



NOAA Technical Memorandum NMFS-XXX-##

UW FISH 572: Principles and applications of fisheries-independent surveys

Dr. Stan Kotwicki, Dr. Alan Hicks,
Dr. Lewis Barnett, Dr. Sophia Wassermann,
Emily Markowitz

January 2023

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric
Administration
National Marine Fisheries Service
Northwest Fisheries Science Center



**NOAA
FISHERIES**

UW FISH 572: Principles and applications of fisheries-independent surveys

Dr. Stan Kotwicki^{1,*}, Dr. Alan Hicks^{2,*},
Dr. Lewis Barnett^{1,*}, Dr. Sophia
Wassermann^{1,*} and Emily Markowitz^{1,*}

1. NOAA Fisheries Alaska Fisheries Science Center, Groundfish
Assessment Program

2. International Pacific Halibut Commission

** Correspondence:* Dr. Stan Kotwicki Stan.Kotwicki AT noaa.gov *

Correspondence: Dr. Alan Hicks Allan.Hicks AT iphc.int *

Correspondence: Dr. Lewis Barnett Lewis.Barnett AT noaa.gov *

Correspondence: Dr. Sophia Wassermann Sophia.Wassermann AT
noaa.gov *

Correspondence: Emily Markowitz Emily.Markowitz AT
noaa.gov

Table of contents

1	Welcome	1
1.1	Instructors	1
1.2	Class Teaching Assistants	1
1.3	Lectures	2
1.4	Office hours	2
1.5	Credits	2
1.6	Prerequisites	2
1.7	Course Summary	2
1.8	NOAA README	4
1.9	NOAA License	5
2	Course Information	6
2.1	Specific Learning Goals	6
2.2	Course Material	6
2.3	Course Format	6
2.4	Grading	7
2.5	Grading Scale	8
2.6	Lecture plan	10
2.7	Academic integrity	25
2.8	Disability accommodations	25
3	Frequently Asked Questions	26
3.1	<i>Why would this course prepare you well for the future career in the field of fisheries science?</i>	27
4	Resources	37
4.1	AFSC Grounfish Bottom Trawl Survey	37
5	References	38

Table of contents

6 NOAA quarto book with R and download PDF or docx	39
References	40

List of Figures

1.1 Course flyer	3
----------------------------	---

List of Tables

2.2	Survey of products developed by GAP	11
-----	---	----

1 Welcome

Principles and applications of fisheries-independent surveys” is a 4-credit course (FISH 572) that delves into the importance of fisheries-independent surveys as a cornerstone for fisheries stock assessment and ecosystem research.

Last run date: Sunday, September 07, 2025

Please consider this resource to be a **Living Document**. The code in this repository is regularly being updated and improved. Please refer to releases for finalized products and project milestones.

1.1 Instructors

Dr. Stan Kotwicki, Groundfish Assessment Program Manager, Alaska Fisheries Science Center, NOAA. Stan.Kotwicki@noaa.gov

Dr. Allan Hicks, Quantitative Scientist, International Pacific Halibut Commission. Allan.Hicks@iphc.int

Dr. Lewis Barnett, Research Fish Biologist, Groundfish Assessment Program, Alaska Fisheries Science Center, NOAA. lewis.barnett@noaa.gov

1.2 Class Teaching Assistants

Dr. Sophia Wassermann, Research Fish Biologist, Alaska Fisheries Science Center, NOAA. Sophia.Wassermann AT noaa.gov

Emily Makowitz, Research Fish Biologist, Alaska Fisheries Science Center, NOAA. Emily.Markowitz AT noaa.gov

1.3 Lectures

Mon, Wed, 9:00-10:50 am - In person. FSH 203

1.4 Office hours

Email instructors to set up meetings.

1.5 Credits

It is a 4-credit class with numerical grades. It is expected that students will work on assignments about 8 hours per week. Given the limited in-class time, we expect active participation in all lectures and discussions.

1.6 Prerequisites

Basic statistics, statistical modeling, background in fisheries/wildlife science; if unclear of eligibility, please correspond with the instructor to obtain permission.

1.7 Course Summary

The course covers the science and practice of fishery-independent surveys, the primary monitoring approach supporting fisheries management. Fishery-independent surveys form the foundation for stock assessments and ecosystem research, which will be exemplified by case studies from the field. The course covers survey designs for different objectives, types of data collections, and data products from fisheries-independent surveys. It explores the newest developments and challenges in survey science, from observation to spatial and temporal analysis, and introduces career opportunities in the field of scientific surveys. Practical challenges in implementing these principles and managing fisheries-independent surveys will be discussed. You will learn how survey data products inform marine research, stock assessment, ecosystem analysis, and ultimately accumulate into fisheries management advice.

1 Welcome



Principles and applications of fishery-independent surveys

Designing, implementing, and managing fishery-independent surveys for use in fisheries research, assessment, and management advice.

The goal of the class is to increase student knowledge of the value of field observations collected by fishery-independent surveys, and create awareness of career opportunities in survey science.

Dr. Stan Kotwicki, Groundfish Assessment Program Manager, Alaska Fisheries Science Center, NOAA
Dr. Lewis Barnett, Research Fish Biologist, Alaska Fisheries Science Center, NOAA
Dr. Allan Hicks, Quantitative Scientist, International Pacific Halibut Commission

FISH 572

WINTER 2026, 4 Credits
COURSE TIMES:
MW 9-10:50 in FSH 203

LEARN

1. Importance of fishery-independent surveys as a foundation of fisheries stock assessment and ecosystem research.
2. Survey designs, data types, and data products from fishery-independent surveys.
3. Newest developments and challenges in survey science.
4. Career opportunities in the field of surveys.

EXPLORE

1. Survey data products used in ecosystem processes research, ecological studies, stock assessment, and forecasting of these elements.
2. Design your own survey or critically evaluate an existing survey.
3. Methods for improving quality of survey data products.

Figure 1.1: Course flyer

1 Welcome

This course is designed for students with a background in basic statistics, statistical modeling, and fisheries/wildlife science. It covers a wide range of topics, including:

- **Survey Design:** Learn about various survey designs for different objectives, types of data collection, and the resulting data products.
- **Data Analysis:** Gain practical skills in analyzing fisheries-independent survey data using both design and model-based methods.
- **Current Topics:** Explore the latest developments and challenges in survey science, such as uncertainty, survey continuity, effort optimization, flexible survey design, and the use of statistical tools and new technology.
- **Real-World Applications:** Understand the logistical challenges in implementing and managing fisheries-independent surveys, and how survey data products are used in fisheries research, assessment, and management advice.
- **Career Opportunities:** Discover career paths in the field of research surveys.

The course format includes lectures from instructors and visiting experts, student-led literature reviews and discussions, and hands-on survey data analysis. A significant portion of the grade is based on a final research project using survey data, providing students with valuable experience in research planning and execution. This class is designed to provide useful skills for ongoing research in the field.

1.8 NOAA README

This repository is a scientific product and is not official communication of the National Oceanic and Atmospheric Administration, or the United States Department of Commerce. All NOAA GitHub project code is provided on an 'as is' basis and the user assumes responsibility for its use. Any claims against the Department of Commerce or Department of Commerce bureaus stemming from the use of this GitHub project will be governed by all applicable Federal law. Any reference to specific commercial products, processes, or services by service mark, trademark, manufacturer, or otherwise, does not constitute or imply their endorsement, recommendation or favoring by the Department of Commerce. The Department of Commerce seal and logo, or the seal and logo of a DOC bureau, shall not be used in any manner to imply endorsement of any commercial product or activity by DOC or the United States Government.

1.9 NOAA License

Software code created by U.S. Government employees is not subject to copyright in the United States (17 U.S.C. §105). The United States/Department of Commerce reserve all rights to seek and obtain copyright protection in countries other than the United States for Software authored in its entirety by the Department of Commerce. To this end, the Department of Commerce hereby grants to Recipient a royalty-free, nonexclusive license to use, copy, and create derivative works of the Software outside of the United States.

2 Course Information

2.1 Specific Learning Goals

This class is intended to provide useful skills for your ongoing research.

1. Review types of fisheries-independent surveys and survey data products for ecosystem processes research, ecological studies, stock assessment, and forecasting within these disciplines.
2. Learn principles of sampling and survey designs, survey logistics and management, and survey data product estimation and application.
3. Analyze fishery-independent survey data using various statistical methods.
4. Plan research in survey science topics, e.g. uncertainty (observation error), survey continuity (catchability), effort optimization, flexible survey design, model-based estimators, simulations, statistical tools and new technology.
5. Complete a research project using survey data.
6. Learn concepts and tools for long-term strategic planning of surveys, including adapting monitoring programs to our changing ecosystems as species distributions shift due to environmental change and ecological interactions.

2.2 Course Material

No required text. Course materials will be selected from journals, books, and other published scientific literature. These will be available as PDFs through the course website. Materials will be divided into required and optional.

2.3 Course Format

Lectures: Lectures will take up approximately half of the in-class time. There will be two to three lectures per week given by instructors or visiting experts. Lectures will focus on a range of topics, described with examples from different survey programs

2 Course Information

around the world. Lecture slides will be made available on the course website for downloading and reviewing.

Literature review and discussion sections: Students (in groups of 1-3) will be responsible for presentations on relevant literature and leading subsequent discussions in-class. Approximately one-quarter of in-class time will be used for these presentations and discussions. Presentations will include a summary of relevant scientific papers on a chosen survey-related topic and all students will be expected to actively participate in discussions. List of papers for student presentations and discussion will be provided by instructors, but students will be given the opportunity to propose a paper of their choice for presentations. The point of the discussion section is to read peer-reviewed literature and become familiar with current topics in survey science.

Survey data analysis: Each student will be responsible for one mid-course project to include survey data analysis on a data set of their choice (data sets from several actual surveys will be available, as needed). Analysis can involve estimation of standard design-based or model-based survey data products or could involve custom analysis for class projects.

Research plan and final paper: Half of the student grade is based on a final written research paper using survey data. Topics for the final paper will be proposed by students and will be presented for class discussion and feedback within the first 3 weeks of the quarter.

2.4 Grading

Students will be graded on 4 tasks:

1. Project plan - 1 page and 5 min presentation (10% weight) *DUE: Presentation January 14*

Within the first days of the quarter students will be responsible for planning a research project. Students can propose a project of their choice as long as the data for the project is of survey origin. Project plans should be discussed with and accepted by instructors. Once accepted students will be responsible for writing a 1 page project plan and for presentation of the plan during the class. Instructors and students will provide feedback on the plan during the class discussion.

2. Literature review 20-30 min presentation on the survey topic (20%)

DUE: Presentation February 9

2 Course Information

Students will be responsible for presentations on relevant literature and leading subsequent discussion. Literature review presentations will be conducted on Feb 9 or later depending on the number of presentations. Papers for this literature review should be relevant to the final project. Students are advised to discuss potential papers for this review with instructors, but students will be given the opportunity to propose a paper(s) of their choice for presentations. Literature review presentation will be followed by Q & A session and in-class discussion on the presented topics

3. Survey data analysis (20%) *DUE: 16 February*

Survey data analysis will involve estimation of standard design-based and model-based survey data products (from provided "true distributions") or could involve custom analysis of survey data used for class projects. Format of the analysis presentation will be open and can include analysis description and graphs or tables. Analysis will be graded separately, but can be included as part of the final paper or as an independent document. Data analysis will be due at the end of week 6 of the course.

4. Final project - up to 5-8 pages and 20-30 min presentation (50%) *Due: Presentation March 4-11; Paper March 13*

Final project results will be presented in the form of 20-30 minutes in-class PPT presentation. Students will receive feedback from instructors and time for in-class discussion will be provided. Presentations will occur during the last 2 weeks of the course. Final 5 - 8 page paper will be due at the end of week 10 and graded during the week of finals.

2.5 Grading Scale

Learn more about the UW grading scale.

The following package(s) will be installed:

- flextable [0.9.10]

These packages will be installed into "~/work/UW-FISH572/UW-FISH572/renv/library/linux-ubun

```
# Installing packages -----
- Installing flextable ... OK [linked from cache]
Successfully installed 1 package in 4.9 milliseconds.
```

2 Course Information

Percent	GPA	Letter
≥95	4	A
94	3.9	
93	3.8	A-
92	3.7	
91	3.6	
90	3.5	
89	3.4	B+
88	3.3	
87	3.2	
86	3.1	
85	3	B
84	2.9	
83	2.8	B-
82	2.7	B-
81	2.6	
80	2.5	
79	2.4	C+
78	2.3	
77	2.2	
76	2.1	
75	2	C
74	1.9	
73	1.8	
72	1.7	
<72	1.6- 0.0	E

2.6 Lecture plan

Please fill out a class evaluation!

2 Course Information

Table 2.2: Survey of products developed by GAP

Week	Date	Lecture	Instructor	Description
	Jan 5	Kotwicki 1	(Wassermann)	Course outline and introductions. Overview of fisheries dependent and independent data collection, types of fisheries surveys, and other survey science topics. Describe potential class project. Provide examples. Guest Lectures: Lyle Britt (AFSC), Denise McKelvey (AFSC)

2 Course Information

Week	Date	Lecture	Instructor	Description
1	Jan 7	2	Kotwicki (Markowitz)	Overview of survey data products for ecosystem processes research, ecological studies, stock assessment, and forecasting. Guest Lectures: Kayla Ualesi (IPHC), Ebett Siddon (NOAA)

2 Course Information

Week	Date	Lecture	Instructor	Description
	Jan 12	3	Barnett (Markowitz)	Guest presentation. Design principles, sampling designs, logistics and estimation. (Ray Webster) Guest presentation. Case study for implementing survey design (Zack Oyafuso).

2 Course Information

Week	Date	Lecture	Instructor	Description
2	Jan 14	4	Kotwicki (Markowitz)	<p>Student presentations on project plan: 5 minutes presentation, 5-10 minutes for discussion. Some general topics</p> <p>a. Design of a new survey from the ground up.</p> <p>b. Analysis of existing survey data (e.g. present survey data product and its uncertainty, use of survey data in assessments, role of uncertainty in assessment).</p> <p>c. Literature review of a survey topic under active</p>
		14		

2 Course Information

Week	Date	Lecture	Instructor	Description
	Jan 19			<i>Martin Luther King Jr. Observed Holiday</i>

2 Course Information

Week	Date	Lecture	Instructor	Description
3	Jan 21	16	Kotwicki 5 (Wassermann)	Overview of current hot topics in survey science: Uncertainty (observation error), Survey continuity (flexibility and catchability), multi-species optimisation, flexible survey design, model-based estimation of survey data products, simulations, statistical tools and new technology. Combining surveys. Absolute indices of abundance (catchability). Changes in technology affect

2 Course Information

Week	Date	Lecture	Instructor	Description
-------------	-------------	----------------	-------------------	--------------------

2 Course Information

Week	Date	Lecture	Instructor	Description
	Jan 26	6	Hicks (Markowitz)	Examples of combining surveys into one platform and/or combining different data types across platforms to improve survey products. Combining acoustic/rawl data and integrating NW and SW acoustic surveys. Main topics: changes to survey, calibration, scientific and legal process. Guest Lectures: Cole Monahan/Derek BolserJulia Clemons (NWFSC)
		18		

2 Course Information

Week	Date	Lecture	Instructor	Description
4	Jan 28	7	Hicks (Wassermann)	General considerations for using survey data in stock assessments and a few examples from recent assessments. Guest Lecture: Ian Stewart/Allan Hicks (IPHC)
	Feb 2	8	Barnett (Markowitz)	Model-based approaches for standardizing both abundance and compositional data. Guest Lecture: Eric Ward (NWFSC)

2 Course Information

Week	Date	Lecture	Instructor	Description
5	Feb 4	9	Barnett (Wassermann)	Student data simulation and analysis with design- and model-based approaches
	Feb 9	10	Kotwicki (Markowitz)	Student Led Literature Review (20min/10min)

2 Course Information

Week	Date	Lecture	Instructor	Description
6	Feb 11	11	Kotwicki (Wassermann)	Explore total variance of a survey, sources of error, estimation methods, minimizing error, and sampling effort optimization. Survey design planning in a changing environment.
	Feb 16			<i>President's Day Observed Holiday</i>

2 Course Information

Week	Date	Lecture	Instructor	Description
7	Feb 18	12	Hicks (Wassermann)	Acoustic Techniques for Fishery and Ecosystem Surveys Guest Lecture: John Horne (UW/SAFS)
				Engaging Industry Guest Lecture: John Gauvin, John Harms

2 Course Information

Week	Date	Lecture	Instructor	Description
	Feb 23	13	Kotwicki (Markowitz)	International perspective Guests & panel discussion: Richard O'Driscoll (NIWA), Olav Rune Godø (IMR Norway - retired), Mark Dickey-Collas (ICES)

2 Course Information

Week	Date	Lecture	Instructor	Description
8	Feb 25	14	Hicks (Wassermann)	Advanced Technologies. Platforms, technologies and provision of data for stock assessment. Guests + panel discussion: Alex De Robertis (AFSC), Kresimir Williams (AFSC), Ole Shelton (NWFSC)
	Mar 2		Kotwicki (Markowitz)	<i>Future of surveys (Kotwicki)</i>
9	Mar 4		Barnett (Wassermann)	<i>Student Presentations</i>
	Mar 9		Hicks (Markowitz)	<i>Student Presentations</i>

2 Course Information

Week	Date	Lecture	Instructor	Description
10	Mar 11		Kotwicki (Wassermann)	Student Presentations Class Evaluation URL: https://uw.iasystem.org/survey/268860

2.7 Academic integrity

Plagiarism, cheating, and other misconduct are serious violations of your contract as a student. I expect that you will know and follow the University's policies on cheating and plagiarism. Any suspected cases of academic misconduct will be handled according to University regulations. More information can be found at: <https://depts.washington.edu/grading/pdf/AcademicResponsibility.pdf>

For this course, plagiarism is defined as figures and legends that are identical or eerily similar to those of other students. You should absolutely work together, get advice and tips from other students, and help each other (this is the essence of being a successful and helpful scientist), but the final project must be your own work.

Religious accommodation policy

Washington state law requires that UW develop a policy for accommodation of student absences or significant hardship due to reasons of faith or conscience, or for organized religious activities. The UW's policy, including more information about how to request an accommodation, is available at Religious Accommodations Policy. Accommodations must be requested within the first two weeks of this course using the Religious Accommodations Request form.

2.8 Disability accommodations

To request academic accommodations due to a disability, please contact Disability Resources for Students, 448 Schmitz, (206)543-8924 (V/TTY). If you have a letter from Disability Resources for Students indicating that you have a disability which requires academic accommodations, please present the letter to the instructor so we can discuss the accommodations needed for this class.

3 Frequently Asked Questions

Why fisheries-independent surveys are important?

Fisheries-independent surveys are a foundation of fisheries stock assessment and ecosystem research. They are crucial for tracking trends in fish stocks globally. These surveys provide consistent time series data that are used in stock and ecosystem assessments.

Here's how they are useful:

- **Foundation for Research and Management:** Fisheries-independent surveys are considered a cornerstone for fisheries stock assessment and ecosystem research. They are instrumental in focusing attention, triggering opinions, and stimulating ideas, discussion, and activity in specific research fields.
- **Data Collection and Products:** The surveys provide data products used in ecosystem processes research, ecological studies, stock assessment, and forecasting. They offer observations of fish abundance, environmental parameters, species distribution, the discovery of new taxa, and community structure.
- **Unbiased Information about Change:** Unlike data obtained from commercial or recreational fisheries, surveys aim to obtain samples based on statistically rigorous designs. This allows for the inference that observed changes in an abundance index (AI), or other types of data over time are indicative of true changes in the abundance and other population parameters of a monitored stock.
- **Stock Assessment Input:** Fish stock assessment models require AIs as a measure of the relative or absolute abundance of a population. Estimates of AI uncertainty are often incorporated into these models as weighting criteria.
- **Monitoring and Adaptation:** Surveys are conducted worldwide to determine the status of marine populations and characterize the state of marine ecosystems. As marine ecosystems change and technology advances, modernizing survey tools allows to maintain critical survey time series and deliver the best available science to support sustainable fisheries management. This includes adapting to changes in ecosystems and technology through evolving design, estimation, and technology.

3.1 *Why would this course prepare you well for the future career in the field of fisheries science?*

This course, “Principles and applications of fisheries-independent surveys” (FISH 572), is designed to prepare you well for a future career in fisheries science due to its comprehensive curriculum and practical focus:

- **Foundational Knowledge:** It establishes a strong understanding of fisheries-independent surveys as a cornerstone for fisheries stock assessment and ecosystem research, which are fundamental to the field.
- **Essential Skills:** The course covers crucial skills such as survey design for various objectives and data types, practical data analysis using diverse methods, and understanding current topics like uncertainty and effort optimization. These are highly valuable for any career in fisheries science.
- **Real-World Application:** You will gain insight into the logistical challenges of implementing and managing these surveys, and critically, how the data products are directly used in fisheries research, assessment, and informing management decisions. This bridges theoretical knowledge with practical application.
- **Hands-on Experience:** The course includes student-led literature reviews, discussions, and particularly, hands-on survey data analysis. The significant portion of the grade based on a final research project using survey data provides invaluable experience in research planning and execution, mirroring real-world scientific work.
- **Career Insights:** The curriculum explicitly addresses career paths in fish research surveys, offering guidance and networking opportunities.
- **Relevance to Current Trends:** By exploring topics like survey continuity, flexible survey design, and the use of new technology, the course ensures you are updated on the latest developments and challenges in survey science, preparing you for an evolving field.

Overall, the course provides a blend of theoretical knowledge, practical skills, and real-world context, making it an excellent preparation for a career in fisheries science, particularly in research and stock assessment roles.

3.1.1 *Why learning about fisheries-independent surveys is critical to prepare you well for future collaboration with artificial intelligence (AI)?*

Learning about fisheries-independent surveys, as a data collection tool, can prepare you well for future collaboration with AI for several key reasons:

3 Frequently Asked Questions

- **Understanding Data Quality and Bias:** AI models are highly dependent on the quality and objectivity of the data they are trained on. Fisheries-independent surveys are specifically designed to collect high quality data through statistically rigorous designs. By understanding these methodologies, you learn to recognize and appreciate the importance of data integrity. This knowledge is crucial when working with AI, as you'll be able to identify potential biases in datasets and assess the reliability of AI-driven insights, ensuring the AI is learning from sound information.
- **Data Structure and Organization:** Surveys generate structured time series data, including observations of abundance, environmental parameters, species distribution, and community structure. Understanding how this data is collected, organized, and stored (e.g., in databases) is fundamental. This knowledge directly translates to preparing data for AI algorithms, which often require well-structured and standardized inputs. You'll be better equipped to design data pipelines and ensure compatibility between survey outputs and AI models.
- **Uncertainty Quantification:** Fisheries-independent surveys inherently deal with uncertainty in their estimates (e.g., in abundance indices). The course explicitly covers topics like uncertainty and how it's incorporated into stock assessment models. This focus on quantifying and managing uncertainty is highly relevant to AI, as many AI models also produce predictions with associated uncertainties. Your understanding of survey-derived uncertainty will enable you to better interpret AI model outputs, evaluate their confidence, and even contribute to developing AI models that explicitly account for data uncertainty.
- **Identifying Key Variables and Relationships:** Through learning about survey design and analysis, you'll gain an understanding of which environmental and biological variables are critical for understanding fish populations and ecosystems. This domain expertise is invaluable when collaborating with AI. You can guide AI in identifying relevant features for its analysis, suggest appropriate modeling approaches, and validate whether the AI's findings align with ecological principles.
- **Interpreting Model Outputs:** The course emphasizes how survey data products are used in ecosystem processes research, ecological studies, stock assessment, and forecasting. This gives you experience in interpreting complex scientific data and model outputs. When AI is applied to fisheries data, it will generate its own set of outputs (e.g., predictions, classifications, anomaly detections). Your background in interpreting survey-derived insights will allow you to critically evaluate AI-generated information and discern its practical implications for fisheries management.
- **Adapting to New Technologies:** The course highlights the importance of modernizing survey tools and adapting to new technology. This forward-looking perspective fosters an open mind towards integrating innovative solutions, including AI, into fisheries science. Your exposure to evolving design, estimation, and

3 Frequently Asked Questions

technology within surveys will make you more receptive to, and capable of, leveraging AI for advanced data analysis and management.

In essence, a deep understanding of fisheries-independent surveys provides you with a robust foundation in data collection principles, data quality assessment, uncertainty management, and domain-specific knowledge – all of which are critical for effective and responsible collaboration with artificial intelligence in the evolving field of fisheries science.

3.1.2 What is the future of fisheries-independent surveys?

The future of fisheries-independent surveys is characterized by continuous modernization and adaptation to dynamic marine ecosystems and rapid technological advancements.

Key aspects of this future include:

- **Responding to Environmental and Anthropogenic Changes:** Surveys will need to continuously adapt to shifts in species distribution due to climate change, increased human activities in survey areas (e.g., offshore wind farms, marine protected areas), and disruptions from extreme weather events. This requires expanding sampling areas and combining information across multiple jurisdictions.
- **Technological Integration and Modernization:** The future will see the incremental incorporation of advanced technologies, rather than wholesale replacement of existing methods. This includes:
 - **New Sampling Technologies:** Increasingly sophisticated and high-resolution acoustics, eDNA (environmental DNA), and optical techniques will become more widespread. eDNA, for instance, shows promise for detecting rare species, quantifying community composition, and estimating abundance.
 - **Evolving Platforms:** While crewed research vessels will remain key, surveys will be augmented and potentially partially replaced by uncrewed and autonomous platforms like uncrewed surface vehicles (USVs), remotely operated vehicles (ROVs), and even animal-borne sensors. Stationary platforms (piers, moorings, seabed landers) and satellites will also contribute data.
 - **Data Processing and Transmission:** Improvements in data storage, processing, and near real-time transmission from sea to land will enable adaptive sampling decisions and remote involvement of scientists and stakeholders.

3 Frequently Asked Questions

- **Artificial Intelligence and Machine Learning (AI/ML):** AI/ML will play an increasingly significant role in rapidly processing large, multidisciplinary observational datasets, identifying and counting organisms (e.g., scallops from camera footage), and informing adaptive sampling designs.
- **Expansion of Survey Objectives:** Surveys are evolving beyond single-taxon stock assessments to become comprehensive platforms for ecosystem monitoring. This means collecting a wider range of biotic and abiotic data, including oceanographic parameters (salinity, dissolved oxygen, pH), physiological status, condition, food habits, genetics, and even microplastics, to support ecosystem-based fisheries management and climate change forecasting.
- **Advancements in Statistical Methods:** Rapid advancements in spatial statistical methods, including spatio-temporal models, will be crucial. These models will facilitate estimation from unbalanced data, bridge time series across changes in survey effort or design, and help optimize survey designs for efficiency and precision, even under budget constraints.
- **Flexible and Multi-Platform Designs:** Future surveys will prioritize flexibility in design to continuously adapt to changing conditions and stakeholder needs. This will involve using probabilistic sampling designs, parsimonious stratification, and designing surveys to be “platform-agnostic,” allowing the integration of data from various sources (e.g., trawl, acoustics, eDNA, video) and multiple platforms.
- **Addressing Resource Constraints:** Static budgets necessitate innovative approaches, including increased use of commercial vessel platforms for surveys and exploring cost-recovery models, while carefully assessing tradeoffs between cost-saving measures and data quality.
- **Maintaining Consistency and Continuity:** A core challenge and priority for the future is to manage change while ensuring the consistency and comparability of long-term time series data. This will involve careful calibration of new and old methods, running parallel operations, and using model-based approaches to account for method differences.
- **Increased Automation and Data Accessibility:** There will be a drive towards greater automation in sampling and data analysis to ensure timely access to data. Furthermore, data products will need to be standardized and accessible to a broad range of stakeholders, aligning with open science and data-sharing policies.

In summary, the future of fisheries-independent surveys is not about wholesale replacement, but rather about strategic, incremental integration of advanced technologies, sophisticated statistical methods, and broadened ecological objectives, all while rigorously maintaining the invaluable consistency of long-term data series to inform sustainable fisheries and ecosystem management in a dynamic world.

3 Frequently Asked Questions

3.1.3 *I'm considering a career in marine ecology. How would this class benefit me in that pursuit?*

This course would significantly benefit you in a career in marine ecology by providing a strong foundation in data collection, analysis, and understanding of marine ecosystems:

- **Understanding Ecosystem Dynamics:** The course emphasizes how survey data products are used in “ecosystem processes research” and “ecological studies.” In marine ecology, understanding how populations interact with their environment and with each other is fundamental. This class will teach you how to collect and interpret data that reveals these critical ecological relationships.
- **Comprehensive Data Collection Skills:** Marine ecologists often rely on robust data to study populations, habitats, and environmental changes. This course will teach you about “various survey designs for different objectives, types of data collection, and the resulting data products.” You’ll learn about methods for observing “fish abundance, environmental parameters, species distribution,” and “community structure,” which are all central to marine ecological research.
- **Data Quality and Scientific Rigor:** Marine ecology thrives on reliable data. The course highlights that surveys “aim to obtain samples based on statistically rigorous designs,” leading to “unbiased information about change.” This understanding of how to collect high-quality data is crucial for any marine ecologist seeking to draw accurate conclusions and inform conservation efforts.
- **Data Analysis and Interpretation:** A significant part of marine ecology involves analyzing complex datasets. You will “gain practical skills in analyzing fisheries-independent survey data using both design and model-based methods.” This will equip you with the analytical tools to interpret ecological patterns, assess population health, and evaluate the impact of environmental changes.
- **Real-World Application and Logistical Understanding:** Marine ecologists often engage in fieldwork and collaborate with management agencies. The course will provide insight into “logistical challenges in implementing and managing fisheries-independent surveys.” This practical understanding is vital for planning your own research and working effectively within large-scale ecological monitoring programs.
- **Adaptation to Change and New Technologies:** Marine ecosystems are dynamic. The course’s focus on “current topics” like “survey continuity, effort optimization, flexible survey design, and the use of statistical tools and new technology” will prepare you to adapt your ecological research methods to changing environmental conditions and integrate cutting-edge tools (like eDNA, acoustics, and AI/ML) into your work.

3 Frequently Asked Questions

- **Ecosystem-Based Management Context:** The course highlights how survey data supports “ecosystem-based fisheries management.” This broader perspective is highly relevant to marine ecology, which increasingly aims to manage and conserve entire ecosystems, not just individual species. You’ll understand how your ecological research can directly inform real-world management and policy.
- **Hands-on Research Experience:** The “final research project using survey data” provides invaluable “experience in research planning and execution,” mirroring the work of a professional marine ecologist. This hands-on experience will build your confidence and capabilities for future ecological research.

In essence, this course provides a robust toolkit for a marine ecologist: strong data collection and analytical skills, an understanding of ecological principles in action, and practical knowledge of how to contribute to the management and conservation of marine environments.

3.1.4 *I’m considering a career in fisheries stock assessment. How would this class benefit me in that pursuit?*

This course would be incredibly beneficial for a career in fisheries stock assessment for the following reasons:following:

- **Foundational Role of Surveys:** You will learn that fisheries-independent surveys are the cornerstone of modern fisheries stock assessments. This includes understanding why they are often the most reliable and consistent source of information for estimating population abundance, spatial distribution, and demographic structure—all crucial for stock assessments.
- **Data for Assessment Models:** The course will teach you precisely how survey data are used to generate the relative indices (or absolute estimates) of abundance and biomass that are essential inputs for stock assessment models. You’ll also learn how the uncertainty in these abundance indices is incorporated into models, which is vital for robust assessments.
- **Ensuring Data Quality:** You’ll understand the principles behind designing statistically rigorous surveys to ensure the collection of high-quality, unbiased data. This is critical because the accuracy and reliability of stock assessments directly depend on the quality and consistency of the input data.
- **Managing Data Challenges:** The class will prepare you for common issues in stock assessment data, such as changes in survey methodology or environmental conditions disrupting long-term data series. You will learn approaches to combine data from different methods and use model-based techniques to account for these differences, ensuring the continuity of assessments.

3 Frequently Asked Questions

- **Advanced Analytical Skills:** The course will introduce you to sophisticated statistical methods, including spatio-temporal models. These are key tools for stock assessors to handle complex, unbalanced datasets, bridge different data sources, and optimize survey designs for maximum efficiency and precision.
- **Integrating New Technologies:** You will gain insight into how advanced technologies like eDNA, optical instruments, autonomous vehicles, etc. can be integrated into surveys for more efficient data collection and processing. Understanding these advancements will allow you to leverage new data streams in future stock assessments.
- **Ecosystem-Based Assessment:** The class will broaden your perspective to include the collection of a wider range of environmental and biological data during surveys to support ecosystem-based fisheries management. This prepares you for assessments that consider broader ecological factors beyond single species.
- **Practical Research Experience:** Through a hands-on final research project using real survey data, you will gain practical experience in planning, executing, and analyzing data relevant to stock assessments. This experience directly mirrors the work performed by professionals in the field.

In summary, this course provides a comprehensive and forward-looking education in the science of fisheries-independent surveys, equipping you with the fundamental knowledge, advanced analytical skills, and practical understanding of data quality and technological integration that are indispensable for a successful career in fisheries stock assessment.

3.1.5 *I'm considering a career in fisheries management. How would this class benefit me in that pursuit?*

This class would significantly benefit you in a career in fisheries management by equipping you with a foundational understanding of the data and science that underpins management decisions:

- **Understanding the Basis of Management Advice:** Fisheries management fundamentally relies on scientific data to make decisions about quotas, regulations, and conservation measures. This course will teach you that fisheries-independent surveys are a foundation of fisheries stock assessment and ecosystem research, directly informing the management advice. Understanding where this critical information comes from and its strengths and limitations is very important for fishery managers.
- **Evaluating Data Quality and Reliability:** As a manager, you'll constantly review scientific reports and data to inform your decisions. This course emphasizes

3 Frequently Asked Questions

that surveys aim to obtain samples based on statistically rigorous designs to provide information about change in ecosystems. This knowledge will enable you to critically assess the quality and reliability of the data presented to you, ensuring your management decisions are based on sound science.

- **Interpreting Stock Assessments and Ecosystem Reports:** The course highlights how survey data products are used directly in stock assessment and to characterize the state of marine ecosystems. You will learn how abundance indices are generated and incorporated into assessment models. This understanding will allow you to better interpret the outputs of stock assessments and ecosystem reports, enabling you to grasp their implications for management actions.
- **Informing Policy and Regulation:** Effective management requires setting appropriate policies and regulations. By understanding survey design, data analysis, and the uncertainties involved, you'll be better positioned to translate scientific findings into practical management measures, weigh trade-offs and risks, and explain the scientific basis for regulatory decisions to stakeholders.
- **Adapting to Ecosystem Changes:** Marine ecosystems are dynamic, influenced by climate change and human activities. The course's focus on adapting to changes in ecosystems and technology through evolving design, estimation, and technology will prepare you to understand how scientific monitoring can adapt to these changes and provide the necessary data for adaptive management strategies.
- **Communicating with Scientists and Stakeholders:** A key aspect of fisheries management is effective communication between scientists, managers, and the public. This course will give you the scientific vocabulary and understanding of data collection methodologies to effectively engage with scientists who provide the data and to explain complex scientific concepts to various stakeholders.
- **Appreciating Logistical Challenges:** Understanding the logistical challenges in implementing and managing fisheries-independent surveys will give you a practical appreciation for the effort and resources required to collect essential data. This insight can help you allocate resources more effectively and appreciate the constraints scientists face.
- **Future-Proofing Your Knowledge:** The course touches on current topics such as: new technology, flexible survey design, and AI/ML in data processing. This forward-looking perspective will ensure you are prepared for future advancements in how fisheries data is collected and analyzed, allowing you to incorporate innovative tools into management practices.

In essence, this course provides a critical scientific literacy for any fisheries manager, enabling you to effectively use, interpret, and advocate for the robust scientific data that underpins sustainable fisheries management.

3 Frequently Asked Questions

3.1.6 *I'm considering a career in academia. How would this class benefit me in that pursuit?*

If you're considering a career in academia, this class would provide significant benefits, particularly if your academic focus is in marine science, ecology, or fisheries:

- **Research Foundation:** Academia is built on research. This course teaches you that fisheries-independent surveys are a foundation of fisheries stock assessment and ecosystem research. You will learn the rigorous methodologies for collecting data essential for designing and executing high-quality academic research projects.
- **Methodological Expertise:** You'll gain deep knowledge in various survey designs for different objectives, types of data collection, and the resulting data products, as well as practical skills in analyzing fisheries-independent survey data using both design and model-based methods. This methodological expertise is crucial for developing your own research programs, securing grants, and publishing in peer-reviewed journals.
- **Bridging Theory and Practice:** Academia often involves translating theoretical concepts into practical applications. Understanding the logistical challenges in implementing and managing fisheries-independent surveys, and how survey data products are used in fisheries research, assessment, and management advice will enable you to design research that is both scientifically sound and relevant to real-world problems.
- **Advanced Statistical Skills:** Academic research often requires sophisticated statistical approaches. The course's focus on advancements in statistical methods, including spatio-temporal models, and their use for estimation from unbalanced data and optimizing survey designs, directly enhances your quantitative skillset, making you a more capable researcher and modeller.
- **Publication and Grant Writing:** The final research project using survey data provides experience in research planning and execution, including the analysis and interpretation of data. This hands-on experience is directly transferable to writing manuscripts for publication and developing compelling research proposals for funding.
- **Teaching and Mentorship Preparation:** In academia, you'll likely teach and mentor students. Having a strong grasp of the fundamental data collection tools and analytical methods, as provided by this course, prepares you to effectively teach these subjects and guide future researchers.
- **Interdisciplinary Collaboration:** Modern academic research is highly collaborative. The course's emphasis on "Expansion of Survey Objectives" to include a wider range of biotic and abiotic data for ecosystem monitoring prepares you

3 Frequently Asked Questions

for interdisciplinary projects common in academia, where you might collaborate with oceanographers, geneticists, or climate scientists.

- **Staying at the Forefront of the Field:** Academia demands staying current with the latest advancements. The course explores current topics such as uncertainty, survey continuity, effort optimization, flexible survey design, and the use of statistical tools and new technology, including AI/ML. This ensures you're aware of cutting-edge methods and technologies that can shape your research direction.
- **Building a Research Network:** Exposure to lectures from instructors and visiting experts and student-led literature reviews and discussions will help you build valuable connections within the academic community, which are crucial for collaborations, post-doctoral positions, and faculty roles.

In essence, this course provides the comprehensive scientific and methodological toolkit necessary to initiate and sustain a successful research program in marine ecology or fisheries science within an academic setting.

4 Resources

4.1 AFSC Grounfish Bottom Trawl Survey

- Groundfish Assessment Program Bottom Trawl Surveys
- AFSC's Resource Assessment and Conservation Engineering Division
- All AFSC Research Surveys
- Publications and Data Reports
- Research Surveys conducted at AFSC

5 References

6 NOAA quarto book with R and download PDF or docx

This is a template for a simple Quarto book (`type: book`). It has download links (under the logo) for PDF or docx download.

The repo includes a GitHub Action that will build the book (html, PDF, and docx) automatically when you make changes to the files. The webpage will use the `gh-pages` branch. Serving the website files from this branch is a common way to keep all the website files from cluttering your main branch.

References