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US DELEGATE TO ICES

MAY 2017

Advanced technologies for smart data collection: recent developments and future opportunities

A Personal Historical Perspective

MINISTRY OF AGRICULTURE, FISHERIES AND FOOD
FISHERIES LABORATORY, LOWESTOFT, SUFFOLK, ENGLAND

1971 RESEARCH VESSEL PROGRAMME

REPORT: RV TELLINA: CRUISE 9

(PROVISIONAL: Not to be quoted without prior reference to the author)

STAFF

Part A

J D Riley 15-18 & 21-27 August
G T Thacker 6-14 & 19-20 August
P R Witthames 6-14 August
N G Nice (Student) 15-27 August

Part B

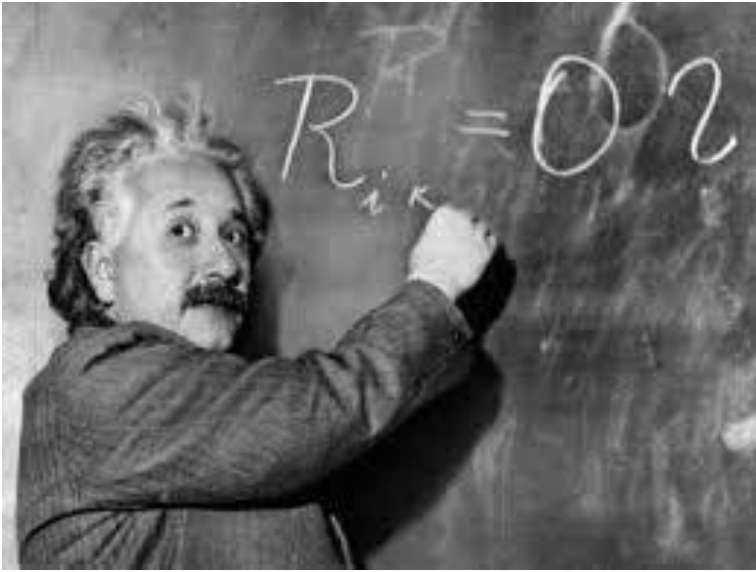J D Riley 6-14 September
W A Karp 6-14 September

'Push Net' Survey (Shore based)

A Jones 6-14 September
B Baxter 6-14 September

LOCALITY

South coast of England and north coast of Cornwall

Let's rearrange the equation:

Being smart and using technology wisely

Outline

Fishery Dependent

Fishery Independent

Ecosystem Monitoring

Being Smart and Using Technology Wisely
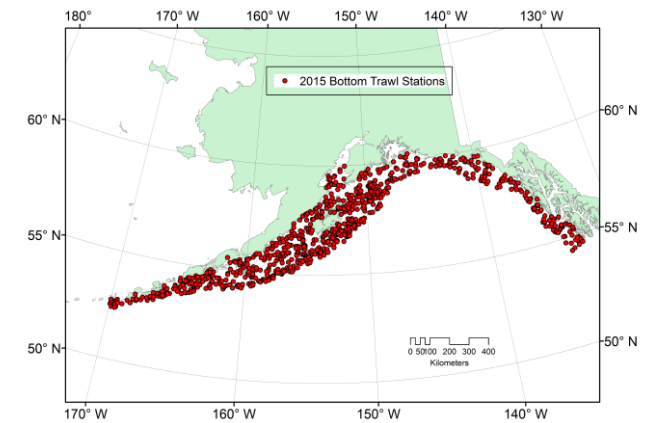
Some Examples and Ideas

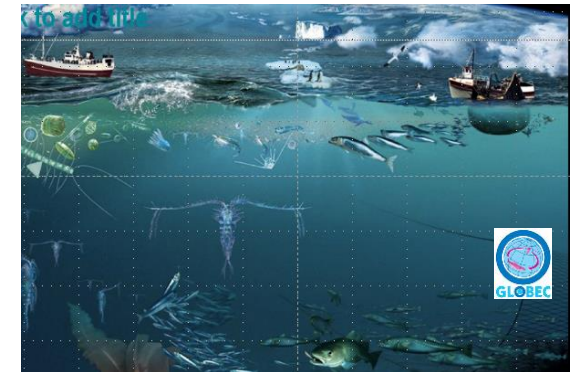Emerging Technologies

IT Considerations

Closing Thoughts

Boston Globe

NOAA Alaska Fisheries Science Center

Cisco Werner

Science
- Catch Quantity & Composition
- Size & Age, Other Biological Information
- Discard/Bycatch
- Seabird/Mammal/Turtle Interactions
- Fishing Effort & Operations

Management and Compliance
- Quota Monitoring
- Bycatch Avoidance
- Regulatory Compliance
- Observer Regulations

Business Operations
- Responsible Fishing/Certification
- Performance

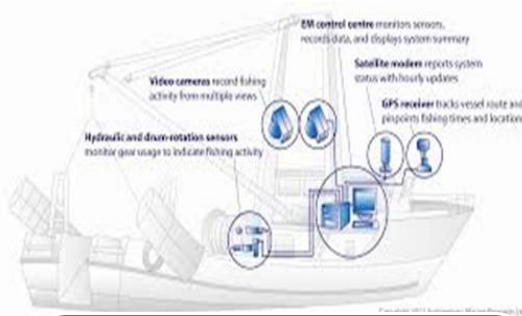# Why do we monitor fisheries?

Self Reporting
(Logbooks, etc.)

Port
Sampling

Recreational
Fisheries

Observers

Electronic
Technologies
(Logbooks, CCTV)

How do we monitor fisheries?

Standards and Partnerships
Being Smart

- Regulations that encourage accurate reporting
- Regulatory information needs should be fully met
- Assumption of monitoring bias should be disproved
- Precision standards based on risk – sensitivity of assessments or management actions
- Managers set standards – fishers submit plans – multiple solutions encourage innovation
- Collaboration encourages innovation and shared ownership

Innovation
Using Technology Wisely

- Increased use of CCTV, electronic logbooks, VMS, etc.
- **Advances in image processing**
- **Accurate and timely data that meets information needs for management, science, and business operations and is available to the public (within confidentiality limits)**
- **State of the art information systems which meet current and likely future needs**

How will we monitor fisheries in the future?

Biomass or Relative Biomass and Trends

trawl survey biomass

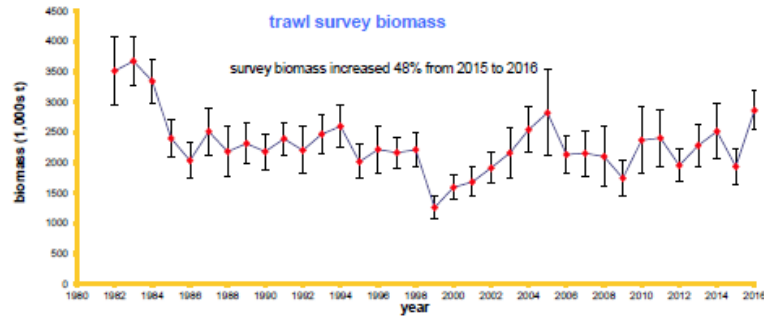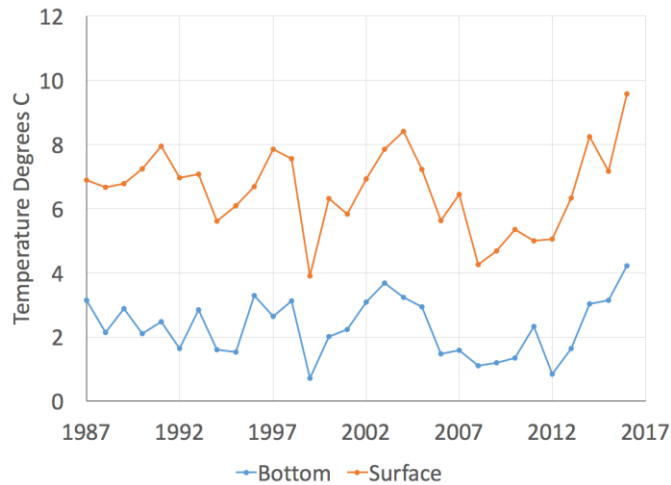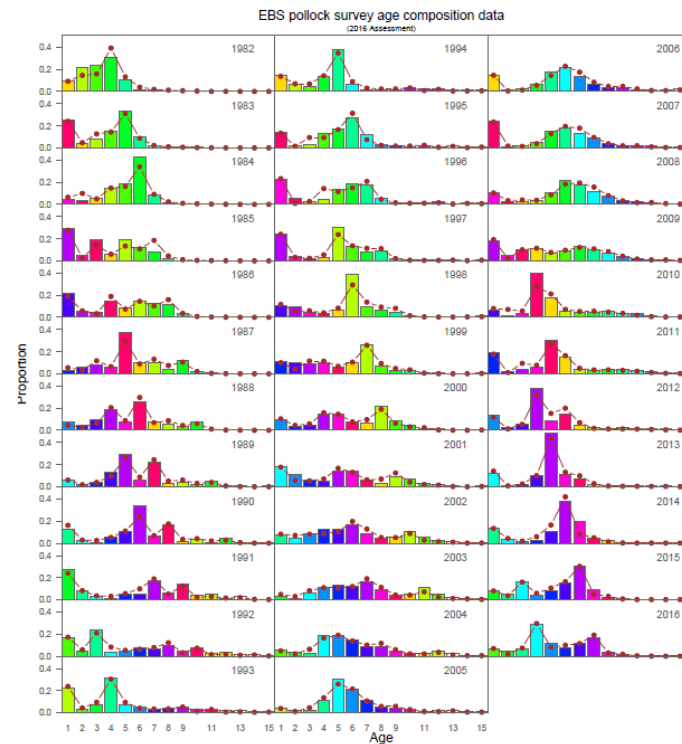survey biomass increased 48% from 2015 to 2016

Figure 4.6.--Annual bottom trawl survey biomass point-estimates and 95% confidence intervals for yellowfin sole, 1982-2016.

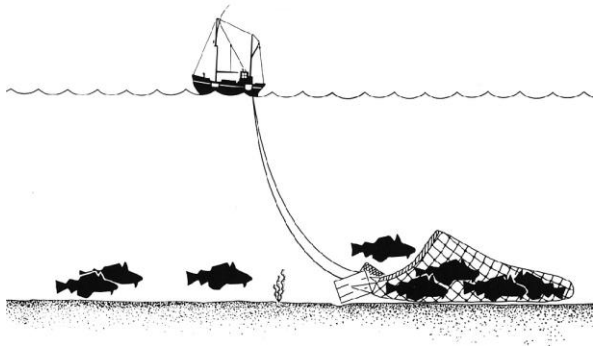**Size and Age Composition and Other Biological Characteristics**

EBS pollock survey age composition data
(2016 Assessment)

Environmental Factors, Species Interactions, etc.

From: 2016 North Pacific Groundfish Stock Assessment and Fishery Evaluation Reports for 2017 Fisheries. North Pacific Fishery Management Council, Anchorage Alaska
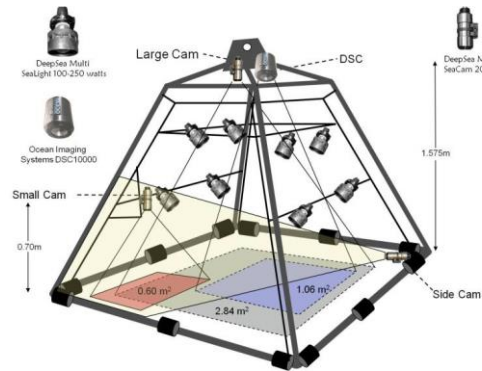
Why do we survey fish stocks?

Surveys Using Standardized Gear (Trawl, Longline, Pot, etc.)
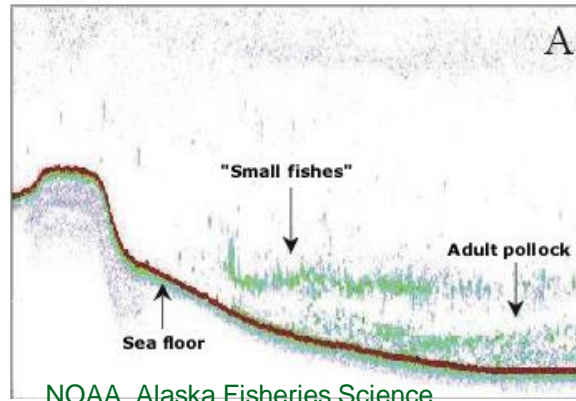
NOAA, Alaska Fisheries Science Center

Surveys Using Acoustics with sampling by trawl or other gear

Kevin Stokesbury, SMAST

NOAA, NE Fisheries Science Center and Woods Hole Oceanographic Inst.

Surveys using emerging technologies e.g. camera surveys for scallops

How do we survey fish stocks?

These data hint at the ultimate potential of periodic surveys using ATM
sampling augmented with physical oceanographic, zooplankton, ichthyoplankton, fish, seabird, and mammal investigations to characterize the ecosystems.
(Zwolinski et al. 2014)
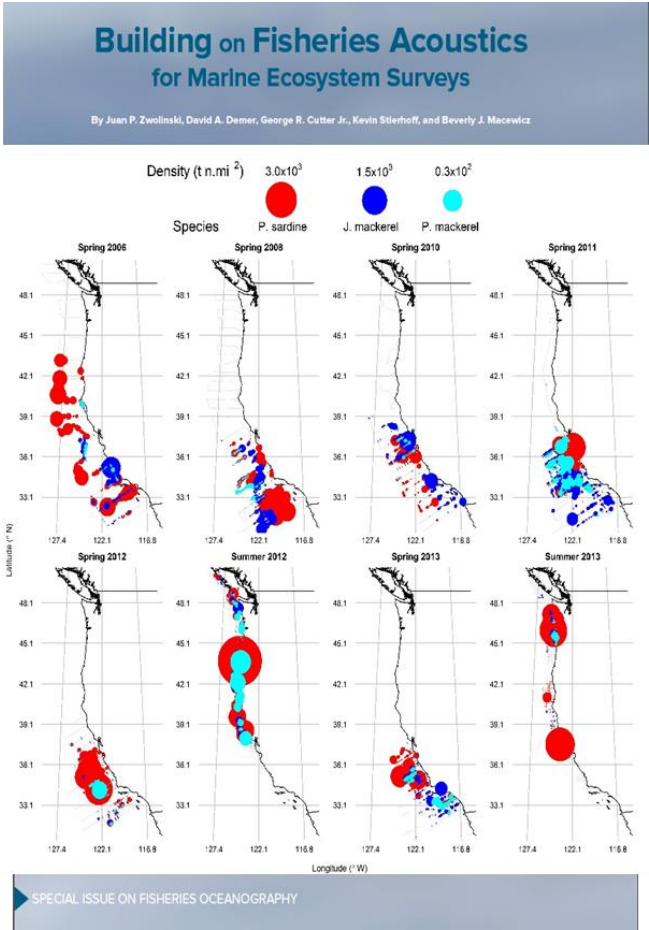
Ecosystem monitoring — improving understanding of ecosystem processes and trends, and improving stock assessments

Being Smart

Using Technology Wisely

Setting Priorities

Advancing and improving current approaches

Cooperative Research - Increasing use of commercial vessels

Improving survey design and efficiency

Ecosystem monitoring to understand processes and improve assessment

Changing the way we think about survey platforms

Emerging technologies as survey tools

Innovation

Managing and disseminating increasingly complex and voluminous data sets

# How will we collect data in the future?

Setting Priorities – Data Quadrant Framework

(IV) Assessments that will still be *good* with less or same amount of data collected ("data-rich"?)

(III) Assessments that will improve with more/better or improved data

(I) Too little data to provide "truly quantitative" or robust assessments

(II) Assessments that will *not* improve with more data ("diminishing returns")

Improved Assessments

Data

(IV) Stocks (pollock/hake?) where efforts could shift?

(III) Increase data but keep the methods (for now). Example: reef fish, Pacific Bluefin Tuna?

(I) Data-poor stocks (rockfish?)

(II) Is it a matter of better or different data or methods? Example: Pacific sardine?

Improved Assessments

Data

Semi objective framework for guiding survey and development resource allocation

Can be used to address questions about costs/benefits of increasing/reducing survey effort

Helps identify assessments which would benefit from survey innovation

Thanks to Cisco Werner
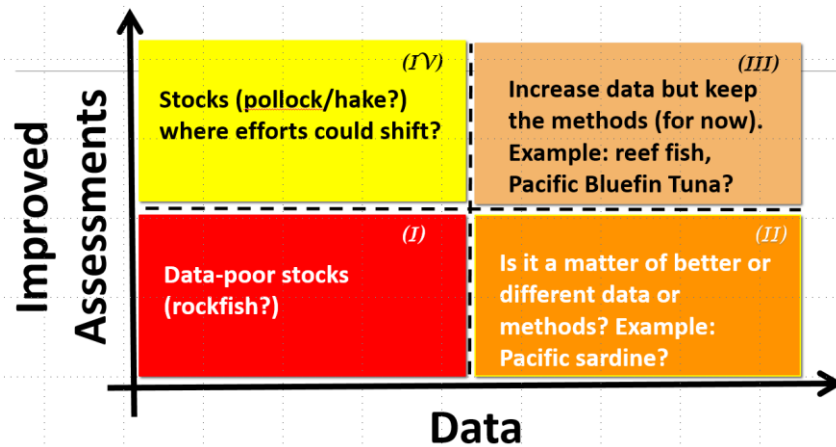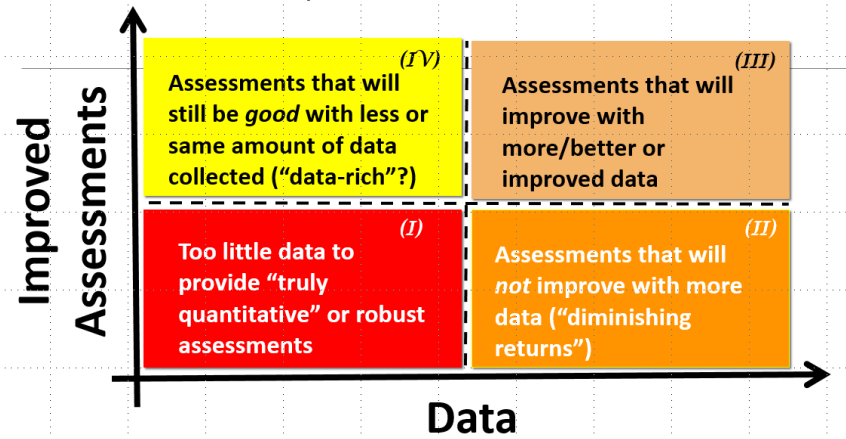
Improving Survey Design

e.g. Habitat mapping and survey planning – California sardine

- Sardine execute seasonal movements in concordance with their habitat

- Sampling can be done more efficiently by taking the **habitat** into consideration
  - Summer (coastwide) surveys have shorter transects
  - Spring surveys have variable boundaries

- Constrained-adaptive sampling design permits high intensity sampling where fish are present
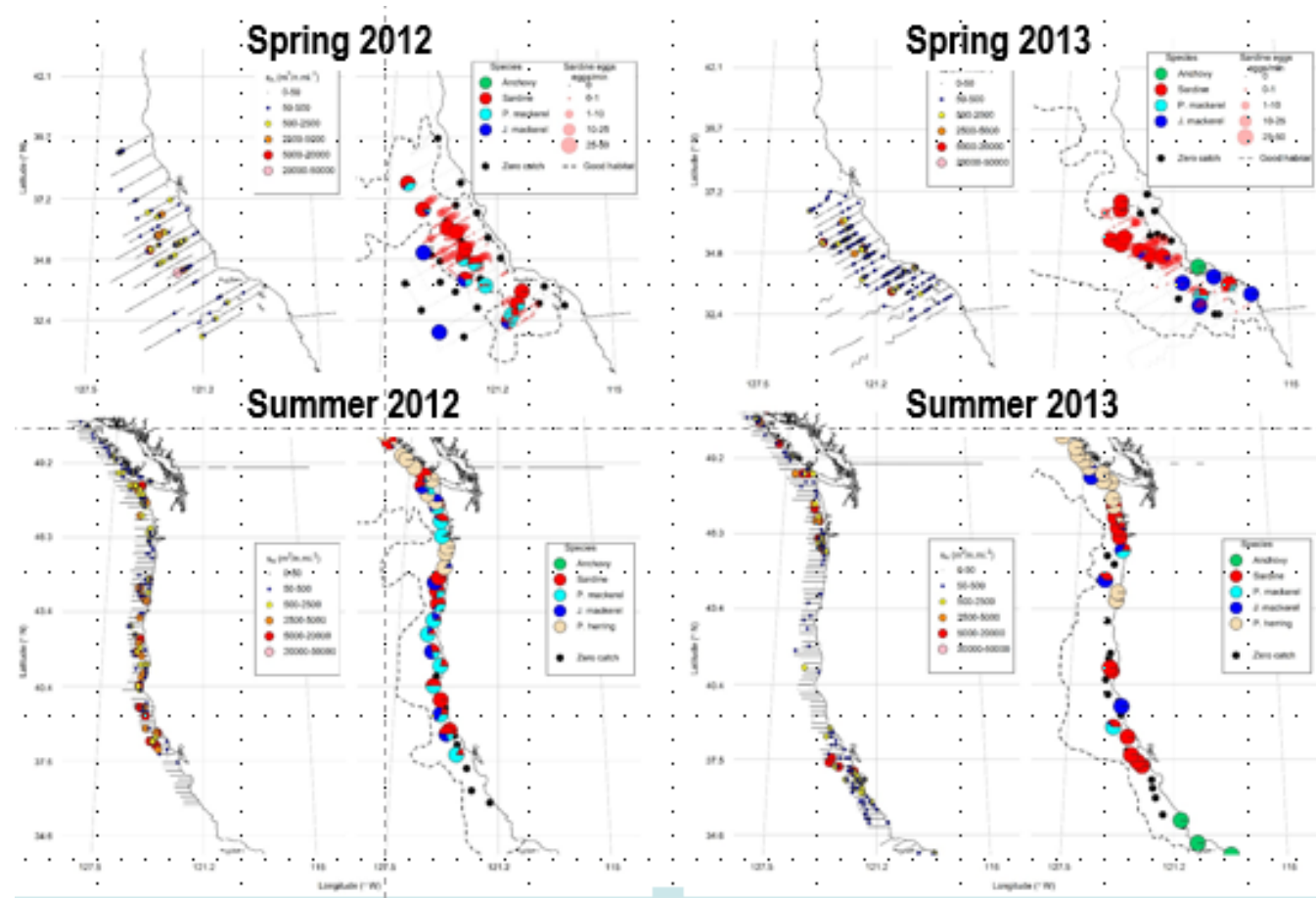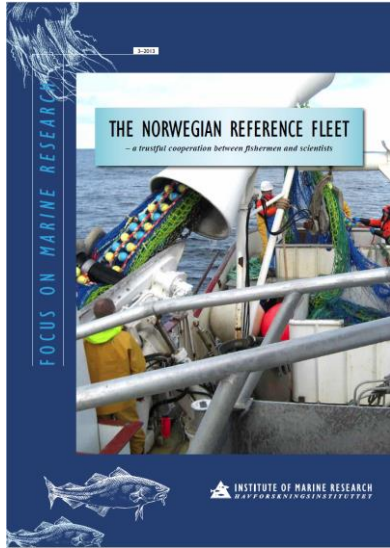
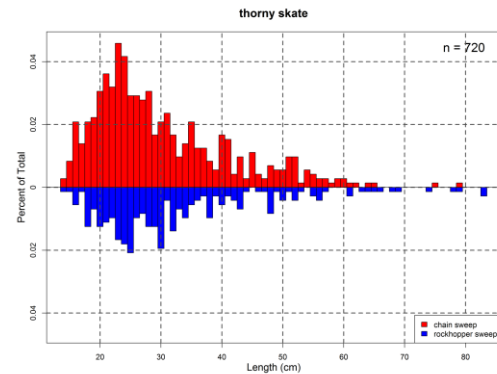Juan P. Zwolinski
NOAA, Southwest Fisheries
Science Center

Cooperative Research

Improves efficiency, communication, transparency, trust and encourages innovation and shared ownership
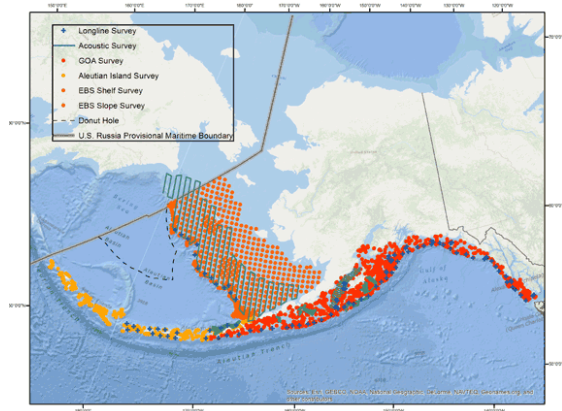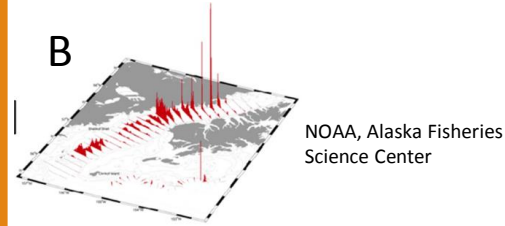
- A) Norwegian reference fleet (and elsewhere)
- B) Scientific acoustic sampling from fishing vessels
- C) Routine trawl surveys in e.g. Alaska conducted on chartered fishing boats
- D) Gear efficiency (catchability) research conducted on commercial trawler in NE USA
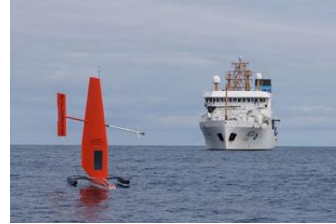- Many more
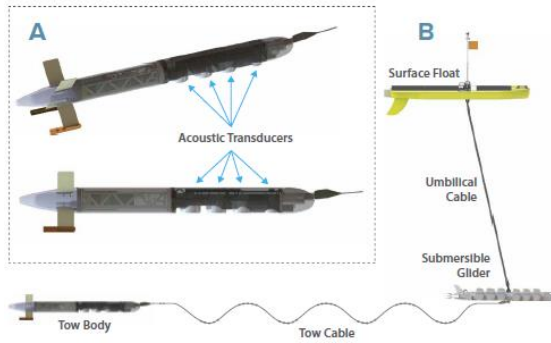
Alternative Platforms
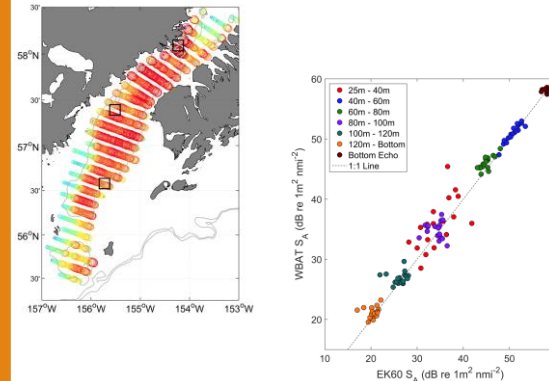
Ship time is expensive. How can we use alternative data collection platforms?

A) Waveglider for acoustic sampling etc.

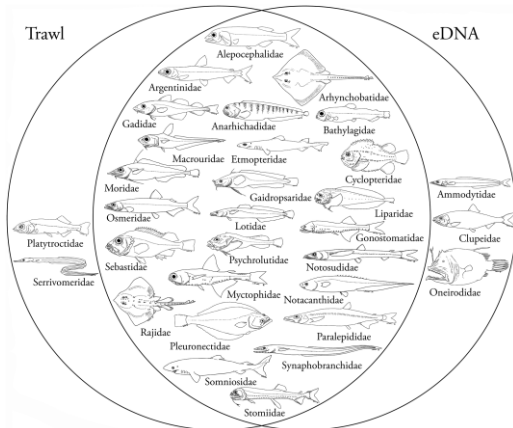B) Saildrone for acoustic sampling etc.
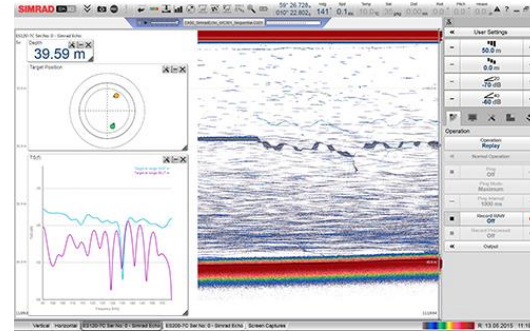
C) AUV

D) Fixed acoustic arrays (bottom mounted)

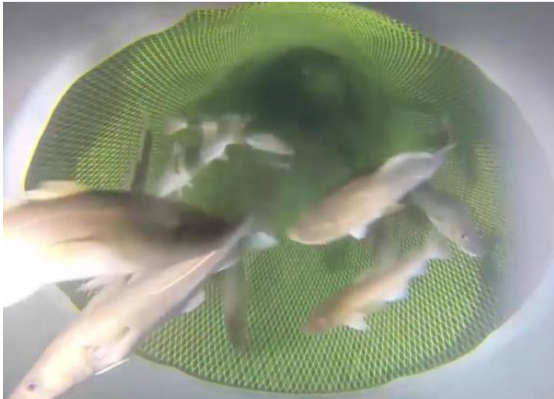Other examples include ships of opportunity

A

Trawl / eDNA

Thomsen et al. 2016:
https://doi.org/10.1371/journal.pone.0165252

B

Kongsberg Maritime AS

C

UMass Dartmouth scientists deploy new video system to survey Atlantic Cod population on the Stellwagen Bank fishing grounds.

D

School of Atlantic bluefin tuna image taken using a hexacopter rdrone northeast of Provincetown MA. Photo Credit: NOAA Fisheries/Michael Jech and Jennifer Johnson; Large Pelagics Research Center/Molly Lutcavage and Angelia Vanderlaan.

Emerging Technologies

A) Genetic technologies including eDNA

B) Advances in acoustics (echo sounders and sonars)

C) Advances in video applications e.g. open codend trawls, surveying untrawlable habitat, catch monitoring; image processing

D) Unmanned Aerial Systems (drones)

Managing and disseminating increasingly complex and voluminous data sets

Core Issue: *Exponential* Data Growth
_____

Storage:

The latest scientific instruments provide vastly greater quantities of data than most US Government data centers and network infrastructure are designed to support. The solution is not simply "buy more hard drives" e.g.

- 2014 / 2015: 90-day cruise generated a total of 4-5GB of active acoustic data.
- 2016: same 90-day cruise, with new acoustic instrumentation, generated an average of 8TB per day.

US Government IT systems have significant overhead for compliance with the government information systems management mandates and ever-increasing cybersecurity and statutory compliance.

Closing thoughts

- Need for smart thinking and technological innovation in fishery dependent and fishery independent data collection and ecosystem monitoring
- Value of risk/uncertainty approaches for setting priorities for collection and R&D
- Role of cooperative research and data collection should be prioritized
- Social sciences will become more important
- Advances in platforms and sensors will increase data collection capabilities to support fishery, stock and ecosystem monitoring
- R&D priorities should include image processing and catchability
- Investment in IT systems is essential