CalCOFI: Best Practices In a Changing Climate

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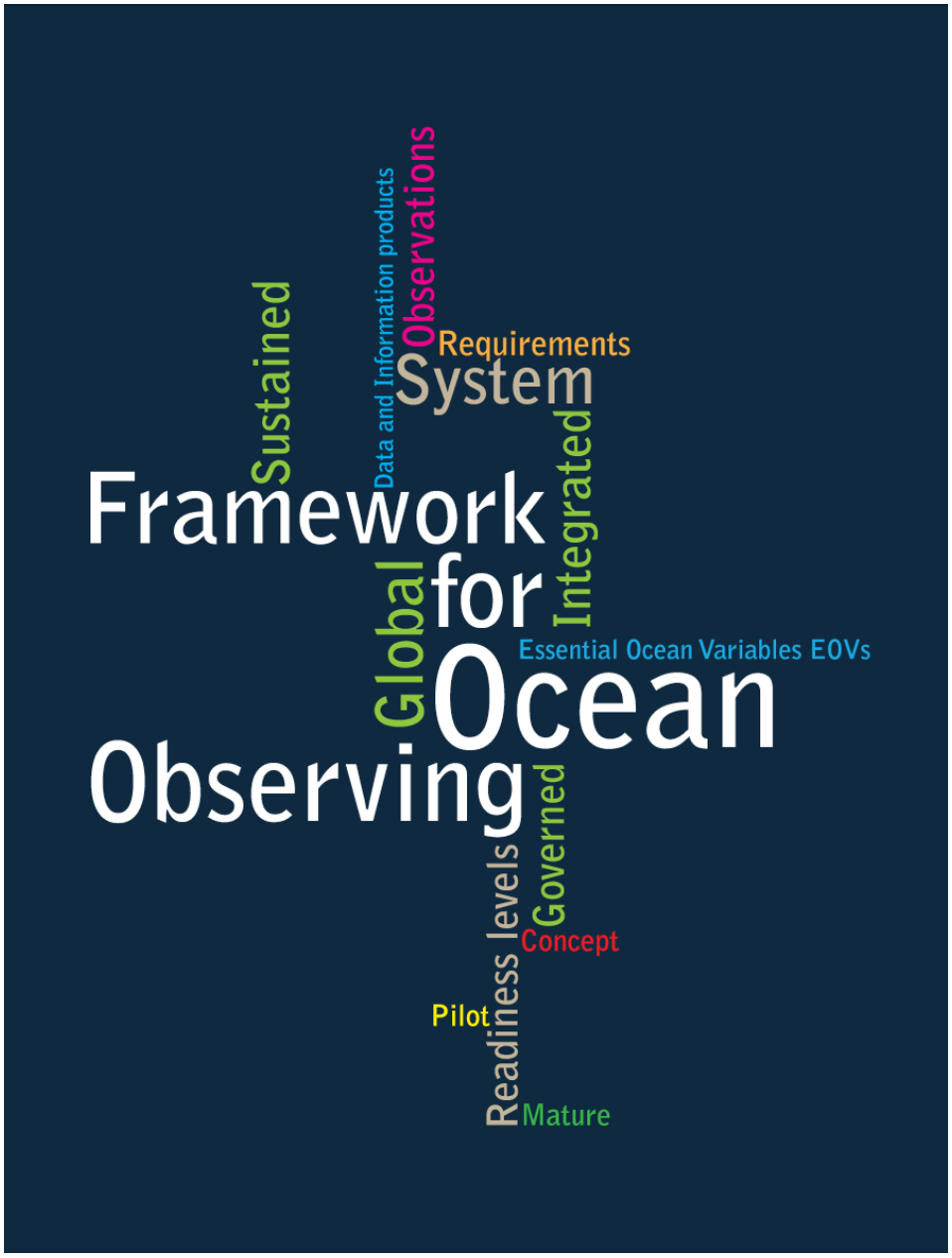
Outline

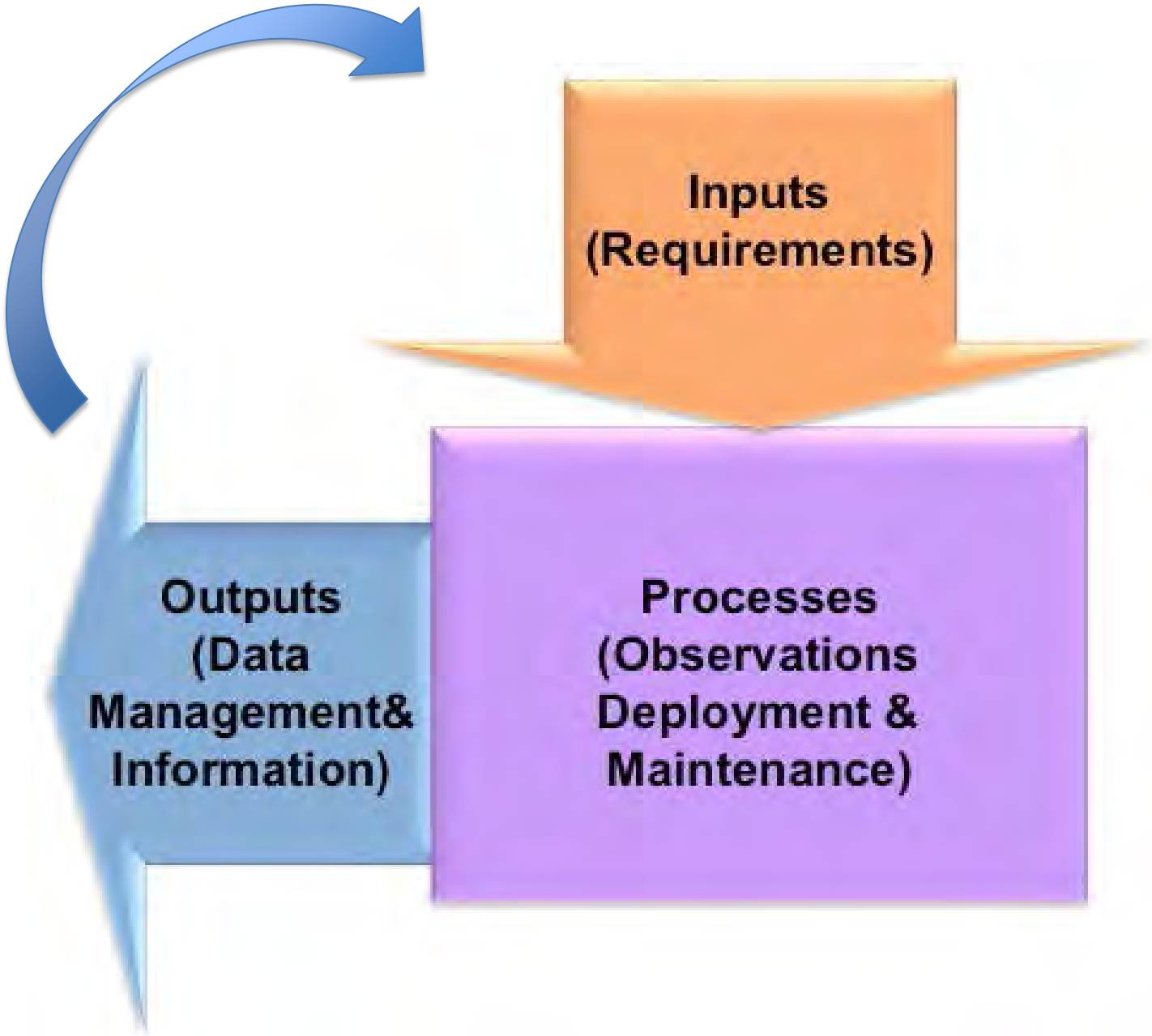
- Framework for Ocean Observing
- Regional Observing including CalCOFI
- Best Practices

FOO

http://unesdoc.unesco.org/images/0021/002112/211260e.pdf

Search “FOO and IOC”




Inputs
(Requirements)
Processes
(Observations
Deployment &
Maintenance)
Outputs
(Data
Management&
Information)

California Cooperative Oceanic Fisheries Investigations
CalCOFI - 1949 to present

(Photo courtesy of Jim Wilkinson)

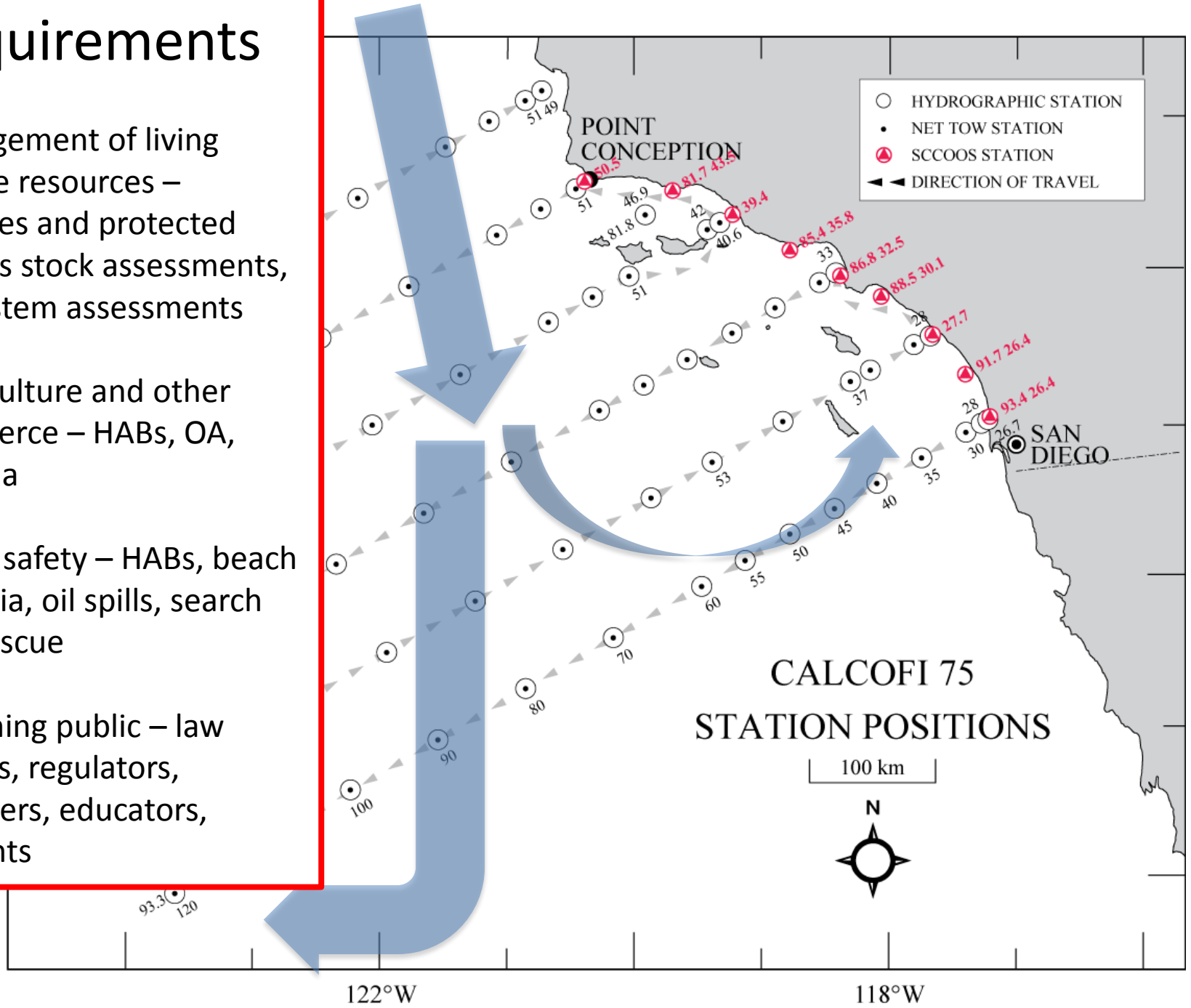
Requirements

Management of living marine resources – fisheries and protected species stock assessments, ecosystem assessments

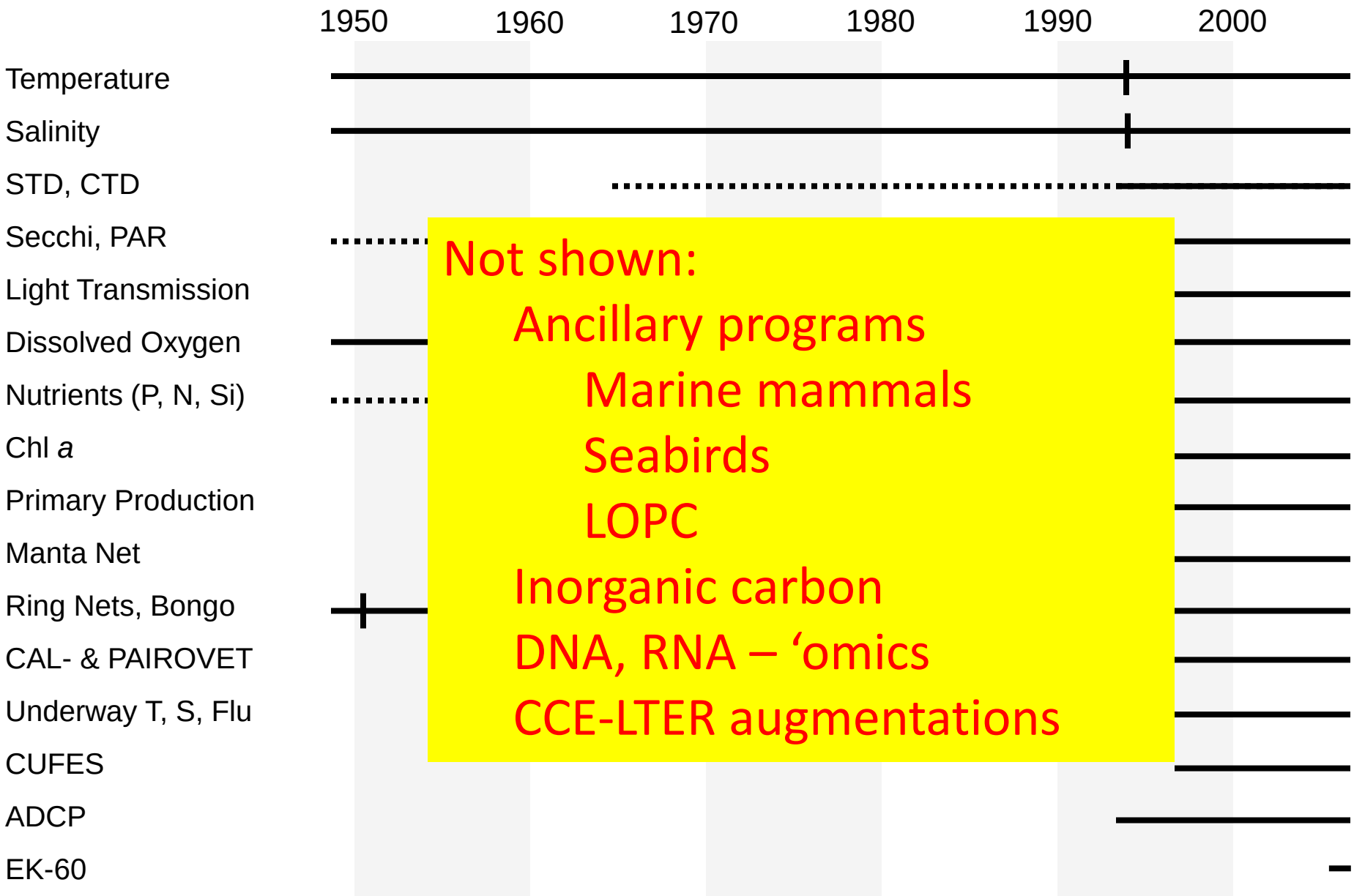
Aquaculture and other commerce – HABs, OA, hypoxia

Public safety – HABs, beach bacteria, oil spills, search and rescue

Informing public – law makers, regulators, enforcers, educators, students



Time Series of CalCOFI Observations



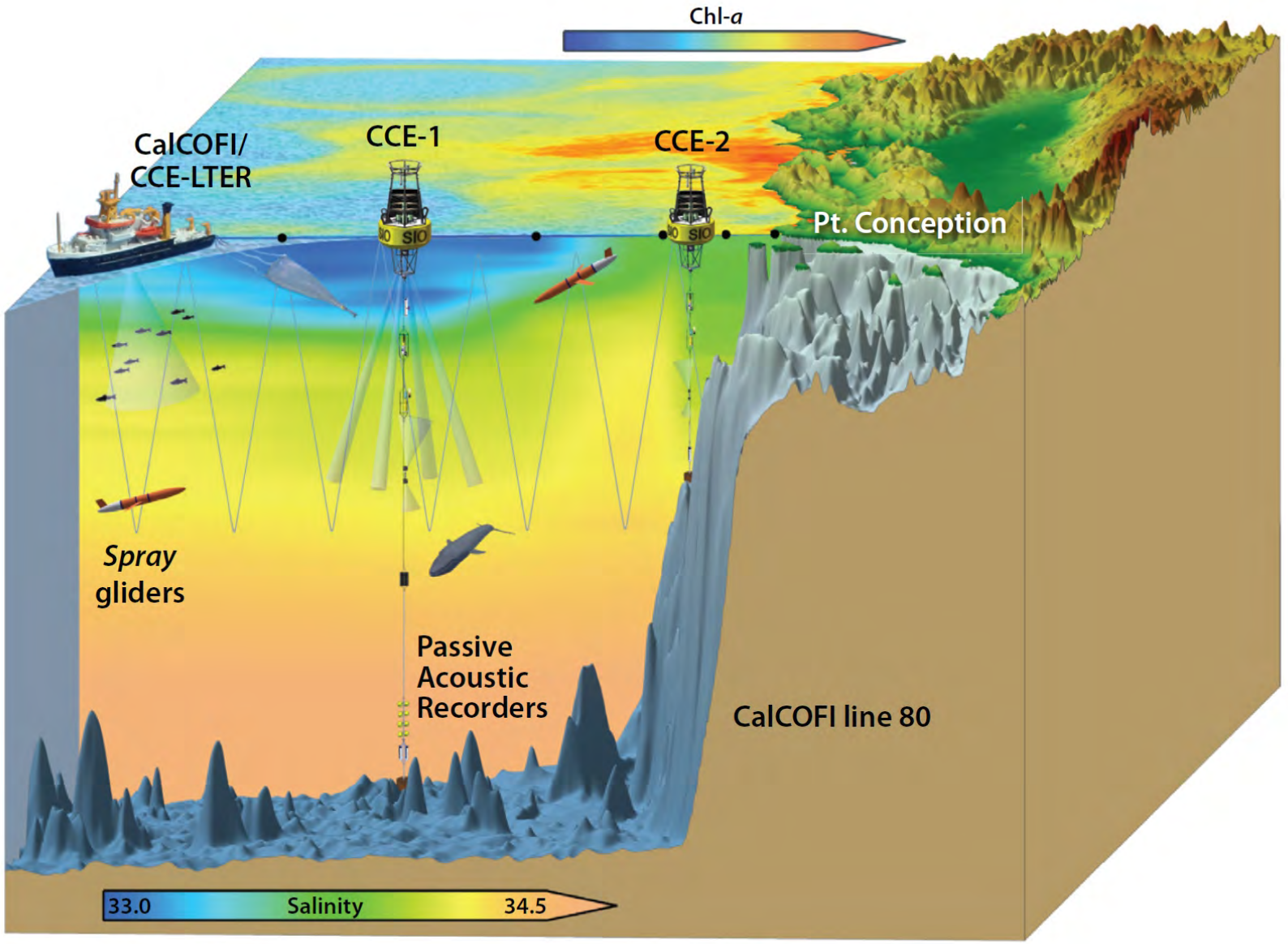
Platforms

- Ships
- Gliders
- Drifting buoys – surface and profiling
- Moorings
- Aircraft
- Satellites

Sensors

- Physical - thermistors, conductivity cells, radar, altimeter, ADCP
- Chemical (gases, dissolved nutrients) – electrodes, optodes, inorganic C – pH, pCO_2, DIC, A_T
- Genomics, transcriptomics, proteomics – sequencing, ESP
- Optics – imaging (LOPC, VPR), bio-optics (pigments, fluorescence)
- Bio-acoustics – active (EK60) and passive (HARPs)
- Human – plankton, including fish eggs and larvae (CUFES)

Diversity of sensors
Diversity of data
Diversity of people

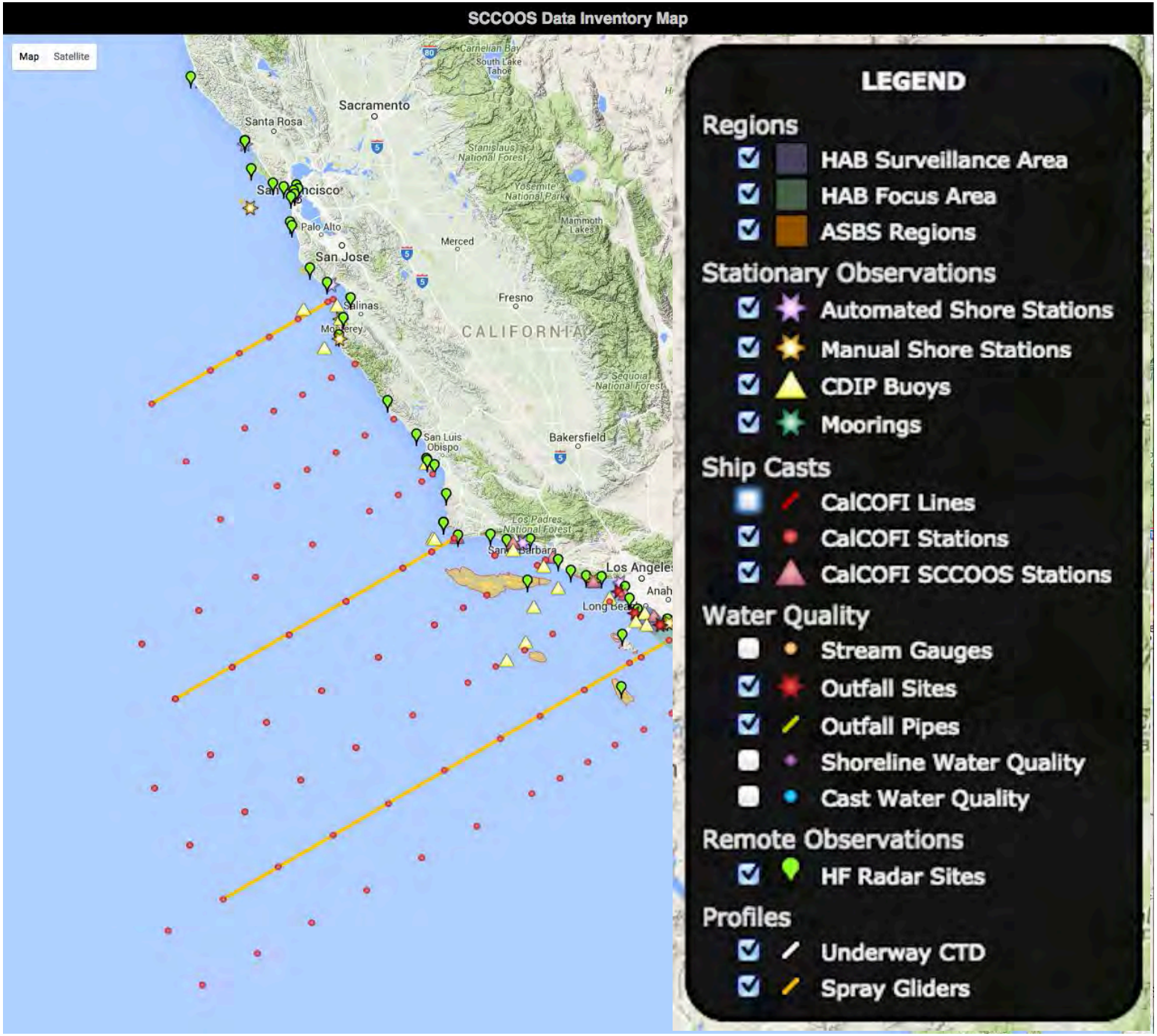


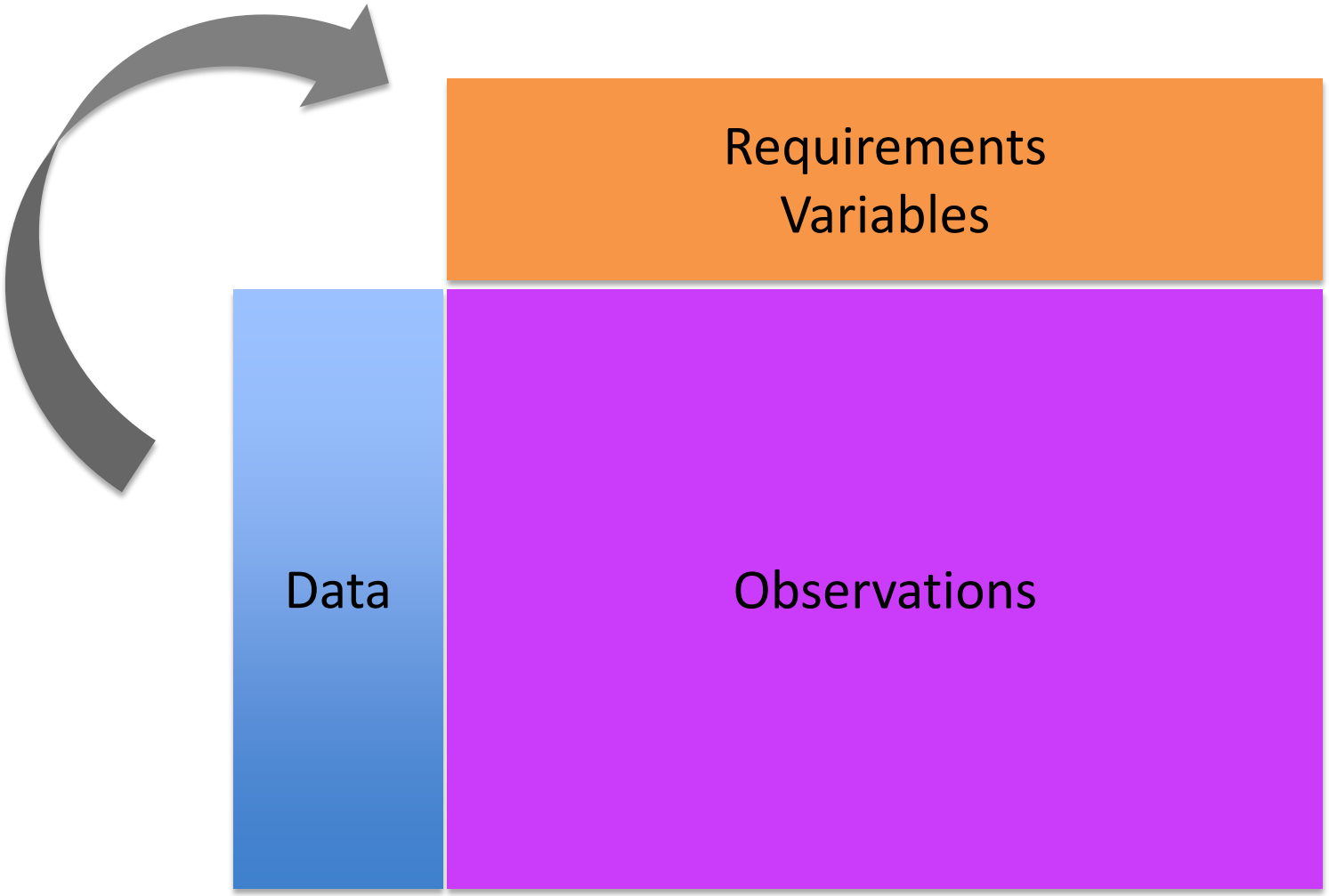
Ohman et al. 2013

S C C O O S

Southern California Coastal Ocean Observing System

Part of IOOS




Requirements
Variables
Data
Observations

Feds lower boom: no sardine fishery next year

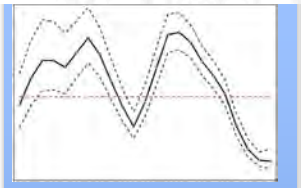
By **Jason Hoppin**, *Monterey County Herald*

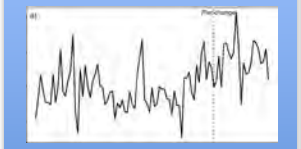
POSTED: 04/13/15, 6:20 PM PDT UPDATED: ON 04/13/2015 3 COMMENTS

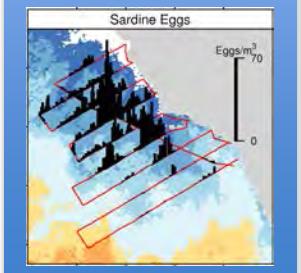
Rohnert Park >> For t[illegible]irst time in 30 ye[illegible], boats ope[illegible] from pursuing the fish that helped build Cannery Row: s[illegible]

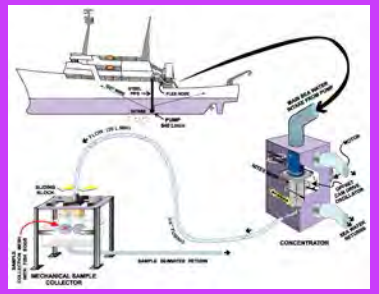
Meeting Sunday [illegible]n Rohnert Park, federal fishery regulat[illegible] was set to begi[illegible] July 1. For the first time since 1986 — wh[illegible] life following [illegible]18-year fishing ban that stretched back t[illegible] industry — fis[illegible]men will have to make their livelihoods elsewhere.

Sardine Management
Temperature, abundance and distribution

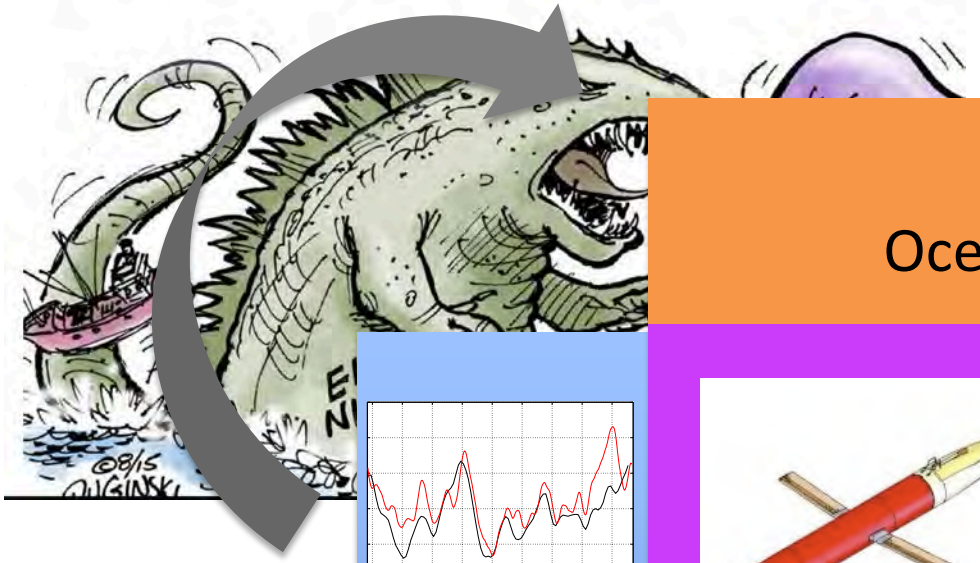




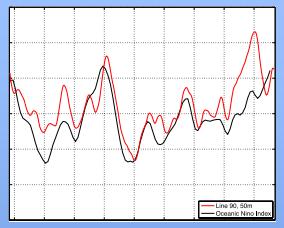


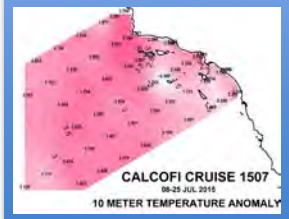


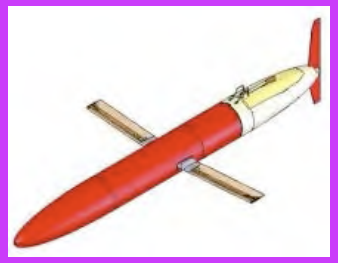
Q&A 'Godzilla' El Niño: Unbelievable rain for California, dry winter for Midwest



El Niño
Ocean Temperature





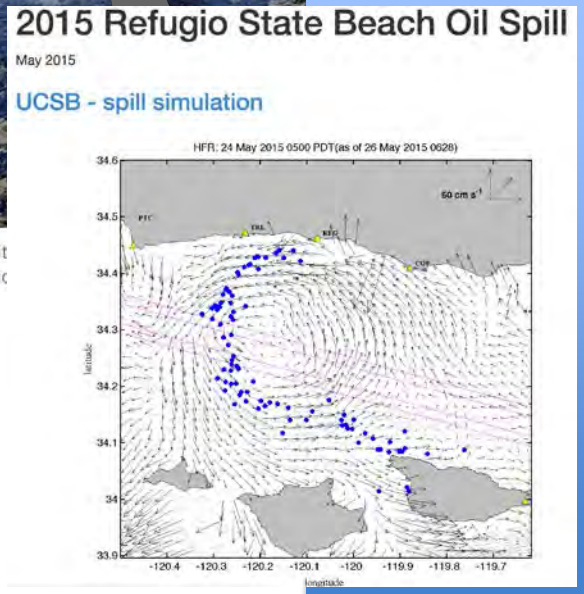


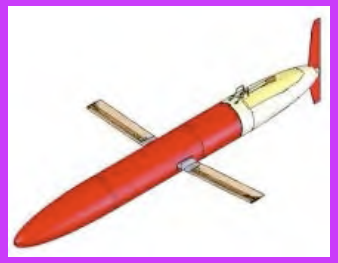
'Nightmare' California oil spill damages rare coastal ecosystem

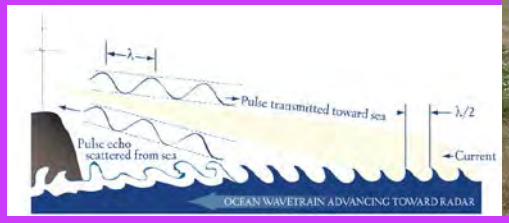
Activists say accident is soiling Gaviota coast, a Mediterranean-climate region of which there are only five in the world, and will be closed off for weeks or months

Cit
Pacific

Oil Spill
Surface currents, model







Modeling

- Scale – Populations (e.g., of fish) affected by management decisions are at a scale currently resolved poorly in global-scale models. Increasing computing power and new modeling schemes give promise here.
- Tradeoffs – Resolution and domain vary inversely.
- Data assimilation – Useful data must be available.
- Forecast & evaluate skill – Observations are needed to create models and evaluate their predictive skill.
- Communication & collaboration – Within modeling community and with observers and users.

Best Practices

- Standardize
  - Metadata in data fields
  - In-file annotation of metadata
  - Quality Control of Real-Time Data (QCRTD)
  - NetCDF
  - CF compliance (Climate Forecasting http://cfconventions.org)
  - Humans necessary

Anomalous warming has caused anomalous observations
Humans need to verify correct

Best Practices

- Standardize – QC, QCRTD, Net CDF, CF compliance
- Observe full time behavior of variable
  - Avoid aliasing
  - Use to design future sampling

  Diel, event scale and seasonal variation in pH
  Tony Koslow – is reduced ichthyoplankton sampling effort sufficient?

Best Practices

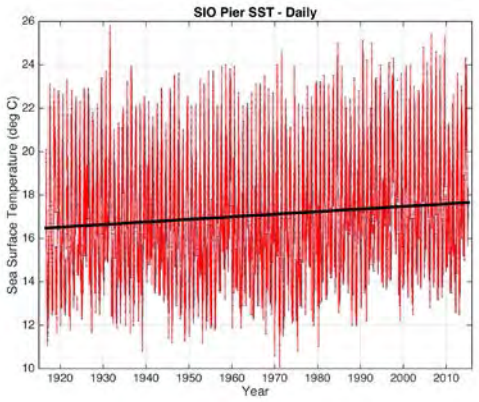
- Standardize – QC, QCRTD, Net CDF, CF compliance
- Observe full time behavior of variable – avoid aliasing
- Know your data
  - Understand how sensors work
  - Calibrate
  - Understand data processing
  - Understand what your data mean

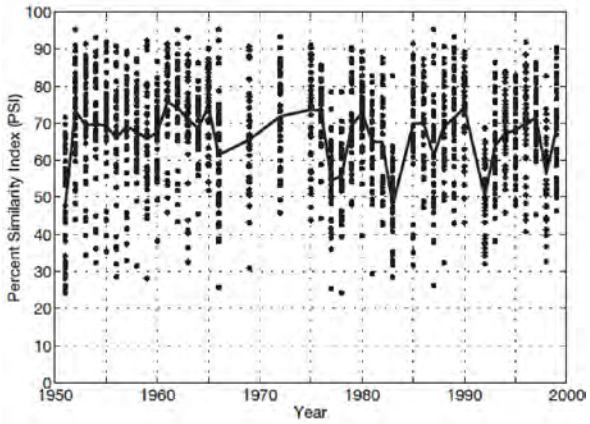
  Laser Optical Plankton Counter
  Laser Optical Particle Counter

Best Practices

- Standardize – QC, QCRTD, Net CDF, CF compliance
- Observe full time behavior of variable – avoid aliasing
- Know your data
- Consistency and continuity
  - ➢ Data comparable in time and space
  - ➢ When method changes – overlap can compare methods

CalCOFI 1949 to 2000 zooplankton comparable
SIO Pier – 1916 to present





Best Practices

- Standardize – QC, QCRTD, Net CDF, CF compliance
- Observe full time behavior of variable – avoid aliasing
- Know your data
- Consistency and continuity
- Data – Process Post Promptly Publically – PPPP
  - Data quality suffers if not processed fast
  - Users may need data rapidly
  - Publically funded data should be publically accessible

  HAB, OA and hypoxia warnings to public and industry, oil spill models, fishery closures, beach closures, assimilation into models

Best Practices

- Standardize – QC, QCRTD, Net CDF, CF compliance
- Observe full time behavior of variable – avoid aliasing
- Know your data
- Consistency and continuity
- Data – Process Post Promptly Publically – PPPP
- Complementary and redundant observing
  - Multiple ways of measuring
  - No one way is complete
  - Provide checks on data quality

Temperature from satellite, mooring, glider, ship

$\Omega_{aragonite}$ from pH, DIC, A_T, pCO_2

Best Practices

- Standardize – QC, QCRTD, Net CDF, CF compliance
- Observe full time behavior of variable – avoid aliasing
- Know your data
- Consistency and continuity
- Data – Process Post Promptly Publically – PPPP
- Complementary and redundant observing
- Autonomous platforms and sensors
  - Humans and ships - limited effort and ability
  - Efficient
  - Innovate
  - Require calibration and comparison

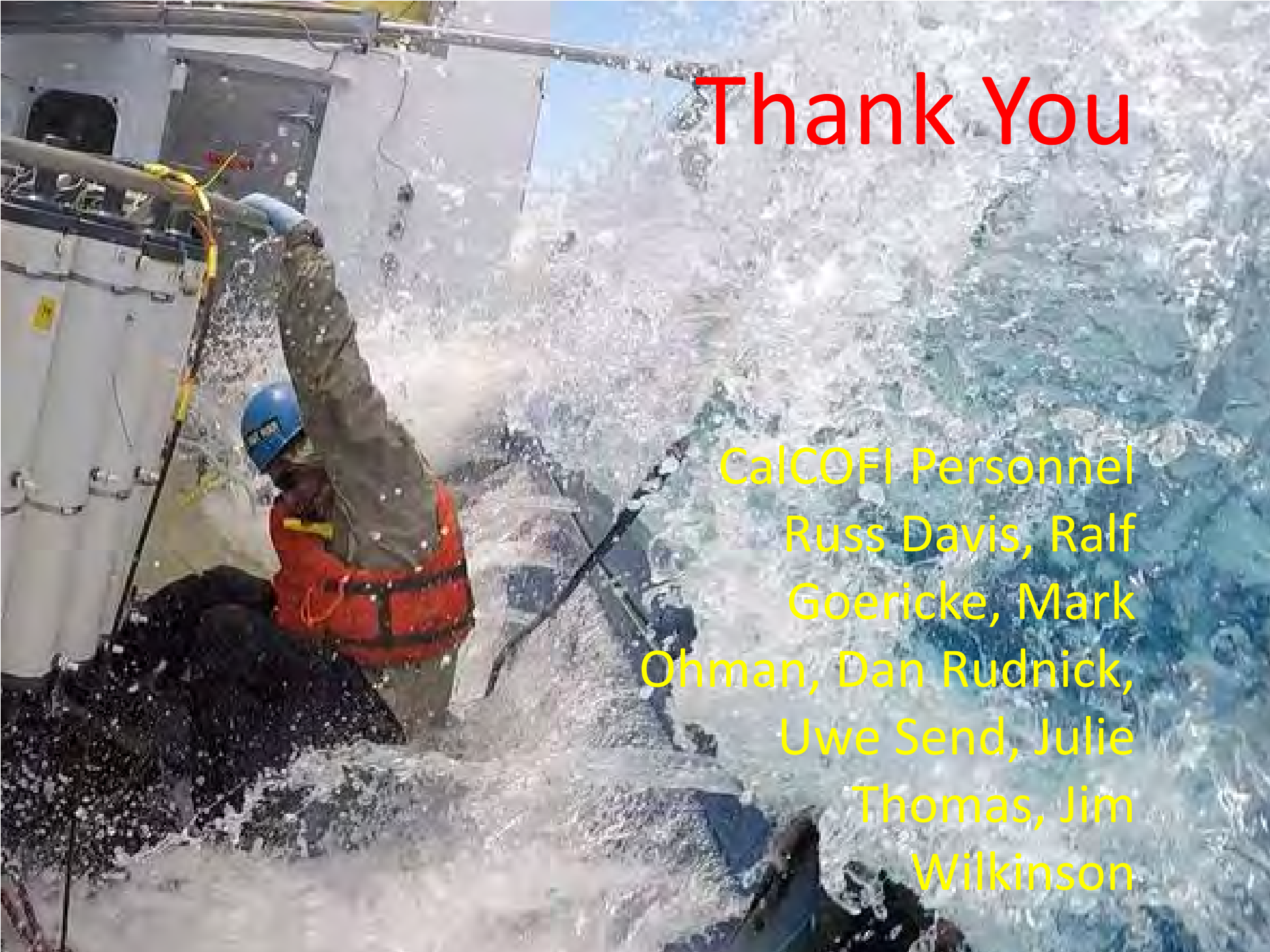
CalCOFI NO_3 measurements near CCE mooring SUNA NO_3 sensor

Best Practices

- Standardize – QC, QCRTD, Net CDF, CF compliance
- Observe full time behavior of variable – avoid aliasing
- Know your data
- Consistency and continuity
- Data – Process Post Promptly Publically – PPPP
- Complementary and redundant observing
- Autonomous platforms and sensors
- Collaborate
  - Observers, experimenters, modelers
  - Understand needs and abilities
  - Common language; NetCDF
  - “It takes a village”
  - “The whole is greater than the sum of the parts”

Best Practices

- Standardize – QC, QCRTD, Net CDF, CF compliance
- Observe full time behavior of variable – avoid aliasing
- Know your data
- Consistency and continuity
- Data – Process Post Promptly Publically – PPPP
- Complementary and redundant observing
- Autonomous platforms and sensors
- Collaborate
- Trust
  - Necessary
  - Slow to make, fast to lose



Thank You

CalCOFI Personnel
Russ Davis, Ralf Goericke, Mark Ohman, Dan Rudnick, Uwe Send, Julie Thomas, Jim Wilkinson