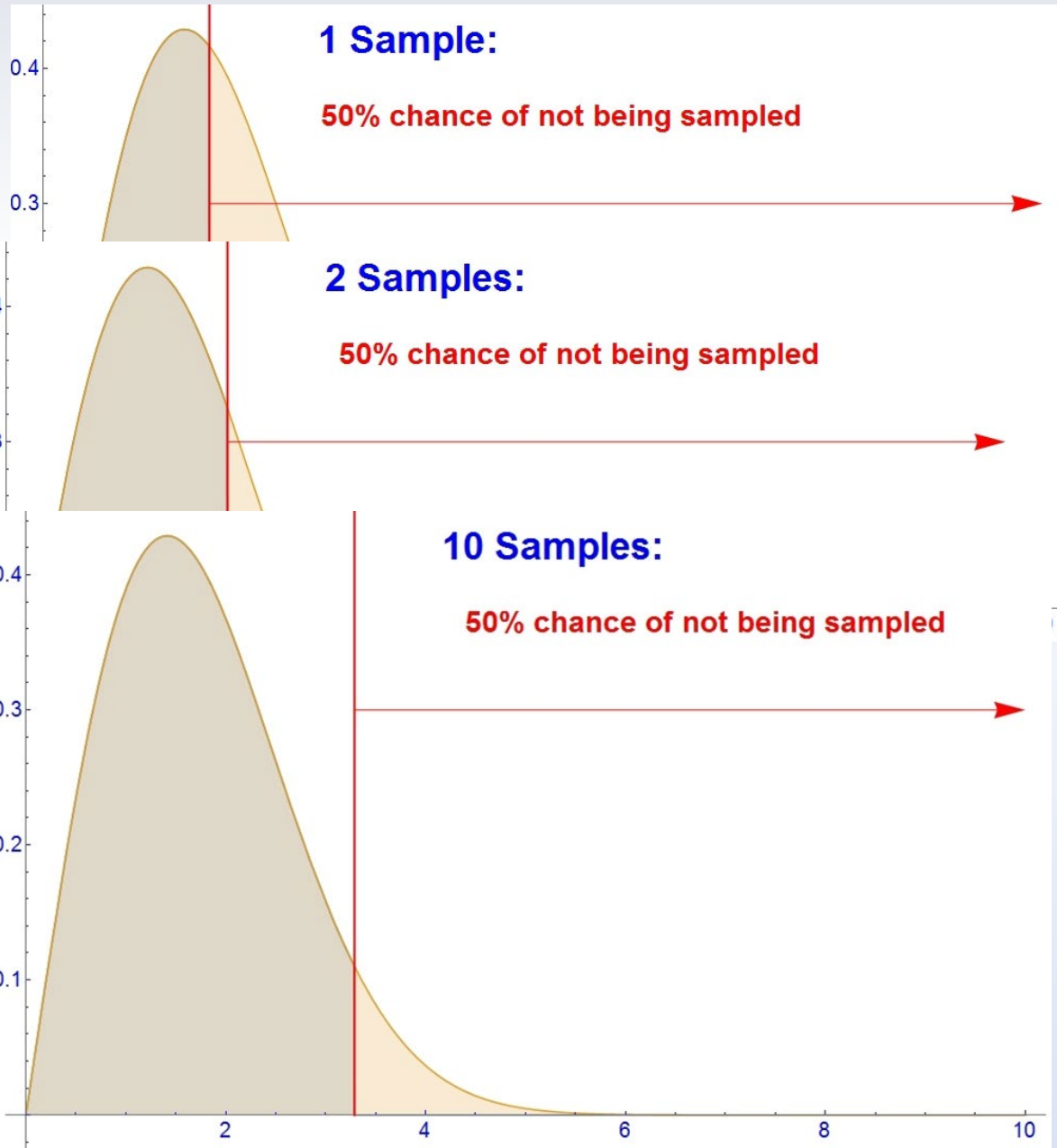
- Tidal
- Wind
- Turbulence

The chance of exceeding a particular speed *(after a bit of fancy log-log manipulation)*

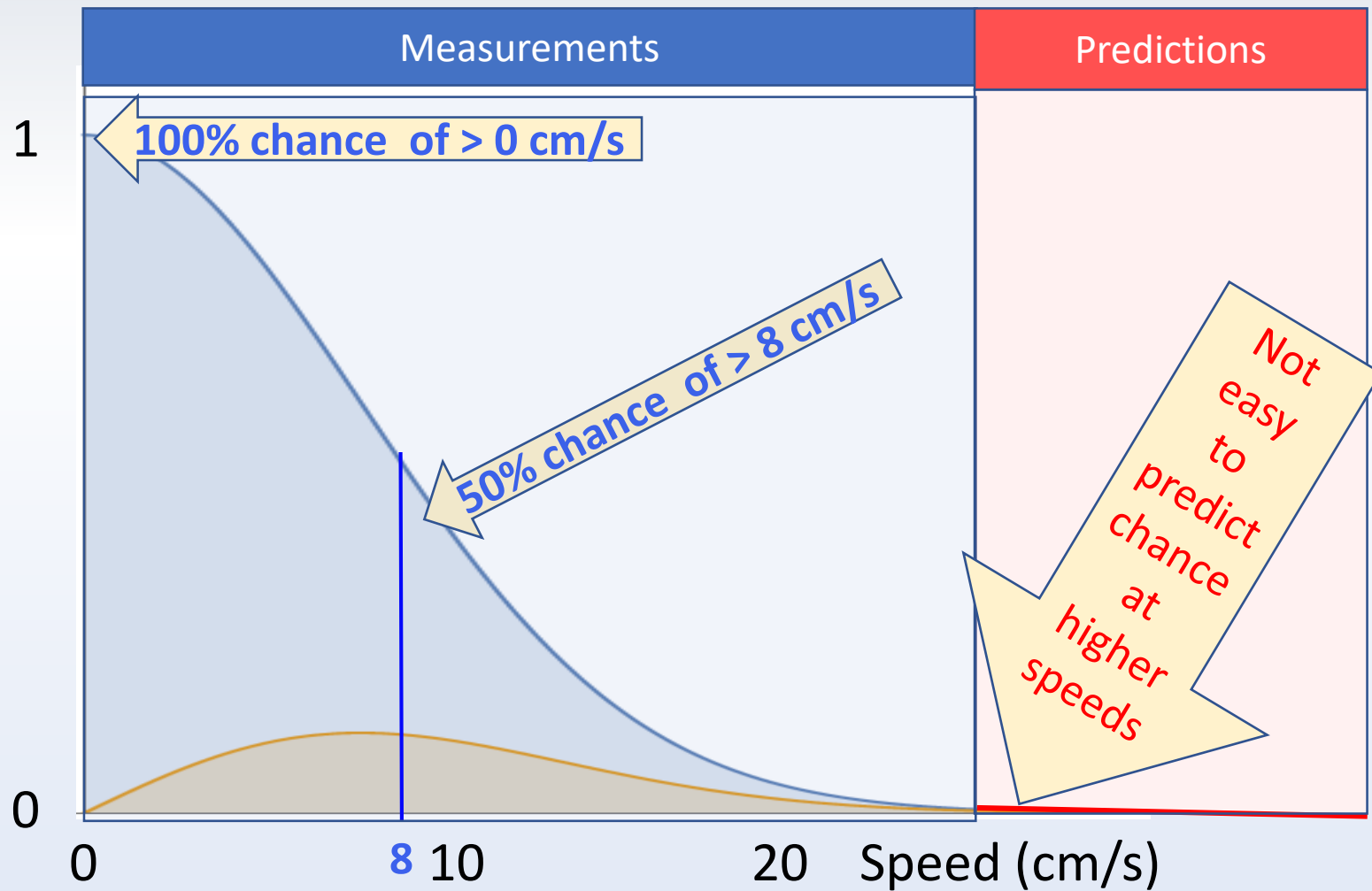
Log-Log Transformation of Exceedance Probability



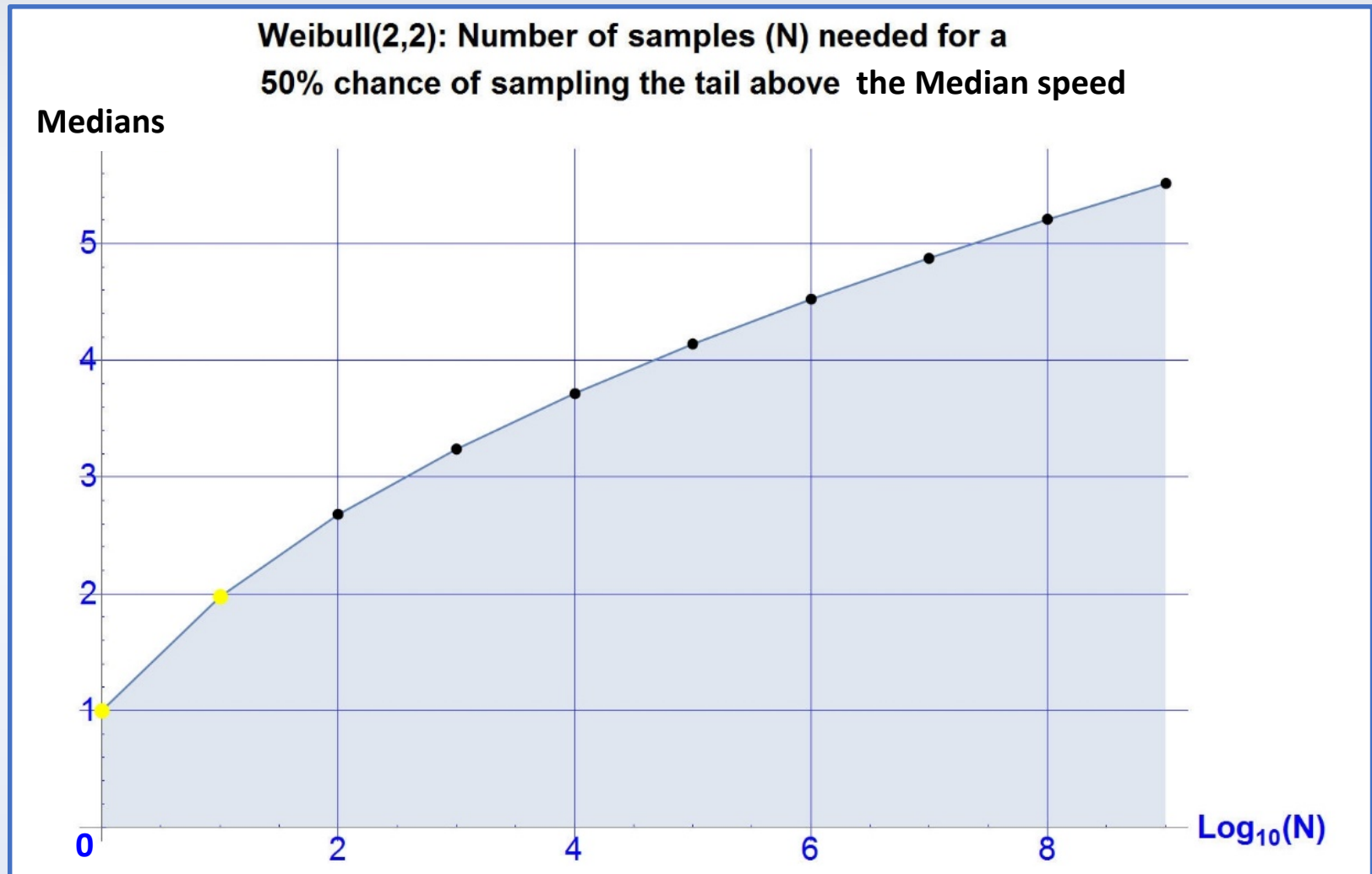
How many independent measurements?



The chance of exceeding a particular speed



How many independent measurements?



Diminishing returns from longer sampling

Return Periods in the Gareloch

	Years	> Speed cm/s	Factor above measured maximum
Measured	0.25	35	1
Predicted	1	43	1.2
	5	50	1.7
	50	60	1.8

How many **independent** measurements?

