MIT SEA GRANT
COLLEGE PROGRAM

2021 CALL FOR PRE-PROPOSALS OPEN MEETING

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MIT SG Director

January 14, 2021

MAIN FOCUSED THEMES FOR 2022-2024

- **Offshore aquaculture, a topic first introduced three years ago.** The focus is on novel technologies to enable offshore installation and operation within three topics: (a) Flexible surfaces with embedded sensors and actuators that can be used as "intelligent" nets, capable of sensing the environment and controlling flow and fish; (b) Autonomy for surface and underwater craft for inspection and maintenance of offshore farms – autonomy algorithms should be open, extensible, and applicable to a wide variety of platforms and missions; and (c) Very low power physical, chemical, or biological sensors for farm monitoring. Highly ranked aquaculture proposals received through this competition will allow MITSG to take advantage of up to 50% co-funding by the NSGCP.
- **Ocean acidification.** The focus is on ocean monitoring using physics-based data inference, fusing diverse sources of data, e.g. at least two of satellite data, data from drifters, and buoy data. The target is to demonstrate such a computer monitoring system for the Boston Harbor or the Gulf of Maine.
- **Technology for observation and underwater manipulation.** Focusing particularly on shallow water applications, this area builds on past topics in underwater transmission and data communication. Principal obstacles in underwater monitoring and manipulation include: (a) Re-charging rapidly and effectively; (b) Transferring data reliably at high rates; (c) Equipping underwater and surface vehicles with manipulation capabilities targeting aquaculture applications.
- **Machine Learning for Fisheries Management:** Monitoring and assessment of fisheries resources is a timely, costly, and resource intensive process. Advances in artificial intelligence and machine learning for computer-assisted image recognition, quantification, and real-time monitoring of target species is a need expressed by a variety of stakeholders. MITSG is soliciting research that supports and/or leads to the development of user-friendly systems for commercial or recreational, wild and aquaculture fisheries and species of concern to assist in monitoring and assessments.

ELIGIBILITY AND REQUIREMENTS

- University-based, Massachusetts scientists eligible for Principal Investigator status at home institution.
- If the PI is receiving any other MIT Sea Grant project funding during the FY2021 period (2/1/2022 to 1/31/2024) s/he is not eligible to apply in this round.
- Projects are generally funded for two years at a maximum of $100,000 per year, with a 50% match requirement.
- PRE-PROPOSALS DUE FRIDAY, FEBRUARY 19, 2021
- PROPOSALS DUE TUESDAY MAY 18, 2021(pre-proposal submission prior to proposal submission is a requirement)

MAIN FOCUSED THEMES FOR 2022-2024: THEME 1

- **Offshore aquaculture, a topic first introduced two years ago.** The focus is on novel technologies to enable offshore installation and operation. Within this area, we particularly encourage submissions in three topics: (a) Flexible surfaces with embedded sensors and actuators that can be used as "intelligent" nets, capable of sensing the environment and controlling flow and fish; (b) Autonomy for surface and underwater craft for inspection and maintenance of offshore farms – autonomy algorithms should be open, extensible, and applicable to a wide variety of platforms and missions; and (c) Very low power physical, chemical, or biological sensors for farm monitoring. Highly ranked aquaculture proposals received through this competition will allow MITSG to take advantage of up to 50% co-funding by the NSGCP.

Theme 1, TECHNOLOGY FOR OFFSHORE FARMING

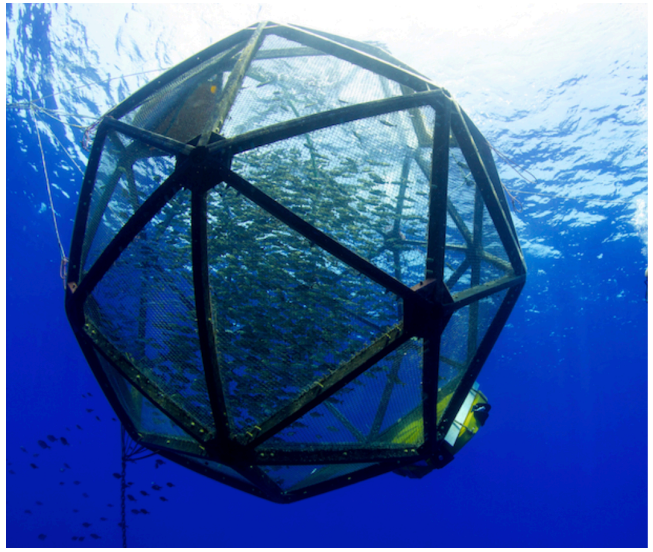
Selected based on data gathered in our constituent meeting in 2017, and supported by our Advisory Committee

- Seven experts in the field made presentations, followed by discussion with about 50 attendees
- Ocean produces 1 to 2% of food, yet its biomass is about equal to the land biomass
- Ocean fish demand is estimated to increase by 70% by 2030. This will have to come mostly through farming – offshore farming is thought to be friendlier to environment and consume less resources
- Norway, other countries are at forefront of offshore farming research and initiatives, but US sees initiatives as well
- Several technological, economic, regulatory challenges identified before offshore farming becomes a reality
- REFERENCE National Science & Technology Council, Subcommittee on Ocean Science and Technology, June 2018, "Draft for Public Comment, Science and Technology for Anerica's Oceans: A Decadal Vision", includes MARICULTURE

MAIN GOAL FOR MIT SEA GRANT: DEVELOP NOVEL TECHNOLOGY FOR ECONOMICALLY FEASIBLE OFFSHORE FARMING, AND TARGET TO BECOME WORLD LEADER

OFFSHORE AQUACULTURE AND FISHERIES

- IN NORWAY, CULTURED SALMON PRODUCTION WAS HALVED IN 2015 AFTER A LICE EPIDEMIC IN 30 COASTAL FARMS
- SalMar, NORWEGIAN FIRM WITH FOOTHOLD IN JAPAN, WILL BUILD FOR $180M, 160 m WIDE SMART FISH FARM, IN ADDITION TO EXISTING 110 m PILOT OCEAN 1 FARM, 20 km OFFSHORE TRONDELAG FOR 20K TONS PER YEAR SALMON
- MANNA Fish Farms, an example of US based company with offshore farming agenda off Long Island



AREAS OF RESEARCH ON THEME 1, OFFSHORE AQUACULTURE

- MAIN THEME: Develop novel technologies and materials enabling environment-friendly offshore farming. The focus is on:
- (a) Flexible surfaces with embedded sensors and actuators that can be used as "intelligent" nets, capable of sensing the environment and controlling flow and fish;
- (b) Autonomy for surface and underwater craft for inspection and maintenance of offshore farms – autonomy algorithms should be open, extensible, and applicable to a wide variety of platforms and missions; and
- (c) Very low power physical, chemical, or biological sensors for farm monitoring.
- REFERENCE: NS9415. Marine fish farms - Requirements for site survey, risk analyses, design,dimensioning, production, installation and operation. Norwegian standard, SN/ K 509, 2009.

MAIN FOCUSED THEMES FOR 2022-2024: THEME 2

- **Ocean acidification.** The focus is on ocean monitoring using physics-based data inference, fusing diverse sources of data, e.g. at least two of satellite data, data from drifters, and buoy data. The target is to demonstrate such a computer monitoring system for the Boston Harbor or the Gulf of Maine.

THEME 2: OCEAN ACIDIFICATION

- Develop reliable COST EFFECTIVE technology for ocean acidification continuous monitoring using physics-based data inference and demonstrate through the development of combined simulation-experimental systems
- REASON: Sparse field data and insufficient satellite resolution will require either a massive investment in observation floats, or the use of powerful machine learning methods to extract information
- REFERENCE National Science & Technology Council, Subcommittee on Ocean Science and Technology, June 2018, “Draft for Public Comment, Science and Technology for Anerica’s Oceans: A Decadal Vision”, includes Big Data analytics and high performance computing.

THEME 2: OCEAN ACIDIFICATION FOCUS

- MAIN THEME FOR MIT SEA GRANT: The focus is on ocean monitoring using physics-based data inference, fusing diverse sources of data, e.g. at least two of: satellite data, data from drifters, and buoy data. The target is to demonstrate such a computer monitoring system for the Boston Harbor or the Gulf of Maine.

AREAS OF RESEARCH ON THEME 2

- Reliable systems providing continuous area monitoring using physics-based data inference (Gulf of Maine, Boston harbor) based on fusion of sparse on-site measurements and satellite data – acidification is especially exacerbated due to pH variability in the coasts of New England
- A specific deliverable will be a system demonstration through integrated theory-experiment-simulation
- The system must be able to deal effectively with non-stationarity and non-linearity of ocean processes

- REFERENCES

- Gledhill et al , 2015, "Ocean and coastal acidification of New England and Nova Scotia", *Oceanography*, 28 (2), 2015
- P. Perdikaris et al, 2017, "Nonlinear information fusion algorithms for data-efficient multi-fidelity modelling" Proc. R. Soc., London A, 473 (2198)

MAIN FOCUSED THEMES FOR 2022-2024: THEME 3

- **Technology for observation and underwater manipulation.** Focusing particularly on shallow water applications, this area builds on past topics in underwater transmission and data communication. Principal obstacles in underwater monitoring and manipulation, include: (a) Re-charging rapidly and effectively; (b) Transferring data reliably at high rates; (c) Equipping underwater and surface vehicles with manipulation capabilities targeting aquaculture applications.

THEME 3: UNDERWATER POWER TRANSFER AND DATA, COMMUNICATION, AND MANIPULATION

- NEED FOR THE RESEARCH: PRINCIPAL OBSTACLES IN UNDERWATER MONITORING AND MANIPULATION ARE:
- (a) RE-CHARGING RAPIDLY AND EFFECTIVELY,
- (b) TRANSFERING DATA RELIABLY AT HIGH RATES
- (c) Equipping underwater and surface vehicles with manipulation capabilities targeting aquaculture applications.

AREAS OF RESEARCH ON THEME 3

- Focus particularly on shallow water applications. The challenge is to deliver laboratory prototype for:
  - Power transmission at a rate of at least 1 kW
  - New modalities for rapid wireless data transmission over short distances, including through the free surface, OTHER THAN ACOUSTIC
  - A key element is demonstration of effectiveness in experiment under realistic conditions
  - Autonomous underwater and surface vehicles equipped with underwater intervention/manipulation capabilities, as driven by stakeholders in aquaculture farming

- REFERENCES

- C.M.G. Gussen et al, 2016, "A survey of underwater wireless communication technologies", J. Commun. Information Systems, 31 (1), 242-255
- S.V. Lukashov, 2015, "A self-tuning 100 W wireless power transfer system", SM Electrical Engineering and Computer Science, MIT, Cambridge, MA

MAIN FOCUSED THEMES FOR 2022-2024: THEME 4

- **Machine Learning for Fisheries Management:** Monitoring and assessment of fisheries resources is a timely, costly, and resource intensive process. Advances in artificial intelligence and machine learning for computer-assisted image recognition, quantification, and real-time monitoring of target species is a need expressed by a variety of stakeholders. MITSG is soliciting research that supports and/or leads to the development of user-friendly systems for commercial or recreational, wild and aquaculture fisheries and species of concern to assist in monitoring and assessments.

PRE-PROPOSALS DUE: FEBRUARY 19, 2021 BY 5:00 PM

QUESTIONS ?