“Modern oceans have been so vastly altered by overexploitation of fishes as to be barely recognizable semblances of their pre-exploitation states.”

Callum Roberts 2007

*The Unnatural History of the Sea*

All photos taken near Key West, Florida. Left to right: 1 & 2 Monroe County Library collection (Florida Keys) 3. Smithsonian Magazine (September 2008), Loren McClenachan
Fish depletion

Our model: “by 2100 only a fraction of today’s fish biomass will remain”

- Biodiversity loss
- Food problem
- Global omega-3 shortage

Model predictions for the future if we continue fishing at current rates
Modelling ω-3 fatty acid depletion

Metal binding proteins

Scientific impact of iGEM

ω-3 fatty acid synthesis

Resource

Zoe Ashwood
Modelling fish population dynamics

Biomass (this year) – Biomass (last year) = Recruits – Natural Deaths – Fish Caught

\[
\frac{dB}{dt} = rwe^{-\delta r} (1 - \frac{B(t - \tau)}{k})B(t - \tau) - \delta_M B(t) - F(t)B(t)
\]
Real-world fish biomass data

- 77 data points
- 234 sets of data extrapolated and combined
- 1932-2006 time series
Parameter tuning

**Total fish biomass (tonnes)**

- **Solid** – model’s prediction of biomass;
- **Dots** – real-world biomass data

**Year**

- 1950
- 1960
- 1970
- 1980
- 1990
- 2000

**Catch (tonnes)**

- **Solid** – model’s prediction of catch;
- **Dots** – real-world catch data
Model's prediction of world fish biomass (solid), as it changes throughout the years between 1950 and 2100; as well as biomass data (dots).
**Omega-3 flow**

Wild: algae => fish => humans

Aquaculture: algae => fish => fish oil => farmed fish => humans

Substitute with synthetic omega-3

Fish meal is **replaceable** with non-fish products.

Fish oil contains omega-3: wild fish input **required** (at present).
Omega-3: required production levels

Green: fish-free aquaculture (current output of farmed fish). Purple: fish-free aquaculture (increased output of farmed fish). Blue: world population provided with daily recommended intake of omega-3 of 500mg per day
Model predictions for the future if we continue fishing at current rates (dashed) and if we reform our aquaculture habits (orange)
Modelling ω-3 fatty acid depletion

Metal binding proteins

Resource

Josi Buerger

Modelling ω-3 fatty acid depletion

Scientific impact of iGEM
Synthesising the ω-3 pathway

Results

Fatty Acid Methyl Ester (FAME) analysis by Gas Chromatography Mass Spectrometry (GC-MS)
Lipid analysis
Modelling ω-3 fatty acid depletion

Metal binding proteins

resource
Josi Buerger

Modelling ω-3 fatty acid depletion

Scientific impact of iGEM
Short metal binding peptides

GST

6 x His

New Ni binding sequence

![Graph showing absorption spectra with different metal binding peptides](image)
gBlocks

GST

6 x His

New Ni binding sequence

Precious metal scavenger

Toxic metal scavenger

1mbo
Modelling ω-3 fatty acid depletion

Metal binding proteins

Resource
Antti Korpimaki

Modelling ω-3 fatty acid depletion

Scientific impact of iGEM
Results summary

- **Teams**
- **Parts submitted (10s)**
- **Papers mentioning iGEM**
- **Papers mentioning Parts Registry**
- **Papers mentioning specific Registry BioBricks**

The graph shows the number of teams, parts submitted, and papers mentioning iGEM, Parts Registry, and specific Registry BioBricks from 2004 to 2011. The trend lines indicate an increase in all categories over the years.
iGEM – Registry relationship

The graph shows the growth of iGEM, iGEM + Registry, and Registry publications from 2003 to 2011. The number of publications for each category is indicated on the y-axis, with the years on the x-axis.

- iGEM publications increase steadily from 2003 to 2011.
- iGEM + Registry publications also increase but at a faster rate than iGEM alone.
- Registry publications show a significant increase, with a particularly steep rise in the later years.

The data suggests a strong relationship between iGEM and the registry, with both publications growing concurrently.
Team, PartName, PartChassis, Date, [DOI or Link]
Conclusions

- Successfully modelled past and future fish biomass and our omega-3 requirement
- Built part of the omega-3 pathway in E. Coli
- Created novel metal binding peptide
- Quantified iGEM impact
Team St Andrews thanks those who made our project possible

Dr Markus Gierth, Adam Boggon, Dr Morven Shearer, Professor Gordon Bell, Jesse H. Ausubel, Jason Fontana, Twitter's Bootstrap, DTU-Denmark 2011 (iGEM team), School of Geography & Geosciences, The Terry K. Smith Laboratory