# Welcome the Thünen ICES ASC2016 competition!

ICES ASC 2016, RIGA, ICES CM 2016/F:623

The question asked at this year's ICES Annual Science conference was:

If you have 35 assessed stocks in the North Sea, how many of those would have to indicate a good status so that you can claim "The fish stocks in the North Sea are doing well"? These kind of question are often asked in integrated ecosystem assessments (IEA), where assessment from single ecosystem assessments have to be combined. Prominent examples for IEA are the national member states assessments of the Marine Strategy Framework directive (MSFD) or the regional sea conventions HELCOM and OSPAR.

As a hint I pointed out to the fact that single assessments are associated with uncertainty and that the binomial distribution could help us to find an answer to the question, how many stocks of the North Sea should be at good environmental status (GES). The MSFD in many places states that ***everything*** should be at GES, so this would mean all stocks should indicate GES. But in reality, this will be difficult to achieve, because each assessment is associated with uncertainty, or to word it positively, with a confidence level $p$. Let us say, in our case $p = 0.95$, this means that we are 95% confident that each single stock has achieved GES.

If we use the binomial distribution, we can estimate, how many GES (k) out of $n$ assessments can be expected under this given $p$:

$$\mathrm{P}(k|n,p) = \binom{n}{k} p^k (1-p)^{n-k}$$

So given that $p = 0.95$, $n = 35$ stocks and we would observe 30 stocks at GES (k=12):

$$\mathrm{P}(30|35,0.95) = \binom{35}{30} 0.95^{30} (0.05)^5 = 0.022$$

Then we can use the cumulative distribution to estimate the numbers for $k$, which are unlikely:

$$\mathrm{F}_X(\mathrm{x}) = \sum_{k=0}^{35} \binom{35}{k} p^k (1-p)^{35-k}$$

For those $k$, where Fx(X) < 0.05, these will be unlikely constellations of $k|n,p,$. In our example, Fx(x) will be < 0.05 if $k$ is < 31 and hence **at least 31 out of 35 stocks** should indicate GES to claim:

**"Looks like overall, the fish and shellfish stocks in the North Sea are doing okay!"**