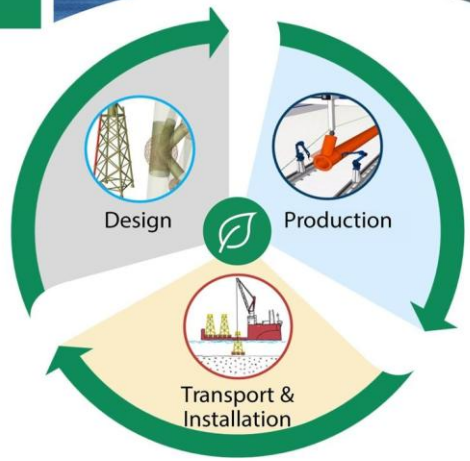
SINTEF

Grønn plattform
WINDRISE





SINTEF
AkerSolutions
SCANMUDRING
BOA
sarens
DCF
NGI
MANUFACTURING TECHNOLOGY | NORWEGIAN CATAPULT CENTRE

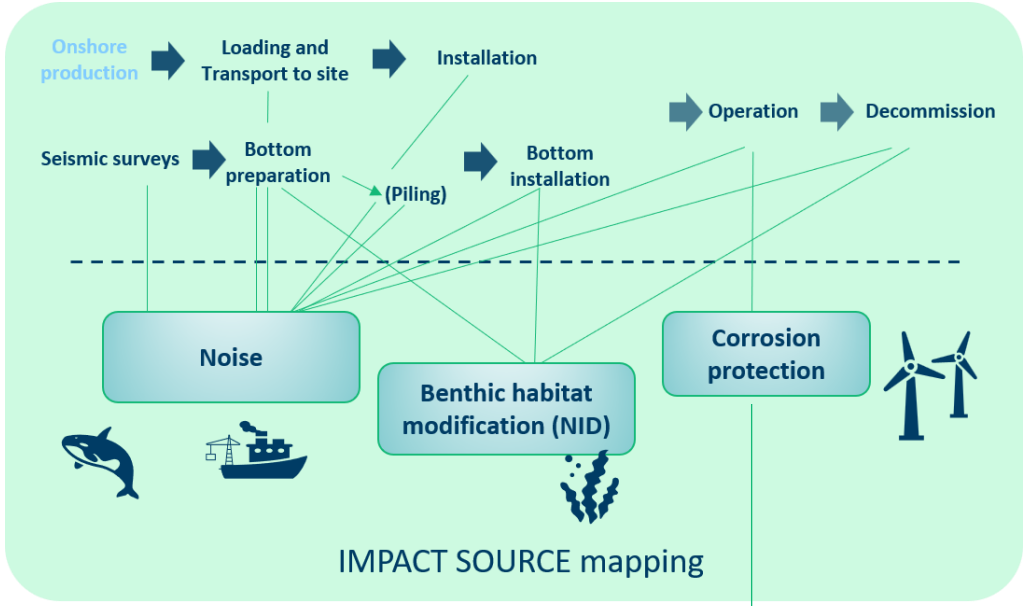


To accelerate the energy transition and reach the national and global climate goals, there is a need for rapid and large-scale development of large offshore wind farms →

- **increase production capacity and efficiency by 40-60 percent**
- **reduce costs by 15-25 percent**
- **reduce CO_2 emissions by 30-50 percent**
- **increase exports by 30-50 percent**

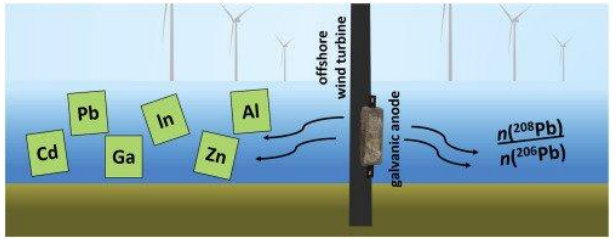
- **NID should be included in the design**
- **Need for a clear ecological target**
- **The "target" environment is central for type and design of NID**
- **Impact needs to be validated**
- **Performance monitored**

Task: Environmentally friendly installation and nature inclusive design



IMPACT SOURCE mapping

Study effects of corrosion protection

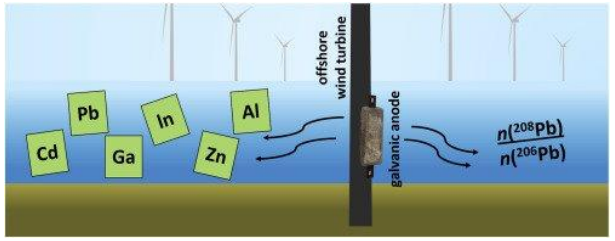


Methods

Toxicity testing of anode relevant metals

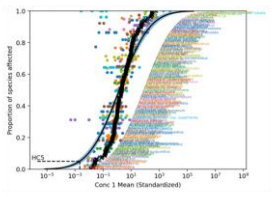
Literature search and information from workshop: relevant released metals are **Zn, Cd, Al**

Use SINTEFs SSD (species sensitivity distribution) data mining tool to map available toxicity data



Zinc chloride

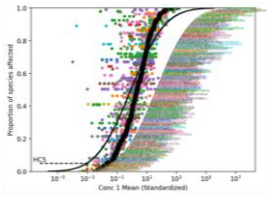
Number of species: 155, number of data points: 802, HC5 = 0.0022 (0.0012-0.0042) mg/L



HC_5=2.2 µg/L

Cadmium chloride

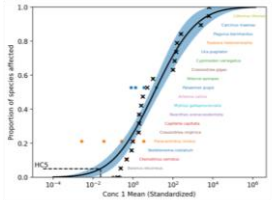
Number of species: 295, number of data points: 2537, HC5 = 0.0009 (0.00074-0.0012) mg/L



HC_5=0.9 µg/L

Aluminium

Number of species: 20, number of data points: 39, HC5 = 0.024 (0.0077-0.09) mg/L



HC_5=24 µg/L

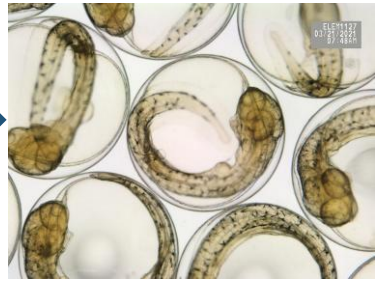
EC_{50} concentration that causes an effect for 50 % of the population

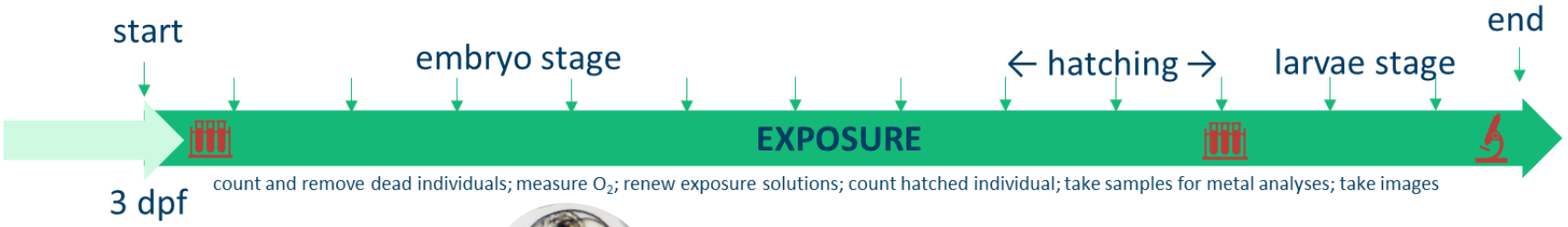
LC_{50} lethal concentration 50 % of the population

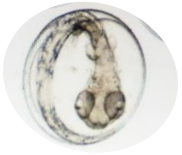
NOEC No observed effect concentration

Quite a lot of data available for Zn and Cd; not much for Al

Do a toxicity test on Al and Zn, using Atlantic cod early life stages









ENDPOINTS:

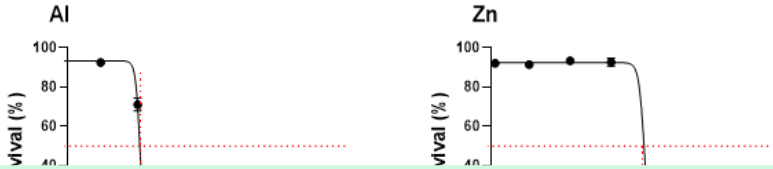
- Mortality (embryos, larvae)
- Hatching – time and % hatched
- Malformations
- Biometry
- Samples for ICP-MS analyses

Results and Outlook

	Zn nominal		Zn measured (mg(L)	
	$ZnCl_2$	Zn	Start	End
Control	0	0	0.005	0.008
C6	0.024	0.0115	0.0169	0.0136
C5	0.12	0.0576	0.0599	0.0540
C4	0.6	0.29	0.26	0.28
C3	3	1.44	1.46	1.46
C2	15	7.2	6.97	7.16
C1	75	36	34.68	36.17

	Al nominal		Al measured (mg/L)	
	$AlCl_3$	Al	Start	End
Control	0	0	0.0100	0.0048
C6	0.0096	0.0019	0.0044	0.0053
C5	0.048	0.0097	0.0107	0.0051
C4	0.24	0.05	0.0472	0.0433
C3	1.23	0.24	0.2301	0.2461
C2	6	1.21	0.3029	0.2734
C1	30	6.05	6.3250	0.1922

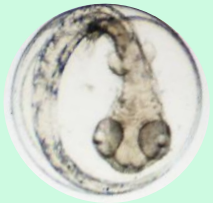
- All embryos died at Zn C1 (~30 mg/L)
- Zn was toxic for embryos, Al was toxic for larvae
- LC_{50} Al: **0.212** mg/L (95% CI 0.207-0.2188 mg/L)
- LC_{50} Zn:



NEXT PROJECT?

Learn more about fate and effects of anode materials, especially Al!
Find less toxic anode materials?

Julia.farkas@sintef.no



- Natural background concentrations of Al and Zn in seawater vary, reaching from 0.0005 – 0.015 mg/L for Al, and 0.0006 – 0.005 mg/L for Zn
- Kirchgeorg et al. 2018: "If we consider an OWF with **80 OWT** with monopile foundations and an **OSS**…., an OWF will release annually **45 tons** of **Al** and **2 tons** of **Zn** (if we assume 5% Zn)". (more for jackets than for monopiles)