THE PAUL G. ALLEN
OCEAN CHALLENGE
MITIGATING ACIDIFICATION IMPACTS

CONCEPT SUBMISSION FORM

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*Title of concept (100 characters max.):

MANAGED SEAWEED FORESTS WITH NUTRIENT CYCLING RAISE GLOBAL OCEAN pH

*Description of concept

Managed seaweed forests could raise ocean pH to pre-industrial levels by removing CO2 to safe storage, replacing fossil fuels with biofuels, and increasing the diversity of life in and around them. The forests are sustained, in what are now nutrient deserts, by recycling plant nutrients.

The oceans need mitigation ecosystems that address the scale and duration of humanity's addiction to fossil fuels plus our inadvertent release of methane hydrates. Seaweed forests can remove more than 2 trillion tons of CO2 from air and water this century, thus reversing global warming and ocean acidification.

ADVANTAGES

Complete ecosystems – Managed seaweed forests are complete photosynthesis-powered ecosystems. Forests address the root causes of 21st Century human and ecological crises: ocean pH, sea level, food, warming air and oceans, energy, extreme storms and droughts, fresh water, changing climate, migrating disease, overfishing, decreasing ocean primary productivity and biodiversity, etc. The new forests, growing in what are now nutrient deserts, will capture primarily anthropogenic CO2.

Economically self-sustaining – These forests can pay for themselves by selling food, energy, and other products. When we stop using fossil fuels, sale of food and energy products may subsidize storing legacy CO2. Spreadsheets and other info at www.OceanAfforestation.org/References.html

Ocean scale – Seaweeds can grow over 71% of Earth. Land-based carbon mitigations access only 29% of Earth's surface and that surface will be much more crowded with people and their activities in 2050.

Food other benefits – Replacing fossil fuels requires so much seaweed forest that the additional production of more than 0.5 kg of fish and sea vegetables per person per day for 10 billion people could be almost an "incidental" by-product. Globally, humanity is already using seaweed farming for food production. We might use a mostly "bootstrap" progression from first producing food products, to food & fertilizer, to food & fertilizer & energy, to incidental food plus energy & CO2 storage.

Denitrification – Galbraith, et.al. (Nature Geoscience, 2013) confirmed the importance of oceanic denitrification (anoxic bacteria converting nitrate to N2) during deglacial warming. Less oxygen dissolves in warmer water. Low oxygen favors anoxic bacteria who obtain oxygen from nitrate. Most team members believe the availability of nitrate already limits ocean primary productivity much more than does CO2. Managed seaweed forests counter this potential drop in ocean primary productivity and dissolved oxygen with rapid nutrient cycling.

Interdisciplinary nature – The "stone soup" analogy is akin to the Paul G. Allen Foundation desire for interdisciplinary efforts. The Foundation would fund (stones and kettle) promising pH mitigations. The science and engineering team would share their potential grant-winning concepts (carrots, potatoes, parsley, etc.) to make managed seaweed forests (soup). These forest ecosystems can only be successful and sustainable as a "soup" of interdisciplinary effort. We expect to need more than the team's current 24 scientists and engineers.

Interdisciplinary opportunities – Drs. Brune and Chynoweth have examined seaweed forests and anaerobic digestion since the 1980s. Dr. Brune's efforts confirmed a pressurized seawater macroalgal digester operating at typical ocean temperature will produce 90% bio-methane in acceptable time frames. Only now is this concept becoming economically viable due to continually improving materials science (particularly geosynthetics and nanotechnology), artificial intelligence (autonomous and remotely operated sensors and systems), microbiology, chemistry, and ocean engineering. The new science allows relatively large and inexpensive submerged process containers, harvesting processes, nutrient-treating equipment, nutrient-dispersal systems, and energy conversions for transporting product energy.

PROCESS STEPS

1. GROW SEAWEED, about 18 ash-free dry tons of seaweed per hectare per year with typical nutrient supplies has been well documented. We start managed forest operations in sheltered water with excess nutrients as explained in our Phase 1 small-scale pH mitigation concept, MANAGED SEAWEED RAISES OCEAN pH WHILE REMEDIATING OCEAN DEAD

ZONES. In sheltered water, we can perfect nutrient recycling systems to grow more macroalgae than microalgae.

After learning in sheltered water, we expand seaweed forests to open ocean. Forests in gyres, eddies, and moving with currents may mimic the free-floating and biodiverse Sargasso Sea. Our diverse team will develop nutrient-recycling techniques to grow 18 tons/ha/yr of seaweed even as the seaweed drifts with the current.

2. HARVEST SEAWEED: The open ocean operation will be a forest, not a farm because anaerobic digestion accepts any relatively wet biomass. We need not shelter a mono-culture from competition. Our low-energy harvest can happen at the natural pace of biology, wind, and wave. For example, allow a few days to contract an open-bottom floating curtain net around the harvested area and another day or two to winch the contracted "tea bag" of biomass over and into the digestion container. Orbiting and high altitude sensors allow us to select harvesting spots and catch any break-away seaweed clumps.

3. DIGEST SEAWEED: The plant nutrients are separated from the plant energy (carbon and hydrogen from the nitrogen, phosphorous, iron, etc.). Improved anaerobic digestion or other processes may reduce the 9% of world ocean surface needed to replace 100% of global fossil fuel demand.

4. RECOVER SEPARATED BIO-CH4 AND BIO-CO2: Dr. Brune demonstrated direct production of 90% biomethane (differential dissolution) from seaweed at 7 atmospheres pressure in the 1980s. The higher concentrations of dissolved CO2 improved process pH stability. This means we produce two gas streams: 1) 90:10 CH4:CO2 gas at the pressure of the digester depth (likely 10 to 50 atmospheres); and 2) 10:90 CH4:CO2 dissolved inside the digester. Higher than about 95% CH_4 purity may be liquefied or piped as natural gas or converted to synthetic diesel, jet fuel, gasoline, etc.

5. RECYCLE NUTRIENTS: Seaweeds concentrate the nutrients from the water. Digesting the seaweed further concentrates the nutrients in two forms: 1) dissolved in seawater and 2) trapped in partially digested solids. Distributing the nutrients must be carefully managed to prevent ammonia toxicity and maximize macroalgal forest sustainability without microalgae blooms.

Our Life Cycle Assessment (LCA) includes energy and materials to recycle 100% of nutrients with three distribution systems: 1) dispersing the water with dissolved nutrients and some suspended solids; 2) floating “teabags” of “solids”; and 3) creating an artificial upwelling from 200 meters depth to return falling nutrients which were not collected during harvesting.

6. CAPTURE AND COMPRESS THE BIO-CO2: When anaerobic digestion is completed in a submerged digester, we are left with the liquid and solid nutrients plus dissolved gas. As we lift the liquid, the gases bubble out of solution and are captured on the surface at 1-atm pressure.

All the captured (previously dissolved) bio-CO_2, bio-CH_4, H_2S, N_2O, etc. is compressed to 50-bar and cooled as it is moved to the 500-meter depth. The compressed bio-CO_2 condenses to a liquid. We recover non-condensing gases, including bio-CH4.

7. STORE THE BIO-CO2: Several carbon storage technologies are available, including: deep earth hot "geologic" storage; as rock via reaction with olivine and other minerals; in conjunction with H2 production via electrolysis with silicate minerals; or per the concept: "RAISE OCEAN pH BY STORING CO2 CAPTURED FROM SEAWEED FORESTS AS CONTAINED HYDRATE."

*Statement of expected impact

Seaweed forests over 9% of the world's oceans reverse ocean acidification by producing and storing over 30 billion tons of bio-CO_2 and captured combusted bio-CH4 per year.

Public awareness of a self-funding, sustainable, food-producing ocean-based solution to humanity's energy and climate needs revives hope and invigorates our mitigation efforts.

Seaweed forest ecosystems also increase ocean primary productivity and biodiversity, while relieving pressure on terrestrial food and fuel supplies.

***Expected duration of work to make progress**

2-3 years for Fiji. 1-2 decades for open ocean.
Expect 2-3 years to economically self-sustaining sheltered water operations, likely one 2,000+ ha forest in a Fiji lagoon. Fiji has ideal conditions of polluted bays, high electricity costs, and need of fertilizer for terrestrial crops. Our biogas production can directly replace imported diesel fuel using the existing engine-generators. Most engines would be modified to vary fuel instantly from 0 to 80% biogas (100% to 20% diesel).

The University of the South Pacific is funding Dr. N'Yeurt's initial research project starting in September 2013 focused on producing both energy and terrestrial agriculture fertilizer. See our related concept "MANAGED SEAWEED RAISES OCEAN pH WHILE REMEDIATING OCEAN DEAD ZONES." Other researchers are currently investigating efforts to produce energy from seaweed. There are well established marine agronomy operations producing food and terrestrial fertilizer around the world.

Once our Fiji project is operational, it could be replicated in bays and lakes throughout the world. It would quickly displace 60 MW capacity of imported diesel-fueled electricity, costing much less than Fiji's standing offer of US$0.12/kWh for renewable energy, or the US$0.15/kWh fuel-only cost of diesel produced electricity. Expect at least a decade to economically self-sustaining open-ocean operations, likely a cluster of ten 10,000+ ha forests in the North Pacific Gyre. Development time depends on rate of expenditure. A decade implies learning lessons expensively with large-scale trials. One could spend less but take longer by taking many small steps in sequence.
Learning to operate seaweed forests may take more time and be more difficult than we expect. But our learning time pales next to the centuries humans must take to mitigate ocean acidification by any other means.

(See other alternatives: McLaren, D., 2012. A comparative global assessment of potential negative emissions technologies. *Process Safety and Environment Protection*, Vol. 90, p. 489-500). Even if humans can stop using coal, oil, and natural gas, we have to contend with methane hydrates. The U.S. Department of Energy DE-FOA-0000891 states: "… A frequently quoted estimate of the global methane hydrate resource is 20,000 trillion cubic meters …" Should that volume of methane escape or combust, it would become 40 trillion tons of CO2.

After we have learned how to manage seaweed forests with economically viable materials and energy expenditure, the limit for how fast we ramp-up forest area is likely to be the amount of deep-water nutrient borrowing we think the oceans will tolerate. We need a combination of nitrogen fixing, excess nutrients from human terrestrial activities, and borrowed deep water nutrients to expand rapidly.

Ramping up to storing many billion tons of CO2 per year can occur in a decade or two because: 1) The permitting, access, materials, and techniques for construction are relatively easily duplicated for multiple sites. No individual property rights issues. Build in any port. Float to any location. 2) The infrastructure is easily built and installed in large volumes, more like soda bottles, landfill-lining geosynthetics, etc. than solar PV cells, wind turbines, wave energy devices, etc. The more complex items (compressors, gas-to-liquid refineries, liquefied natural gas ports, etc.) can be mass-produced in shipyards. 3) Many countries, especially small islands, can employ their citizens and produce energy, food, stored CO2, and biodiversity. The ocean resources needed for managed seaweed forests are better distributed than fossil fuels, wind, geothermal, geologic CO2 storage structures, etc. 4)During seaweed forest development, the natural gas industry can use the possibility of reliable bio-methane supplies to increase consumer confidence in the long-term price-stability of the methane economy. In the short term, the methane (CH_4) economy is expanding and displacing coal and oil with American technology fracking-produced CH_4 and Japanese methane hydrate harvesting technology. Within a decade or so, the combination of climate action urgency and more difficult fossil-methane extraction allows our bio-methane to flow into the already well-developed methane economy infrastructure. Developing managed seaweed forests is likely to spin off benefits for ocean ecosystems and human beings even should human beings find more profitable ways to mitigate ocean acidification.

*Expected total cost:

EXPECT ECONOMIC SUSTAINABILITY Analysis derived from our LCA projects economic viability, even with no price on carbon. However, a price on carbon more quickly mitigates ocean acidification with a two-step funding strategy. First use excess income from the bio-CO_2 storage to reduce the price of bio-CH4 in order to under price fossil fuels. After fossil fuel use ceases, we can keep storing the legacy carbon by increasing the price of bio-CH4. The atrophied fossil fuel producers would not revive because they would know we could drop our price by pausing the bio-CO2 storage. Specifically, our LCA suggests a carbon fee of US$50 per metric ton of CO_2 allows a bio-CH_4 price of US$0.10 per m^3 at the digester ($0.28/therm, or $2.80/MMBtu). When there is no more fossil fuel use, charging

US$0.16 per m^3 ($0.47/therm) would subsidize legacy capture and permanent storage of the bio-CO_2 and the captured CO2 from the powerplants.

INITIAL EXPENSES Expect expending US$1 million to the first economically self-sustaining sheltered-water operation, likely in Fiji. We prepared a cash-flow analysis as part of our Climate Colab entry "Fiji, then Small Island Ocean Afforestation Initiative, then Indian Ocean, …". The Fiji operation builds on these two: Expect expending US$100 million to the first economically self-sustaining open-water operation. Expect the bio-CO2 capture and artificial geologic seafloor container hydrate storage operations to cost less than US$16/ton of CO2.
EVENTUAL INCOME Expect total ecosystem income to exceed costs by several US$trillion per year as early as 2045. See files at the bottom of http://podenergy.org/References.html prepared for Climate Colab entry "Managed seaweed forests completely replace fossil fuels". SPECIFIC NUMBERS 600 Quadrillion Btu/year (176 million GWh) – The U.S. Energy Information Agency predicts this much fossil fuel use in 2035. 600 quads also corresponds to the energy produced by seaweed forests covering 9% of ocean area. Any more area and our energy production would exceed market demand. 0 – Remaining fossil fuel energy in scenario year. 19 billion metric tons of CO2 per year – Mass of CO2 removed from air and water in the form of stored bio-CO2 when managing seaweed forests covering 9% of the ocean surface. Stored bio-CO2 is incidental to energy and food production. 17 billion metric tons of CO2 per year – We can also use BECCS (bio-energy carbon capture and storage) on the combustion-CO_2 that is made when the bio-CH_4 combusts. 17 billion tons represents half the combustion exhaust. We estimated about half the combustion exhaust would be from residences or vehicles and not be captured. 36 billion metric tons of CO2 per year – This is the net CO2 removed from air and water with above assumptions. 30 years – Time to store 1 trillion tons of CO2 in our "best reasonable scenario" of 36 billion tons per year. Including oceans off-gassing, about 1 trillion tons of CO2 would need to be removed in order to reduce atmospheric CO2 by 100 ppm (say, for example, from 450 back to 350 ppm). 200 years – Time to store 2 trillion tons of CO2 in our "bad case scenario." The bad case is needing to mitigate ocean acidification by reducing atmospheric concentrations from 550 ppm to 350 ppm, no Bio-Energy Carbon Capture and Storage, BECCS (because there is no fossil fuel use paying for BECCS), and the market for seaweed forest energy limited to about 300 quads (less than about 5% of ocean surface), but the income from seaweed forest energy is covering the cost of storing 10 billion tons of bio-CO2 per year.
COSTS BY PROCESS STEP LCA calculations including materials and energy for component processes listed below (material and energy are combined into kWh per metric ton of bio-CO2 stored. "-" means a parasitic loss on the net energy production. 1kWh/ton = 0.16 kJ/mole of CO2) 1 & 2: Growing and harvesting macroalgae: -60 kWh/ton 3 & 4: Digesting macroalgae and recovering CH_4:-150 kWh/ton 5: Recycling plant nutrients: -340 kWh/ton 6: Compressing and cooling the 90% bio-CO2 from 1-atm to liquid CO_2 at 500 meters depth: -430 kWh/ton (-70 kJ/mole of CO2) 7: Converting liquid CO2 to permanently stored hydrate in artificial geologic seafloor containers: -80 kWh/ton (-13 kJ/mole) Total energy and materials for above processes: -1,060 kWh/ton Energy produced from recovered CH_4: 4,400 kWh/ton
NET ENERGY PRODUCTION (rounded)**: 3,300** Wh/ton

LCA ENERGY OUT/IN = 4 WITH THE BIO-CO2 STORAGE, OR 8 WHEN NOT STORING CO2. The LCA provided a most probable number.
More technologies are available to separate the CH4 from the CO2 than we have analyzed: pressure swing absorption, cryogenics, gas-liquid separation nozzles, supersonic desublimation, mimicking carbonic anhydrase enzyme, aminosilicones, etc.) are available to separate the gases of anaerobic digestion.
Our analysis has not included the income from incidental produced food because it is very difficult to estimate how much of that will be recovered by the forest operators. It does appear that food would be the highest value product initially; at least until the increased food supply drops the global cost of seafood. In the Sargasso Sea, bacteria and algae are also fixing nitrogen from the air. Nitrogen fixing plus oxides of nitrogen arriving in the air and water from (mostly terrestrial) human activities are available to expand the forest or sustain the forest while exporting a portion of the harvest for other uses: food, chemicals, durable structures, etc.

Our LCA was based on producing electricity from the 90% bio-CH4 produced after differential dissolution, including a 300 MW power plant supplied by a 100,000 ha forest with a high-voltage DC cable to shore.
Recent research and discoveries indicate methanogenic bacterial colonies exist (in biomass rich anaerobic environments) for most any naturally occurring situation and that microbes can evolve relatively rapidly to adjust to the situation (temperature, salinity, sulfates, pressure, etc.). Team researchers at Scuola Superiore Sant'Anna demonstrated methane production similar to that predicted in our LCA with Orbetello Lagoon seaweed, salinity near 40,000 parts per thousand using bacterial colonies from lagoon sediments at 25°C.
On the open ocean, we may need to produce liquid fuels to reduce transportation costs.

Digestion options include Dr. Zhang's xylose-to-hydrogen, or ethanol from fermentation, or Dr. Mascal's cellulose-to-chloromethylfurfural-to-diesel. If we produce primarily bio-CH4 or bio-H2, existing methods to convert gas to liquid include cryogenics (LNG) and Fischer Tropsch. But we can expect more efficient processes developed faster than we can implement seaweed forests.

The price difference between oil and natural gas and U.S. desire for energy independence is driving helpful research. For example the U.S. Advanced Research Projects Agency – Energy offers $20 million in DE-FOA-0000881, Reducing Emissions using Methanotrophic Organisms for Transportation Energy (REMOTE). There are many organizations which can assist with liquid energy extraction (EnAlgae, www.enalgae.eu; and Bio Architecture Lab, www.ba-lab.com, to name a few). Most team members believe the facilities and energy used to grow and harvest seaweed (the cost of feedstock) will drive the economic feasibility of operating seaweed forests.

*Author biography or biographies (3000 characters max. for each author bio):

If desired, the University of Hawaii would provide a formal funding proposal.

Incidentally, Kevin Hopkins and Mark Capron are co-chairing, other members will be participating, in the February 2014 AGU Ocean Sciences Session: MARINE AGRONOMY & AQUACULTURE - KEY TO FEEDING & POWERING THE WORLD!

Eric D. Galbraith, Markus Kienast & The NICOPP working group members, "The acceleration of oceanic denitrification during deglacial warming", *Nature Geoscience* 6, 579–584 (2013) doi:10.1038/ngeo1832 Published online 02 June 2013

MANAGED SEAWEED FORESTS WITH NUTRIENT CYCLING RAISE GLOBAL OCEAN pH

TEAM MEMBERS

1. OCEAN BIOLOGISTS

1.a. Antoine de Ramon N'Yeurt, Ph.D., Research Fellow / Chargé de Recherche European Union Global Climate Change Alliance Project (EUGCCA) Pacific Centre for Environment & Sustainable Development (PACE-SD). University of the South Pacific

1.b. Nina Bednarsek, Ph.D., NOAA Associate, Pacific Marine Environment Laboratory

2. OCEAN & AGRICULTURAL ECOLOGISTS

2.a. David E. Brune, PhD, PE, Professor of Bioprocess and Bioenergy Engineering, University of Missouri & Professor Emeritus, Clemson University

2.b. Charles Yarish, Professor, Department of Ecology & Evolutionary Biology the University of Connecticut

2.c Kurt A. Rosentrater, Ph.D, Agricultural and Biosystems Engineering, Iowa State University

2.d. John R. M. Forster, Ph.D., President, Forster Consulting Inc.

2.e. Jang Kim, PhD, Department of Marine Sciences, University of Connecticut

2.f. Kevin Hopkins, Ph.D, Director & Professor of Aquaculture, Pacific Aquaculture & Coastal Resources Center, University of Hawaii at Hilo

2.g. James S. Diana, Ph.D., Director, Michigan Sea Grant College Program Professor of Fisheries and Aquaculture, School of Natural Resources and Environment, University of Michigan

2.h. Hillary Egna, Ph.D., Director AquaFish Innovation Lab (formerly CRSP) Unit Head, College of Agricultural Sciences, Oregon State University

3. MATERIALS ENGINEERS

3.a. Ronald Kerry Rowe, BSc, BE, PhD, D.Eng, FREng, FRSC, FCAE, FEIC, FIE(Aust), FCSCE, FASCE , P.Eng, CP.Eng.
Professor and Canada Research Chair in Geotechnical and
Geoenvironmental Engineering, Queen's University, Kingston, Ontario, Canada

4. COMPUTER & ELECTRICAL ENGINEERS

4.a. Syed Rahman, Ph.D., Dept. of Computer Science & Engineering, University of Hawaii-Hilo

5. MICROBIOLOGISTS

5.a. Kartik Chandran, Ph.D., Associate Professor, Department of Earth and ENVIRONMENTAL Engineering, Columbia University

5.b. Giada Migliore, Ph.D., Italian National Agency for New Technologies, Energy and Sustainable Economy Development (ENEA), Environmental Characterization, Prevention and Recovery (EC P&R) UNIT

6. OCEAN, ENVIRONMENTAL AND WASTEWATER ENGINEERS

6.a. Stephen Hugh Salter, Emeritus Professor of Engineering Design at the University of Edinburgh

6.b. Clifford A. Goudey, Principal, CA Goudey & Associates

6.c.. Lisa M. Colosi, Ph.D., Assistant Professor, Department of Civil and Environmental Engineering, University of Virginia

6.d. Mark E. Capron, M.S. P.E., President, PODenergy, Inc.

6.e. Mohammed A. Hasan, dual M.S. P.E., R.E.A., F.ASCE, VP, PODenergy, Inc.

6.f. Sean Becker, recent graduate, University of Virginia

7. POLICY/LEGAL/ECONOMICS/BUSINESS

7.a. Don Piper, M.S., M.B.A., Founder, Myndzeye LLC, Sedona, Arizona

7.b. Alyson Myers, B.S., M.A. Director, Kegotank Farm

7.c. Jim Stewart, Ph.D., PODenergy, Inc.

7.d. Frank W. Sudia, JD, PODenergy, Inc.

MEMBER BIOGRAPHIES

1.a. OCEAN BIOLOGIST, LINGUIST

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Dr. Antoine de Ramon N'Yeurt works as a Research Fellow in climate-change issue at the Pacific Centre for Environment and Sustainable Development (PACE-SD) of the University of the South Pacific in Fiji. For the last 20 years he devoted his activities to the study of marine algae of the Pacific Islands. He has been involved in the topics of Ocean Macroalgal Afforestation (OMA) and renewable energy, ocean acidification and its effects on coral reefs, and population-level climate change adaptation in the South Pacific.

REPRESENTATIVE PUBLICATIONS:

1997a. N'Yeurt, A.D.R. & South, G.R. Biodiversity and biogeography of marine benthic algae in the Southwest Pacific, with special reference to Rotuma and Fiji. *Pacific Science* 51: 18-28.

1997c. N'Yeurt, A.D.R. & Keats, D.W. *Rhipilia penicilloides* sp. nov. (Udoteaceae, Chlorophyta) from Fiji. *Phycologia* 36(2): 172-178.

2001. N'Yeurt, A.D.R. Marine algae from the Suva Reef, Fiji. *Australian Systematic Botany* 14(5): 689-869.

2002. N'Yeurt, A.D.R. A revision of *Amansia glomerata* C. Agardh, *Amansia rhodantha* (Harvey) J. Agardh and *Melanamansia glomerata* (C. Agardh) R. E. Norris (Rhodophyta: Rhodomelaceae). *Botanica Marina* 45 : 231-242.

2006a. N'Yeurt, A.D.R. & Payri, C.E. Marine benthic algal flora of French Polynesia. I. Phaeophyceae. *Cryptogamie, Algologie* 27: 111-152.

2006b. N'Yeurt, A.D.R., Payri, C.E., Gabrielson, P.W. & Fredericq, S. *Pinnatiphycus menouana* gen. et sp. nov. (Rhodophyta: Dicranemataceae) from New Caledonia and Fiji (South Pacific): vegetative and reproductive morphology and molecular phylogeny. *Phycologia* 45(4): 422-431.

2006e. Lobban, C.S. & N'Yeurt, A.D.R. Provisional keys to the genera of seaweeds of Micronesia, with new records for Guam and Yap. *Micronesica* 39(1): 73-105.

2007a. N'Yeurt, A.D.R. & Payri, C.E. *Grammephora peyssonnelioides* gen. et sp. nov. (Rhodophyta, Rhodymeniaceae) from the Solomon Islands, South Pacific. *Phycological Research* 55: 286-294.
2007b. N'Yeurt, A.D.R. & Payri, C.E. Marine benthic algal flora of French Polynesia. II. Chlorophyta. *Cryptogamie, Algologie* 28: 3-88.
2010. N'Yeurt, A.D.R. & Payri, C.E. Marine benthic algal flora of French Polynesia. III. Rhodophyta, with additions to the Chlorophyta and Phaeophyceae. *Cryptogamie, Algologie* 31: 1-200.
2012. N'Yeurt, A.D.R., Chynoweth, D.P., Capron, M.E., Stewart, J.R., Hasan, M.A. Negative Carbon via Ocean Afforestation. *Process Safety and Environmental Protection* 90 (2012) 467-474.

1.b. OCEAN BIOLOGIST AND LINGUIST

Nina Bednarsek, Ph.D., NOAA Associate, Pacific Marine Environment Laboratory
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RESEARCH INTEREST AND SELECT AWARDS:
Global Ocean Change, Ocean Acidification, Chemical and Biological Oceanography, Biology of high-CO_2 Ocean, Pelagic Biogeochemistry.

Erasmus scholarship for international collaboration,2011.
Edith Fanta award for the most prominent young researcher and oral presentation, Scientific Committee on Antarctic Research, Japan, 2009. Annual award for polar science
Best oral presentation, British Antarctic Survey Ph.D. Annual Student Meeting, Cambridge, United Kingdom, 2009.
Marie Curie Doctoral Fellowship, Cambridge, United Kingdom, 2007.

EDUCATIONAL BACKGROUND:
NRC post-doc: National Oceanographic and Atmospheric Administration, Pacific Marine Environment Laboratory

Ph.D. 2010, Collaboration between British Antarctic Survey, Cambridge and University of East Anglia, UK

M.Sc 2006. Environmental Diagnostics, Cranfield University, UK

B.Sc 2005. Interdepartmental Study of Microbiology, University of Ljubljana, Slovenia. Awarded for Outstanding Diploma work.

EXPERIENCE:
- National Research Council Fellowship at National Oceanographic and Atmospheric Administration, Pacific Marine Environment Laboratory, from 11/2012 onwards.
- Fieldwork research on the research vessel RRS James Clark Ross in the Southern Ocean with British Antarctic Survey, Cambridge, UK. including: sea-going instrumentation and

equipment, fieldwork planning, logistics, sample collection and biological and chemical sample analysis, experimental designs for high-CO_2 on board conducted experiments.

- Research Associate and Lecturer at the University of Nova Gorica, Slovenia; Tyndall Centre for Climate Change Research, University of East Anglia, UK; and Woods Hole Oceanographic Institution, USA.

SELECT PUBLICATIONS:

N. Bednarsek, R. A. Feely, J. ReuM, S. Alin, B. Hales. 2013. Is ocean acidification in the California Current Ecosystem driving coastal pteropod populations to decline? *Science*, submitted

Bednaršek, N., Tarling, G. A., Bakker, D. C. E., Fielding, S., Jones, E.M., Venables, H. J., Ward, P., Kuzirian, A., B. Lézé, B., Feely, R. A. and E. J. Murphy, E.J. 2012. Extensive dissolution of live pteropods in the Southern Ocean. *Nature Geoscience 5, 881-885*

Bednaršek, N., Možina, J., Vogt, M., O'Brien, C., Tarling, G.A. 2012. The global distribution of pteropods and their contribution to carbonate and carbon biomass in the modern ocean. *Earth Syst. Sci. Data*, 4, 167-186.

Buitenhuis E. T.,Vogt M., Moriarty R., Swan C., Bednaršek N., Doney S., Leblanc K., Le Quéré C., Luo Y., O'Brien C., O'Brien T., Peloquin J., Schiebel R., Swan C. 2012. MAREDAT: Towards a World Ocean Atlas of Marine Ecosystem Data, *Earth System Science Data Discussions*, 5, 1077-1106

LANGUAGES:
Fluent in English and Slovene, Advanced German and Croatian, Basic Spanish, Russian

2.a. ECOLOGIST FOR INTEGRATED MULTI-TROPHIC AQUACULTURE (IMTA)

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EDUCATION:

Ph.D.	1978	Environmental Engineering	University of Missouri
M.S.	1975	Agricultural Engineering	University of Missouri
B.S.	1974	Agricultural Engineering	University of Missouri

APPOINTMENTS AND RELEVANT EXPERIENCE:
From 1978 to 1983, Dr. Brune operated high pressure digesters using seaweed (Macrocystis) as a substrate, in support of his proposal to build and operate "An Ambient Temperature Shallow Ocean Anaerobic Digester."
Professor of Bioprocess and Bioenergy Engr., Food Systems and Bioengr., Univ. of Missouri, 2009
Newman Endowed Chair of Natural Resource Engineering, Clemson University, 1999 - 2009

Professor of Agricultural and Biological Engineering, Clemson University, 1990 - 1999
Associate Professor of Agricultural Engineering, Clemson University, 1987 - 1990
Assistant Professor of Agricultural Engineering, Pennsylvania State University, 1982 - 1987
Assistant Professor of Agricultural Engineering, University of California-Davis, 1978 – 1982

RELEVANT PUBLICATIONS:

Brune, D. E. and Novak, J. T., Carbon and Light Limitation in Mass Algal Culture, Chapter 6 in Fuels from Biomass and Wastes, pp. 99-129, Edited by D. L. Klass and G. H. Embert, Ann Arbor Science, Ann Arbor, Michigan, 1981

Brune, D. E., Hong Wei Yen, Jack Van Olst, M. J. Massingill, J M. Carlberg, and John R. Benemann, Integrated Production of Biofuel, Biofertilizer, and High Value Aquatic Biomass in a Controlled Eutrophication Process, Proceedings of the International Conference: Bioenergy, 2002.

Brune, D. E. J.R. Benemann , M.J. Massingill, J.C. Van Olst, J.A. Carlberg , Carbon Sequestration and Nutrient recovery in a Controlled Eutrophication Process, The Third Meeting of the International Network on Biofixation of CO_2 and Greenhouse Gas Abatement with Microalgae, Berkeley, Ca, 2003.

J. Benemann, J. Polle, M. Huesemann, J. Yu, D.E. Brune, J. Weissman and D. Kyle, A Novel Photobiological Hydrogen Production Process, Proceeding of the 13th International Congress of Photosynthesis, Montreal Canada, ISBN 1-89127-639-5, pp 878-880, 2004.

D. E. Brune, T. Lundquist, and J. Benemann, Algal Production and Harvest for Food, Feed and Biofuels, Journal of Environmental Engineering, Vol. 135, No. 11, November, 2009.

Brune, D. E., C. Tucker, M. Massingill, and J. Chappell, 2012, Partitioned Aquaculture Systems, pp 308-342 *in* J.H. Tidwell, editor, Aquaculture Production Systems, Wiley-Blackwell, Oxford, UK, 2012.

Brune, D. E. and Lance Beecher, Aquacultural Processes for Harvest and Concentration of Algal Lipid for Biodiesel Production, U.S. Patent Application, # 20090181436, 2012.

2.b. ECOLOGIST FOR NUTRIENT BIOEXTRACTION

Prof. Charles Yarish, Department of Ecology & Evolutionary Biology the University of Connecticut, 1 University Place, Stamford, CT 06901-2315
Tel. No. 203-251-8432 charles.yarish@uconn.edu

EDUCATION

BS	1970	Brooklyn College (City University of New York)
MA	1972	University of Texas (Austin)
PhD	1976	Rutgers - The State University (New Brunswick)

HONORS and EXPERIENCE
2012 – University of Connecticut Provost's Award for Excellence in Public Engagement
2008 – Elected to the Connecticut Academy of Science and Engineering
2007 – Faculty Recognition Award, for sustained outstanding achievements in teaching, research and services benefiting UConn Stamford
Visiting Professor, Scientist awards or appointments involving grant subjects in the USA, Kenya, China, Canada, France, Brazil, Chile, Mexico, Japan, and South Korea
Grant Reviewer for 9 states, NOAA, NSF, SBIR, and 7 programs
Principal or Co-Principal Investigator for 45 grants totaling $4 million, involving Marine Phycology, Ecophysiology, Ecology, Integrated Multi-Trophic Aquaculture (IMTA), Nutrient Bioextraction, Systematics, and Applied Genomics
Professor or Visiting Scientist at Univ. of Groningen, Biol. Anstalt Helogland, Stony Brook University, University of Porto, Shanghai Ocean University of China and Visiting Sea Grant Scholar, Rhode Island Sea Grant College Program

MOST RELEVANT OF 160 BOOKS, CHAPTERS, JOURNALS, REPORTS, & ARTICLES

Lüning, K. 1990. Seaweeds - Their Environment, Biogeography, and Ecophysiology, IN: Yarish, C. and H. Kirkman (Editors) Translation of the German language edit. Meeresbotanik: Verbreitung, Okophysiologie und Nutzung der marinen Makroalgen by K. Lüning. John Wiley and Sons, Inc. NY, 527 pp.

Latimer, J.S., M. Tedesco, R.L. Swanson, C. Yarish, P. Stacey and C. Garza. 2013. *Long Island Sound: Prospects for the Urban Sea.* Springer Publishers, NY

Yarish, C. and G. Wamukoya. 1990. Seaweeds of potential economic importance in Kenya: Field survey and future prospects. Proc. of the 13th International Seaweed Symposium. Hydrobiologia 204/205: 339-346 (1992 Marinalg Award at the XIVth International Seaweed Symposium, Brest/St. Malo – most significant research for the economic development of the seaweed industry).

McVey, J.P., R. Stickney, C. Yarish, T. Chopin. 2002. Aquatic Polyculture and Balanced Ecosystem Management: New Paradigms for Seafood Production.). *In* Responsible Aquaculture, R. R. Stickney and J. P. McVey (eds.), CAB International, Oxon, UK. Pp. 91-104.

Neori, A., T. Chopin, M. Troell, A.H. Buschmann, G. Kraemer, C. Halling, M. Shpigel and C. Yarish. 2004. Integrated aquaculture: rationale, evolution and state of the art emphasizing seaweed biofiltration in modern aquaculture. Aquaculture. 231: 361-391.

Yarish, C. and Pereira, R. 2008. Mass production of Marine Macroalgae. *In* Sven Erik Jørgensen and Brian D. Fath (Editor-in-Chief), Ecological Engineering. Vol. [3] of Encyclopedia of Ecology, 5 vols. pp. 2236-2247. Oxford: Elsevier.

2.c. AGRICULTURE AND OCEAN BIOLOGIST

Kurt A. Rosentrater, PhD
3167 NSRIC Building
Agricultural and Biosystems Engineering
Iowa State University
Ames, IA, 50011, USA
011 515 294 4019
Karosent@iastate.edu

EDUCATION

2001 Ph.D., Iowa State University, Agricultural Engineering
1996 M.S., Iowa State University, Agricultural Engineering
1994 B.S., Iowa State University, Agricultural Engineering

RESEARCH AND PROFESSIONAL EXPERIENCE:

2011 – Present Assistant Professor, Iowa State University
2004 – 2011 Lead Scientist, USDA, Agricultural Research Service
2002 – 2004 Assistant Professor, Northern Illinois University
1997 – 2002 Process Development Engineer, Todd & Sargent, Inc.

AREAS OF EXPERTISE:

Research focuses on analysis of bio-based systems, feed ingredient analysis, development of value-added products and processes, improvements in processing efficiencies, and life cycle assessment. Expertise in value-added bioprocessing and product development, modeling and simulation of processing systems, plant layout, and process design.

PROFESSIONAL SOCIETIES:

1. ASAE Educational Division (ED) 203 Committee (Undergraduate and Graduate Instruction). 2008-Present. (Secretary, 2008-2010).
2. ASAE Educational Division (ED) 412 Committee (Professional Ethics). 2006-Present. (Secretary, 2007; Vice Chair, 2008; Chair, 2009).
3. ASAE Food Process Engineering (FPE) 01/02 Committee (Executive and Steering). 2003-Present.
4. ASAE Food Process Engineering (FPE) 04/041 Committee (Refereed Publications). 2004-Present.
5. ASAE Food Process Engineering (FPE) 80 Committee (Education Priorities Group). 2003-Present (Secretary, 2005; Vice Chair, 2006; Chair, 2007-2009).
6. ASAE Food and Process Engineering (FPE) 701 Committee (Physical Properties of Agricultural Products). 2005-Present. (Vice Chair, 2005-2006; Chair, 2007-2010).

1. ASABE Annual International Meeting. Session Organizer and Moderator. FPE-17 – Physical and Chemical Properties of Bioresource Products, Byproducts, and Co-Products. Pittsburgh, PA. June 22, 2010.
2. ASABE Bioenergy Engineering. Session Organizer and Moderator. Workshop D: Optimal Drying for DDG and Other Solid Wastes. Bellevue, WA. October 14, 2009.
3. ASABE Annual International Meeting. Session Organizer and Moderator. FPE-15 – Advances in Coproduct and Byproduct Management and Utilization. Reno, NV. June 22, 2009.

COLLABORATORS: (last five years)
Elif Kongar, K. Muthukumarappan, Klein Ileleji, Michael Brown, Allen Patillo, Michael Lehman, Shannon Osborne, Padu Krishnan, Kenneth Kalscheur, Alvaro Garcia, Brian Kerr, Steve Trabue, Daniel Anderson

Publications: 107 Total in Past 15 Years (50 in Past 4 Years)

2.d. OCEAN BIOLOGIST – FISHERIES

John R. M. Forster, President
Forster Consulting Inc.
jforster@olypen.com

EDUCATION:
B.Sc. Honors. Zoology, University of Southampton, UK
Ph.D. Marine Science, University of North Wales, UK

REVELANT EXPERIENCE

President, Forster Consulting Inc., 1994 – Present – advising the fisheries government and industry including: Alaska Department of Commerce, US National Marine Fisheries Service, Bank of America Inc., BC Salmon Farmers Association, Canadian Science Advisory Secretariat, FIS.com, Hubbs Sea World Research Institute, Marine Farms ASA, Marine Farms Belize Ltd, NET Systems Inc., etc.

Previous to 1994, founded and developed Columbia River Fish Farms to become the largest producer of Steelhead rainbow trout in N. America. Set up and managed Stolt Sea Farm's salmon and sturgeon farming businesses in Washington, California, Chile, and Norway. Established an international technical services business for Shearwater Fish Farming with projects throughout Europe, the Mid-East, N. America, and Chile. Conducted research on the mass culture of shrimps including evaluation of species, hatching juveniles, formula feeds and design of marine water re-use systems.

INDUSTRY / GOVERNMENT AFFILIATIONS:

- Member, U.S. NOAA Fisheries, Marine Fisheries Advisory Committee (MAFAC) 2002 - 2008.
- Member of the board of directors, Aquaculture without Frontiers.
- Serves, or has served on the boards of four private aquaculture companies.
- President, Washington Fish Growers Association 1988 - 1990, Board Member 1985 - 2012.
- U.S. Representative, International Salmon Farmers Association 1990 - 1993.

SELECT RECENT PUBLICATIONS

Forster, J, 2010. "A review of opportunities, technical constraints and future needs - temperate waters" In: Proceedings of FAO Offshore Aquaculture Initiative, Orbetello Workshop, March 2010 (pre-publication).

Forster, J, 2010. "What Can U.S. Open Ocean Aquaculture Learn From Salmon Farming?" J. Mar. Tech. Soc. Vol. 44, No.3 pp68 - 79

Forster, J, 2008. "Emerging Technologies in Marine Aquaculture" Offshore Aquaculture in the United States, Economic Considerations, Implications & Opportunities. US Dept of Commerce, NOAA. Chapter 3. http://aquaculture.noaa.gov/pdf/econ/3.pdf

Forster, J. 2008. "Broader Issues in the Offshore Fish Farming Debate" Offshore Aquaculture in the United States, Economic Considerations, Implications & Opportunities. US Dept of Commerce, NOAA. Chapter 12. http://aquaculture.noaa.gov/pdf/econ/12.pdf

Loverich, G and J. Forster, 2000. "Advances in Offshore Cage Design using Spar Buoys" Journal of the Marine Technology Society, Vol. 34, No. 1, p 18-28.

Forster, J. & R. Hardy. 2001. "Measuring efficiency in intensive aquaculture" World Aquaculture, Vol. 32, No.2, p41-45.

Forster, J. 1996. "Cost and Market Realities in Open Ocean Aquaculture" Proceedings of Open Ocean Aquaculture. Portland, Maine. p 137-150.

2.e. ECOLOGIST FOR NUTRIENT BIOEXTRACTION

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Department of Marine Sciences
University of Connecticut
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Phone: 203-251-8530, Fax.: 203-251-9534
Email: jang.kim@uconn.edu

EDUCATION

Ph.D. Marine Botany, University of Connecticut, USA. 2008. (Advisor: Prof. Charles Yarish)
Thesis: Mechanism of Nitrogen Assimilation of Porphyra from New England.

M.S. Marine Botany. University of Connecticut, USA. 2003. (Advisor: Prof. Charles Yarish)
Thesis : Ecophysiological Studies of Four Native Porphyra (Bangiales, Rhodophyta) Species from Coastal New England: Responses to Varying Combinations of Ammonium and Temperature.

M.S. Natural Science. University of Inchon, KOREA. 2000. (Advisor: Prof. Taejun Han)
Thesis : Effects of Major Environmental Pollutants on the Green Alga, Ulva pertusa Kjellman.

B.S. Biology. University of Inchon, KOREA. 1997.

PUBLICATIONS: Partial List

Kim J.K., D.J. Garbary, P. Corey and J. Duston. (In revision) Stocking density of Chondrus crispus and Palmaria palmata affects nutrient removal efficiency in high water flux effluent from a land-based Atlantic halibut farm. Aquaculture.

Mao Yun Xiang, J.K. Kim, R. Wilson and C. Yarish (In revision) The appearance of Ulva laetevirens (Ulvophyceae, Chlorophyta) in the northeast coast of the United States. Journal of Ocean University.

Kim J.K., G.P. Kraemer and C. Yarish. 2013. Effects of Emersion on Nitrogen Releaseand Physiological Function in the Intertidal genus Porphyra. Plos ONE. In press.

Kim J.K., G.P. Kraemer and C. Yarish. 2013. Integrated Multi-tropic Aquaculture in the U.S.A. In Greening the Blue Revolution: the Turquoise Revolution of Integrated Multi-Trophic Aquaculture (IMTA) (Eds. Chopin T., A. Buschmann, and A. Neori). In press.

Corey P. J.K. Kim, B. Prithiviraj, D.J. Garbary and J. Duston. 2013. Nutrient uptake by Palmaria palmata and Chondrus crispus at combined concentrations of nitrate and ammonium. J. Appl. Phycology. In press.

Kim J.K., G.P. Kraemer and C. Yarish. 2012. Metabolic plasticity of nitrogen assimilation by Porphyra umbilicalis enables broad intertidal distribution. Journal of Ocean University of China. 11: 517-526.

Corey P. J.K. Kim, B. Prithiviraj, D.J. Garbary and J. Duston. 2012. Bioremediation potential of Chondrus crispus (Basin Head) and Palmaria palmata: effect of temperature and high nitrate on nutrient removal. J. Appl. Phycology. 24: 441-448.

White K. J.K. Kim, D.J. Garbary. 2011. Effects of Land-Based Fish Farm Effluent on the Morphology and Growth of Ascophyllum nodosum (Fucales, Phaeophyceae) in Southwestern Nova Scotia. Algae. 26: 253-263.

Garbary D.J., E. Tompkins, K.L. White, P. Corey, J.K. Kim. 2011. Temporal and spatial Aquaculture Seminar.

PROFESSIONAL SOCIETIES

Sigma Xi, The Scientific Research Society; The Phycological Society of America; World Aquaculture Society; The Northeast Algal Society; Korean Phycological Society

PATENT

Kim J.K., M.S. Yoo and C. Yarish. “Tide Simulating Apparatus for Intertidal Sessile Organisms” Korea Patent No. 2008-6128.

2.f. BIOLOGIST – AQUACULTURE

James S. Diana, (jimd@umich.edu)
Director, Michigan Sea Grant College Program
Professor of Fisheries and Aquaculture
School of Natural Resources and Environment
University of Michigan, Ann Arbor, MI 48109-1041

Phone (734) 763-5834; Fax (734) 936-2195
Lab Website http://sitemaker.umich.edu/diana.lab/home

EDUCATION

University of Alberta	Ph.D., Zoology, 1979
California State University, Long Beach	M.A., Biology, 1975
California State University, Long Beach	B.S., Marine Biology, 1974

PROFESSIONAL EXPERIENCE

2009-present	Director, Michigan Sea Grant
1999-2007	Associate Dean, School of Natural Resources and Environment
1996-present	Professor of Fisheries and Aquaculture
1984-1996	Associate Professor and Associate Research Scientist
1979-1984	Assistant Professor and Assistant Research Scientist

PUBLICATIONS: Partial List

Diana, J.S., H.S. Egna, T. Chopin, M.S. Peterson, L. Cao, R. Pomeroy, M. Verdegem, W.T. Slack, M.G. Bondad-Reantaso, and F. Cabello. 2013. Responsible aquaculture in 2050: Valuing local conditions and human innovations will be key to success. BioScience 63:255-262.

Cao, L., J.S. Diana, and G.A. Keoleian. 2013. Role of life cycle assessment in sustainable aquaculture. Reviews in Aquaculture 4:1-11.

Diana, J.S. 2012. Is lower intensity aquaculture a valuable means of producing food? An evaluation of its effects on near-shore and inland waters. Reviews in Aquaculture 4:234-245.

Diana, J.S. 2012. Some principles of pond fertilization for Nile tilapia using organic and inorganic inputs. Pages 163-177 *in* C.C. Mischke, editor. Pond Fertilization: Impacts of Nutrient Input on Aquaculture Production. John Wiley and Sons, Inc.

Cao L., J.S. Diana, G.A. Keoleian, and Q. Lai. 2011. Life cycle assessment of Chinese shrimp farming systems targeted for export and domestic sales. Environmental Science & Technology 45:6531-6538.

Ahmad, S.A.S., A.N. Bart, YangYi, J.E. Rakocy, and J.S. Diana. 2010. The effect of the introduction of Nile tilapia (*Oreochromis niloticus*, L.) on small indigenous fish species (mola, *Amblypharyngodon mola*, Hamilton; chela, *Chela cachius*, Hamilton; punti, *Puntius sophore*, Hamilton). Aquaculture Research 41:904-912.

2.g. OCEAN BIOLOGIST – FISHERIES

Kevin Hopkins
Director & Professor of Aquaculture
Pacific Aquaculture & Coastal Resources Center
University of Hawaii at Hilo, 1079 Kalanianaole St., Hilo, Hawaii 96720
email -hopkins@hawaii.edu; Telephone 808-933-3290; Fax 808-933-0499

B.S. Zoology, University of Oklahoma
M.S. Fisheries & Aquaculture, Auburn University, M.B.A. Business Administration, Auburn University
Ph.D. Fisheries & Aquaculture, Auburn University

RESEARCH INTEREST
- Informal leader of Marine Agronomy Group
- Culture of finfish, particularly sturgeon and tilapia
- Business aspects of aquaculture
- Application of fisheries and ecological models to aquaculture

COURSES
- Aquacultural Engineering (AGEN 400/MARE 400)
- Aquaculture Production Techniques (AQUA 450/MARE 450 & AQUA 450L/MARE 450L)
- Fisheries Science (AQUA 466/MARE 466)
- Introduction to Aquaculture (AQUA 262/MARE 262)
- Water Quality and Aquatic Productivity (AQUA 425/BIOL 425/MARE 420 & AQUA 425L)

SELECTED PUBLICATIONS

Knud-Hansen, Christopher F., Kevin D. Hopkins and Hans Guttman. (2003) A comparative analysis of the fixed-input, computer modeling, and algal bioassay approaches for identifying pond fertilization requirements for semi-intensive aquaculture. Aquaculture 228:189-214

Hopkins, Kevin and Howard Takata (2002). A preliminary study of Russian sturgeon (*Acipenser gueldenstaedti*) in Hawaii – 1995 to 2001. Rosenthal, H, R. Bruch and F. Binkowski (editors). Technical Compendium to the Proceedings 4th International Symposium on Sturgeon, Oshkosh, Wisconsin, July 2001, Journal of Applied Ichthyology 18(4-6).

Szyper, Jim.P., Kevin D. Hopkins, Wayne Malchow, and Wayne Y. Okamura. 2000. History and prospects of tilapia stocks in Hawaii, U.S.A., pp. 663-672. In: Fitzsimmons, K., and J. Carvalho Filho (eds.), Tilapia Culture in the 21st Century - Proceedings from the Fifth International Symposium on Tilapia Aquaculture, Rio de Janeiro, Brazil.

Hopkins, Kevin D., Natalya A. Lysova, and Howard Takata. (1999). Potential for culturing Russian sturgeon in Hawaii. Proceedings of the International Scientific Conference on Fisheries Research of the World Ocean, Valdivostock, Russia, September 27-29, p.21-22

Mathews, Bruce W. and Kevin D. Hopkins. 1999. Superiority of S-shaped (sigmoidal) yield curves for explaining low-level nitrogen and phosphorus fertilization in the humid tropics. J. Hawaiian Pacific Agric. 10:33-46

2.h. OCEAN BIOLOGIST – FISHERIES

Hillary S. Egna
AquaFish CRSP, College of Agricultural Sciences
Oregon State University, Snell Hall 418, Corvallis, Oregon
tel: 541.737.6415 fax: 541.737.6408 email: egnah@onid.orst.edu

EDUCATION:

Ph.D. Resource Geography (1998), Oregon State University, Corvallis, Oregon
M.Ag. Aquaculture and Fisheries (1985), OSU, Corvallis, Oregon
B.S. Natural Resources (1980), The University of Michigan, Ann Arbor

EXPERIENCE:

Research Leader, College of Agricultural Sciences, Oregon State University (present).

Research Faculty, Oregon State University. College of Agricultural Sciences; Office of International Research and Development, Oregon State University. Adjunct Faculty in the College of Earth, Ocean, and Atmospheric Sciences, and Graduate Faculty in Environmental Sciences.

Project Leader and Principal Investigator. Aquatic Resource Use and Conservation for Sustainable Freshwater Aquaculture and Fisheries in Mali, USAID Mission, Bamako, Mali.

Director, AquaFish Collaborative Research Support Program, Oregon State University (present).

Director, Aquaculture CRSP, Oregon State University; Associate Director, Pond Dynamics/Aquaculture CRSP

National Science Foundation Review Panelist, Marine Biotechnology panel; National Science Foundation, Mixed Food Production and Aquaculture panel, Washington DC.

Program Manager and Principal Investigator, USAID-Egypt Aquaculture Project

Microsoft Corporation; Klamath Tribe, Bureau of Indian Affairs; Oregon Department of Fish and Wildlife (1986); Pacific Fisheries Legislative Task Force; Department of Fisheries and Wildlife at Oregon State University, Oman Project; Consortium for International Fisheries and Aquaculture Development (CIFAD), Indonesian Fisheries Professionals Trainer (1985); Terra-Aquafarms, Inc.

PUBLICATIONS AND PRESENTATIONS (partial list):

Ichien, S. and H. Egna. 2011. Addressing the Impacts of Semi-Intensive Aquaculture on Biodiversity: Developing and Improving the Culture of Indigenous Species. AFS2011 Seattle, Washington.

Egna, H., L. Reifke, and N. Gitonga. 2011. Including Gender Dimensions in Biotechnological Research Projects. FAO Symposium on Gender and Fisheries, Shanghai.

Coulibaly, H., L. Liping, D. Yuan, A.S. Toure, J.R. Bowman, and H.S. Egna. 2011. Promoting Sustainable Rice-Fish Aquaculture in Irrigated Systems in Mali. ISTA, China.

Egna, H.S. and S. Ichien. 2010. Poverty Alleviation in Developing Countries Through Sustainable Solutions in Aquaculture and Fisheries. IIFET France.

Awards and Recognition:

Honorary Consulting Professor, Shanghai Ocean University, China (2009)
UNIFEM, United Nations Pacific Northwest Chapter, Women in Leadership Award (1997)

INTERNATIONAL EXPERIENCE:

Bangladesh, Brazil, China, Egypt, France, Ghana, Greece, Honduras, Indonesia, Kenya, Mali, Panama, Philippines, Puerto Rico, Peru, Rwanda, South Africa, Thailand, Uganda

3.a. MATERIALS ENGINEER

Ronald Kerry Rowe (Kerry Rowe), BSc, BE, PhD, D.Eng, FREng, FRSC, FCAE, FEIC, FIE(Aust), FCSCE, FASCE , P.Eng, CP.Eng.
Professor and Canada Research Chair in Geotechnical and Geoenvironmental Engineering, Queen's University, Kingston, Ontario, Canada, email: Kerry@civil.queensu.ca, phone: 613-533-3113

2013 – Elected to the ROYAL SOCIETY, a fellowship of distinguished scientists

EDUCATION

D.Eng. Geotechnical & Geoenvironmental Eng. University of Sydney 1993
Ph.D. Geotechnical Engineering University of Sydney 1979
B.E. (Hons I) Civil Engineering University of Sydney 1975
B.Sc. Computer Science University of Sydney 1973

PROFESSIONAL EXPERIENCE

Presently Professor and Canada Research Chair in Geotechnical and Geoenvironmental Engineering (Tier I), past Vice-Principal for Research, Queen's University
Past Chair, Associate Dean, than adjunct Professor, Dept. of Civil and Environmental Engineering, University of Western Ontario.
Adjunct Professor, Dept. of Civil Engineering, Royal Military College of Canada

RELEVENT PUBLICATIONS

Rowe, R.K., Mukunoki, T. and Lindsay, H. (2011) "Effect of Temperature on BTEX Permeation through HDPE and fluorinated HDPE geomembranes", *Soils and Foundations* (Submitted 8/2/2011; SANDF-D-11-00016).
Rayhani, M.T., Rowe, R.K., Brachman, R.W.I., Take , W.A. and Siemens, G. (2011). "Factors Affecting GCL Hydration under Isothermal Conditions", *Geotextiles and Geomembranes,* (Accepted 7/3/11; G&G 2151).
Runner-up for best paper published in *Geosynthetics International* in 2008 for the paper: "Leachate chemical composition effects on OIT depletion in an HDPE geomembrane", co-authored by R. K., Rowe, M. Z. Islam & Y. G. Hsuan

Rowe, R.K. (2011) "Long-term performance of barriers in landfills: basic concepts and leachate collection systems" Sustainable Landfilling monograph, _Raffaello Cossu and Hans van der Sloot Eds
Rowe, R.K. (2011) "Long-term performance of landfills liners", Sustainable Landfilling monograph, Raffaello Cossu and Hans van der Sloot Eds
Rowe, R.K. and Seychuk, J. (2011). "Lessons Learned from the Alleged Failure of a Geotextile Filter: A Forensic Examination".
Rowe, R.K. and Booker, J.R. (2005). "POLLUTE v.7.0 - 1D Pollutant Migration through a Composite Liner Systems © 1983, 1990, 1994, 1997, 2005. Distributed by GAEA Technologies Ltd
Bouazza, M., Scheirs, J. and Rowe R.K. (2010). "Guidance on geomembrane use in landfills", Report to EPA Victoria, Australia (31p).
Bouazza, M., Scheirs, J. and Rowe R.K. (2010). "Guidance on geotextile use as protection in landfills", Report to EPA Victoria, Australia (18p).

SCIENTIFIC AND PROFESSIONAL SOCIETIES
Institution of Engineers (Australia)
Association of Professional Engineers of Ontario
The Canadian Geotechnical Society
The Engineering Institute of Canada
American Society of Civil Engineers
International Society for Soil Mechanics and Foundation Engineering
International Society for Rock Mechanics
International Geosynthetics Society
International Association for Computer Methods in Geomechanics
North American Geosynthetics Society

4.a COMPUTER & ELECTRICAL ENGINEERING

Syed (Shawon) Rahman, Ph.D.
Faculty, Dept. of Computer Science & Engineering
University of Hawaii-Hilo
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Phone: (808) 974-7450, Fax: (808) 933-3164
URL: http://www.cse.uhh.hawaii.edu/

EDUCATION
Ph.D., Software Engineering May 2006, GPA: 3.78
Dept. of Computer Science, North Dakota State University (NDSU), Fargo, ND
M.S., Computer Science, December 2002; GPA: 3.80
Department of Computer Science, North Dakota State University, Fargo, ND
B.S., Chemical Engineering, December 1998
Bangladesh University of Engineering and Technology (BUET), Dhaka, Bangladesh.

PATENTS AND HONORS

- "The Architecture of a Micro Knowledge Processor Unit"; Provisional patent number 61/551,399, October 2011
- Nominated for the UH-Hilo's 2011 Award for Excellence in Scholarly/Create Activities
- Nominated for the UH-Hilo's 2013 Award for Excellence in Teaching
- Selected as a "Keynote Speaker" in the third International Conference on Communications Security & Information Assurance (CSIA 2012) Delhi, India with CSIA travel scholarship
- Invited by the UH to present research at "UH TechnologySummer 2011 Showcase"

SELECT GRANTS (over $20 million)

"Marine Agronomy for Biofuel and Fish Feed –Improving Stakeholder Communications", USDA, PI with CO-PI: Kevin Hopkins, Pacific Aquaculture and Coastal Resources Center, UH-Hilo

"Pacific High Island Evolutionary Biogeography: Impacts of Invasive Species, Anthropogenic Activity and Climate Change on Hawaiian Focal Species", NSF Grant No. EPS-0903833, PI

SELECT PUBLICATIONS

Dean, Christopher and Rahman, Syed (Shawon); "Hardened IP Video Teleconferencing Systems"; IEEE System, Man, and Cybernetics Society and IEEE Reliability Society, IEEE the 8th International Conference on System of Systems Engineering (SoSE), Maui, HI, USA, June 2013 (submitted)

Rader, Marc; Rahman, Syed (Shawon) and Erdogan, Sevki; "Off the Hook: Mitigating Phishing and Associated Security Risks"; The Third International Conference on ComputationalScience, Engineering, Information Technology (CCSEIT 2013), KTO Karatay University, June2013, Konya, Turkey

Hailu, Alemayehu and Rahman, Syed (Shawon); "Security Concerns for Web-based Research Survey" IEEE the 7th International Conference on Electrical and Computer Engineering (ICECE), December 2012, Dhaka, Bangladesh

Batz, Forrest, Rahman, Syed (Shawon), and others; "Cross-campus Collaboration to Develop aMobile Learning App for Pharmacy Students"; The 2011 Annual American Associations of College of Pharmacy (AACP); July 2011, San Antonio, TX

Wessels, Andrew, Purvis, Mike, Jackson, Jahrain, and Rahman, Syed (Shawon); "Remote DataVisualization through WebSockets" 8th IEEE **International** Conference on Information Technology : New Generations ITNG 2011, April 2011, Las Vegas, Nevada

Other experience includes: managing projects to assist students, community, and business; reviewing for 21 peer review jounals; serving on 6 scientific and professional societies.

5.a. MICROBIOLOGIST

KARTIK CHANDRAN
Department of Earth and Environmental Engineering, Columbia University
500 West 120th Street, Mudd 918, New York, NY 10027
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EDUCATION

Ph. D. University of Connecticut, Environmental Engineering, 1999
B. S. (Honors) Indian Institute of Technology, Roorkee, Chemical Engineering, 1995

RESEARCH AND SERVICE
Conducted research at Columbia University, Virginia Polytechnic, University of Connecticut, and Metcalf and Eddy with total project funds of $4.4 million for agencies including U.S. ARPA-E and EPA, NSF, and other involving: Environmental and public health microbiology, sustainable wastewater treatment, global climate impacts of wastewater treatment, environmental biotechnology, microbial ecology of waste and water treatment reactors, molecular based biokinetic estimation tools, elucidation of microbial biochemical degradation pathways , bioprocess modeling and parameter identification for complex biotransformations.

Invention topics include microbial fuel cells, gene expression, nitrification, and software.

Reviewer for 12 journals. Board of Directors, Program Chair and other leadership for 23 organizations and events including Trustee for the Water Environment Federation.

Invited into the New York Academy of Sciences.

SELECT PUBLICATIONS AND PRESENTATIONS, of 156
Park, H., A. Rosenthal, R. Jezek, K. Ramalingam, J. Fillos and K. Chandran*, 2010 "Impact of inocula and growth mode on the molecular microbial ecology of anaerobic ammonia oxidation (Anammox) bioreactor communities", Water Research, in press, doi:10.1016/j.watres.2010.07.022

Chandran, K. 2009. Characterization of nitrogen greenhouse gas emissions from wastewater treatment BNR operations. Field Protocol with Quality Assurance Plan. Publisher: Water Environment Research Foundation, Alexandria, VA Industrial Wastewater Management, Treatment, and Disposal, WEF Manual of Practice No. FD-3, Third Edition 2008. Publisher: Water Environment Federation, Alexandria, VA and McGraw Hill, ISBN: 0071592385 / 9780071592383. "Provided review as part of the Technical Practice Group"

Chandran, K. "Use of genomics to study nitrification processes" Delft University of Technology, Advanced Course in Environmental Biotechnology, Delft, Netherlands, June 19th, 2008

Chandran, K. "Characterization and optimization of microbial fuel cells for sustainable wastewater treatment" RUTGERS, The State University of New Jersey, New Brunswick, NJ, March 11th, 2008

Chandran, K. "Nano-Bio-Info Technologies for Process Monitoring and Control of Bioreactors" Battelle Ventures, Princeton, NJ, December 17th, 2007

Chandran, K. 2007 "Bioenergetics and Nano-Bio-Info Technologies Paving the Way for a Sustainable Society" Science and Technology Ventures Where Change Begins: An Introduction to Clean Technologies at Columbia University

5.b. MICROBIOLOGIST

Giada Migliore, Ph.D.
Italian National Agency for New Technologies, Energy and Sustainable Economy Development (ENEA), EC P&R UNIT
ENEA RC Casaccia, Via Anguillarese 301, 00123 Santa Maria di Galeria, Rome, Italy
tel. 0039-06-30483547 e-mail: giada.migliore@enea.it

Dr. Migliore is a Researcher at Italian National Agency for New Technologies, Energy and Sustainable Economy Development, Environmental Characterization, Prevention and Recovery UNIT , Casaccia Research Center.

She works with Anaerobic Digestion of biomass for biogas production, chemical and physical characterization of substrates and digestion products; she is also interested in isolation, microbiological and metabolic characterization of bacteria pool involved in anaerobic digestion. Recently, she has been a fellow in the European Science & Technology Fellowship Programme in China (EU STF CHINA), project "Determination of microbial interaction and metabolic pathways of degradation of seagrass and seaweed organic matter in an anoxic salt lake. Possible use for organic waste disposal and production of bio fuel"

Formerly, Dr. Migliore had achieved a post-graduate Scholarship for the project: "Methods for the classification of the chemical and ecological quality state of waters" Subproject "Identification and classification of macrophytes and macroalgae". She has been a research fellow in "Analitical chemical procedures to measure microbial processes" for the Italian National Project: "Innovative systems for hydrogen production (IDROBIO)".

INTERESTS

- Lagoon Ecology: chemical and physical analysis of lagoon water and sediments. Qualitative and quantitative analysis of lagoon macrophytes and macroalgae and creation of distribution maps of the Submerged Lagoon Vegetation through the application of Global Positioning System and Geographical Information System.
- Anaerobic digestion of biomass and bio-waste for biogas production. Preparation and monitoring of batch and continously stirred reactors, chemical-physical characterization of biomass and end-products of reaction, control of working conditions.
- Characterization of microbial pool by microscopic and bio-molecular techniques, isolation and identification of bacteria strain from natural pool.

SELECTED PUBLICATIONS

Migliore G., Alisi C., Sprocati A.R., Massi E., Ciccoli R., Lenzi M., Wang A., Cremisini C., (2012) "Anaerobic digestion of macroalgal biomass and sediments sourced from the Orbetello Lagoon, Italy", Biomass and Bioenergy 42 69-77;

Signorini A., Migliore G., Varrone C. Izzo G., (2009) "The Fogliano lagoon", Flora and Vegetation of the Italian Transitional Water Systems, 137-146;

Signorini A., Massini G., Migliore G., Tosoni M., Varrone C., Izzo G., (2008) "Sediment biogeochemical differences in two pristine Mediterranean coastal lagoons (in Italy) characterized by different phanerogam dominance. A comparative approach" Aquatic Conservation (18) Special Issue: Transitional States in Transitional Waters 24-44.

6.a. OCEAN ENGINEER

Stephen Hugh Salter, Emeritus Professor of Engineering Design at the University of Edinburgh, Emeritus Professor of Engineering Design School of Engineering University of Edinburgh Mayfield Road Edinburgh EH9 3JL Scotland S.Salter@ed.ac.uk Tel +44 (0)131 650 5704

Stephen Salter was born in Johannesburg South Africa in 1938. He served an old fashioned apprenticeship in the aircraft industry with Saunders-Roe on the Isle of Wight as a fitter, tool-maker and instrumentation engineer working on the Black Knight rocket project before reading physics at Cambridge University where he stayed for six years doing research.

His interests have always been on the border of mechanics and electronics. He moved to Edinburgh University to build robots in Artificial Intelligence and then, in 1973, to Mechanical Engineering to work on wave energy. That required the design of new kinds of directional wave tank with absorbing wavemakers and new types of high-power, computer-controlled hydraulic pumps and motors. Small versions are now being installed in the transmissions of road vehicles where they allow improved engine management and the recovery of energy which would have been wasted in braking leading to a half the urban fuel consumption. These machines may, in future, be used for wind and tidal-stream energy. They enable the design of variable-displacement pumps which despite a low machinery weight can absorb the very high torque needed for multi-megawatt tidal-stream generators suitable for use in the full depth of the Pentland Firth.

Other interests are fatigue reduction in wind turbine blades, desalination using energy from sea waves, improving road-traffic congestion and the capacity of congested bridges, Stirling engines, the mathematics of nuclear disarmament, variable-pitch air turbines, unconventional ways of teaching design engineers and inventors, mine clearance, flood-prevention, the suppression of explosions and the reversal of global warming by increasing cloud albedo.

His research group has its own mechanical and electronic workshops and runs a wide tank with directional absorbing wave-makers. In 1986 he was awarded a Personal Chair in Engineering Design. He is a Fellow of the Royal Society of Edinburgh and an MBE.

Rumours of his retirement in 2004 are exaggerated.

Papers can be downloaded from www.see.ed.ac.uk/~shs

6.b. OCEAN ENGINEER

Clifford A. Goudey, Principal
C.A. Goudey & Associates
21 Marlboro Street
Newburyport, MA 01950
Email: cliffgoudey@gmail.com
Phone: 978-465-2238
Cell: 978-914-1901

EDUCATION:

MASSACHUSETTS INSTITUTE OF TECHNOLOGY Sept. 1974 to June 1977
Master of Science degree in Naval Architecture and Marine Engineering
Master of Science degree in Mechanical Engineering

UNIVERSITY OF MAINE, Orono, Maine Sept. 1964 to Sept. 1968
Bachelor's degree in Mathematics

PRESENT POSITION:

C. A. GOUDEY & ASSOCIATES, Newburyport, MA 2001 to present
Ocean engineering R&D and engineering consulting related to fishing, aquaculture, and ocean renewable energy technologies. Current research focus is on wave and tidal/ocean current energy extraction, ocean-based energy storage systems and mooring technologies for deep-water wind. He is also active in the development for offshore aquaculture technologies and the development of sustainable methods of finfish, shellfish, and macroalgae production.

Partial list of current clients:
Resolute Marine Energy, Inc., Boston, MA
Ocean Farm Technologies, Inc., Searsmont, ME
Maine Marine Composites, Portland, ME
LiveFuels, Inc., San Carlos, CA
Terry G. Spragg & Associates, Manhattan Beach, CA
Mook Sea Farms, Walpole, ME
Thimble Island Oyster Co., Branford, CT

PAST POSITION:

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Cambridge, MA
Project Director, Center for Fisheries Engineering Research 1980 to 2009
Marine Advisory Leader, MIT Sea Grant College Program 1986 to 2008
Project Director, Offshore Aquaculture Engineering Center 1998 to 2009

PATENTS on trawl doors, lifeboat releases, fabric barges, fish pens, and non-entangling buoy.

SELECTED PUBLICATIONS:

Goudey, C.A. 1996. Aquaculture in the U.S. EEZ: Industry in Need of Help, Marine Technology Society Journal, Vol. 30:3, pp. 21-26

Goudey, C.A. 1998. Model Tests and Operational Optimization of a Self-Propelled Open-Ocean Fish Farm. in A. Biran, Ed. Proceedings Offshore Technologies for Aquaculture. Haifa, Israel, 13-16 Oct. 1998.

Goudey, C.A. and H.L. Kite-Powell. 1999. US/Egypt workshop on sustainable coastal development through aquaculture and fisheries. MIT SG 99-3. Cambridge, MA

Goudey, C.A., G. Loverich, H.L. Kite-Powell, and B.A. Costa-Pierce. 2001. Mitigating the environmental effects of mariculture through single-point moorings (SPMs) and drifting cages. ICES Journal of Marine Science, 58:2, 497-503.

Goudey, C.A, T. Boaz, and C. Bridger. 2002. The Design, Installation, And Performance of A Single Point Mooring for an Offshore Cage. in *Open Ocean Aquaculture: from research to Commercial Reality*. WAS, Baton Rouge, LA

Shephard, S., C.A. Goudey and M.J. Kaiser. 2008. Hydrodredge: reducing the negative impacts of scallop dredging, Fish Res.

6.c. RESEARCH ENVIRONMENTAL ENGINEER

Lisa M. Colosi
University of Virginia, Department of Civil and Environmental Engineering
351 McCormick Road, B228 Thornton Hall, Charlottesville, VA 22904-4742
(434) 924-7961 lmcolosi@virginia.edu

EDUCATION

Ph.D. Environmental Engineering, University of Michigan, 2007
M.S.E. Environmental Engineering, University of Michigan, 2004
B.S. Biological & Environmental Engineering (*Magna cum Laude*), Cornell University, 2003

HONORS

UVirginia Young Investigator (2010), UMichigan Digtinguished Dissertation (2007), National Science Foundation Research Fellow (2004-07)
ASCE (2011) and UVirginia (2010) Excellence in Civil Engineering Education (ExCEEd) Teaching Awards

RESEARCH

Applying funding from eight foundations, businesses, governments (including U.S. Department of Energy), and UVirginia sources toward life cycle assessments for and waste-enhanced production of algal biofuels; and understanding the fate of pharmaceuticals and reaction byproducts in natural and engineered systems.

SELECT PUBLICATIONS AND PRESENTATIONS

Clarens, AF; Colosi, LM. (2010) Putting Algae's Promise into Perspective. Biofuels 1: 805.

Clarens, AF; Nassau, H; Resurreccion, EP; White, MA; Colosi, LM. (2010) Environmental impacts of algae-derived biodiesel and bio-electricity for transportation. (2011) Environmental Science and Technology. 45: 7554.

Clarens, AF; Resurreccion, EP; White, MA; Colosi, LM. (2010) Environmental life cycle comparison of algae to other bioenergy feedstocks. Environmental Science and Technology. 44: 1813.

Clarens, AF; Colosi, LM. *The Top Five Things That Environmental Engineers Can Teach Us About Algae-to-Energy Technologies.* Association of Environmental Engineering and Science Professors' Biannual Conference; Tampa, FL; July 2011.

Clarens, AF; Resurreccion, EP; Fry, B; White, MA; Colosi, LM. *What Can Algae Farmers Learn from Environmental Engineers?* The Grand Challenge of Renewable Energy Symposium; Association of Environmental Engineering and Science Professors' Biannual Conference; Iowa City, Iowa; July 2009.

Clarens, AF; Resurreccion, EP; Colosi, LM. *What Can Identifying the Rate-Limiting Steps in Sustainable Algae Production for Bioenergy* New Environmental Technologies Symposium; 239th National Meeting of the American Chemical Society; San Francisco, CA; March 2010.

Colosi, LM. *Life Cycle Assessment of Energy Production from Algae Relative to Other Biofuel Feedstocks*: *An Evolving Outlook for Leveraging Industrial Ecologies;* Exploratory Global Inquiry Group (eGIG) at the College of William and Mary/Virginia Institute of Marine Sciences Seminar Series. Gloucester, VA; December, 2009.

Clarens, AF; Colosi, LM. (2011) Life Cycle Assessment of Algae-to-Energy Systems. In J. Lee (Ed), Advanced Biofuels and Bioproducts. Spring Science + Business Media: Philadelphia, PA. In Press.

6.d. OCEAN, WASTEWATER, AND WATER RESOURCES ENGINEER

Mark E. Capron, California P.E. (Civil)
President, PODenergy, Inc.
2436 E. Thompson Blvd.
Ventura, California 93003
MarkCapron@PODenergy.org
805-760-1967

EDUCATION
B.S. Civil Engineering, University of California, Berkeley 1976
M.S. Structural/Ocean Engineering, UC, Berkeley 1981
Officer's Basic Diving, U.S. Navy Dive School, 1982

PROFESSIONAL EXPERIENCE
President, PODenergy, Inc.
Providing the research and vision for Ocean Macroalgal Afforestation (OMA). OMA involves ocean technologies generating renewable methane, capturing and sequestering CO_2 from the air, and restoring ocean ecosystems. Offshore geothermal energy is an OMA precursor technology.

Ideas & Engineering half-time for the City of Thousand Oaks
Providing the technical expertise for a team making the City's wastewater treatment plant a net energy generator with quickly paid-back projects before 2014. Most of the energy is biogas from anaerobic digestion converted to electricity and heat.

Senior Engineer, Ventura Regional Sanitation District, 1989 to 2009
A sanitation district often has controversial projects. Two sample examples of my project technical and managerial leadership: 1) $3 million invisible, odorless, energy conserving on-site wastewater treatment within 20 feet of some bedroom windows for the Malibu Bay Club; and 2) $5 million (95% grant and loan funded) wastewater treatment plant and collection system for Saticoy Sanitary District with with 5 months for 100% design and California Environmental Qualtity Act documents.

Senior Project Engineer, Naval Civil Engineering Laboratory, '86 to '89
The Navy funded four patents and four technical bulletins to preserve rights to my inventions. One invention demonstrated that a relatively light netting fence could prevent suicide-bomb boats from getting close to Navy ships by using the terrorist's own speed against them. Others related to floating platforms and instant bridges.

Civil Engineer Corps Officer, United States Navy, '76 to '85
The Civil Engineer Corps is primarily project management and learning different jobs, including Ocean Facilities Program Officer and Diving Officer at U.S. Naval Civil Engineering Laboratory, Port Hueneme, California. As an assistant resident officer in charge of construction at Naval Air Station Brunswick, Maine, my change order rate was among the lowest in the Atlantic Division while managing $20 million of work-in-place per year.

RELATED PUBLICATIONS
Seven formal patent applications including "Systems and methods for off-shore energy production and CO2 sequestration."
2008 "Plankton Power," Civil Engineering
2009 "Holistic Approach Needed," Water, Environment, & Technology
2012 N'Yeurt, A.D.R., Chynoweth, D.P., Capron, M.E., Stewart, J.R., Hasan, M.A. Negative Carbon via Ocean Afforestation. Process Safety and Environmental Protection 90 (2012) 467-474.

6.e. WASTEWATER, WATER RESOURCES ENGINEER, LINGUIST

Mohammed A. Hasan, Dual M.S., P.E., R.E.A., F.ASCE, PWLF, Distinguished Life Member AWWA

Vice President, Applied Research and Operations, PODenergy, Inc.
2436 E. Thompson Blvd.
Ventura, California 93003
MohammedHasan@PODenergy.org
805-218-5574
Hasan Consultants, Owner

EDUCATION
M.S., Environmental Engineering, University of Iowa
M.S., Transportation Engineering, University of Iowa
B.S., Civil Engineering, University of Karachi

PROFESSIONAL EXPERIENCE
Over thirty years of diversified professional experience in engineering, management, research and teaching. Specific areas of expertise include commercial and residential land development, water and wastewater system design and operation, operator training, surveying and grading, street improvement, underground tanks evaluation, site assessment and remediation, hazardous waste management, construction management, regulatory agency compliance and expert witness. Immediately prior to opening the engineering firm served as the Utilities Superintendent of the City of Oxnard, CA. Previously employed with Ventura Regional Sanitation District as a civil engineer. Conversant in six languages: English, Spanish, Bengali, Urdu, Arabic and Hindi.

LICENSE
Professional Engineer (Civil), California
Community College Instructor Credential, California
Registered Environmental Assessor, California
Registered Well Inspector, County of Ventura
California Department of Health Services Operator

PROFESSIONAL MEMBERSHIP
American Society of Civil Engineers - Fellow
American Public Works Association
Association of Environmental Professionals
American Water Works Association -Distinguished Life Member
Environmental Business Council of Ventura County – President, 2000
Water Environment Federation
Channel Counties Water Utilities Association - President, 1985
Association of Water Agencies - Director, 1984
Enterprise Forum, Membership Committee
MIT American Society of Testing Materials
North American Society of Trenchless Technology

COMMUNITY SERVICE
Rotary International, Ventura East-Paul Harris Fellow and Benefactor, President 2004-05
Tri-Counties Easter Seal Society - Director, 1998-2003
Hispanic Chamber of Commerce - Director, 2002

Muscular Dystrophy Association - Jailbird, 2002
Ventura County Science Fair - Judge, 2001
Ventura Trade Club - Head Trader, 1993
Ventura Youth Employment Service - Director 1990
Consult/Net - President, 1989
Villa Seville Homeowners Association - President, 1988
Ventura Chamber of Commerce - Governmental Affairs Committee

6.f. RESEARCH ENVIRONMENTAL ENGINEER

Sean Becker, ssb5n@virginia.edu

Sean Becker graduated from the University of Virginia with a Bachelor of Science in Civil Engineering in 2012. As an undergraduate, he worked with Dr. Lisa Colosi of the Civil Engineering Department and members of PODEnergy on a life cycle assessment of the OceanPETRO system, assisting in the development of a spreadsheet model to comprehensively capture all inputs and outputs in the system. This included approximating material requirements and calculating metrics such as energy returned on energy invested (EROI) and the Greenhouse Gas ratio, among others. Sean submitted his research to UVA's Undergraduate Research Design Symposium (URDS) for which he was selected as a finalist and allowed to present his research to a panel and audience.

Sean was a student member of ASCE and has continued his involvement with the organization after graduating. During his fourth year, he wrote his thesis entitled "Obstacles to Alternative Fuel Adoption: a Sociotechnical Approach to the Issues Surrounding Emerging Motive Sources for Passenger Vehicles" and completed a Capstone group project and report entitled "Site Development and Planning in Reston", focusing on responding to a theoretical Request for Proposal for development of an office building at a site in Reston, Virginia.

7.a. SUSTAINABLE STARTUP EXECUTIVE

Don Piper, M.S., M.B.A.
Founder, Myndzeye LLC, Sedona, Arizona
Office: 520-307-3446
Email: don@myndzeye.com

Board Member • CEO • CFO • Internal/External Consultant • Program/Project Manager • Collaborator • Corporate Ambassador and Liaison • Experience in 25+ industries

Recognized by Fortune Small Business and CNN/Money as “top in the field by colleagues, students, and entrepreneurs.” *Go-to guy* for enhancing or restoring underperforming assets. Proven mentor and coach; systems design thinker; permaculture design consultant; sustainable and conscious business advocate. Specializes in helping individuals and organizations solve social and environmental problems by creating fourth bottom line solutions incorporating

purpose, culture, and spirit into economically sustainable ventures. Helped launch over 50 new businesses in the past eight years.

PROFESSIONAL EXPERIENCE

2008- Present Myndzeye LLC, Founder, Sedona, Arizona *Sustainable project management and conscious business consulting*

2007- 2012 Bainbridge Graduate Institute, Core Faculty and Entrepreneurship Discipline Lead, Seattle, WA Led the design and delivery of the capstone for BGI's MBA's, Sustainable Entrepreneurship and Intrapreneurship

2004-2008 University of Arizona, McGuire Entrepreneurship Center, Mentor in Residence, Tucson, AZ
Designed and delivered MBA and Undergraduate Entrepreneurship classes; liaised with Technology Transfer

2002-2003 Holland Brothers Building, Founder/Social Entrepreneur, Durham, North Carolina
Identified a property on the corner of the designated Arts District in downtown Durham for a social enterprise

2001- 2003 *n*touch Research Corporation, Chairman of the Board, Raleigh, North Carolina
A site management organization serving all the leading pharmaceutical and biotech development companies

2000 – 2001 ViOS Corporation, Chief Financial Officer, Cary, North Carolina
Stepped in to assist the Founder and CEO through next round financing

1999 – 2001 VisionTech Partners LLC, Founder, Managing Director, Finance Partner, Cary, North Carolina
Recruited by the Chairman to assist in the spinoff of Integrated Network Solutions and creation of VisionTechHoldings

1998 – 1999 Mediappraise Corporation, Chief Executive Officer, Raleigh, North Carolina
Recruited by Founding team to lead this start-up through launch and first two rounds of financing

1993 – 1998 Drake Beam Morin, Inc., Senior Vice President, Managing Director, Raleigh/Winston Salem/Charlotte
Recruited by Raleigh Managing Director to assist in the build out of a new business and succeed her on transition

EDUCATION

MS/MBA Marine Resources Management, Texas A&M University, College Station
BS Geology Preparatory for Advanced Studies in Oceanography, Duke University, Durham

7.b. SUSTAINABLE STARTUP EXECUTIVE

Alyson Myers, Director
Kegotank Farm
3029 Woodland Dr., NW, Washington, DC 20008
Email: kegotankfarm@aol.com
cell: 202-297-9743

Current projects include shellfish farming and multi-trophic aquaculture (IMTA), nutrient absorption through macroalgae harvest, and agricultural research on halophytes (salt-tolerant plants) for sea level rise. Myers has collaborated with scientists at: U of Delaware, U of Maryland, VA Tech, Iowa State and the U of Maine. She has conducted research at VA Tech-Advanced Research Institute and the Marine Biology Lab (MBL) at Woods Hole, MA. She conducts algae conferences at Kegotank Farm.

Kegotank Farm
2003-Present, Director
Developed Kegotank Farm, a 438 acre coastal research facility for scientists working on response to environmental change.

Oyster Aquaculture: 2008-2013. Initiated triploid oyster farming on the Atlantic coast of Virginia, developed restaurant markets in Washington DC, Rehoboth, DE, and Lewes, DC. Won the Slow Food Snail of Approval award 2012.

Organic Farming. 80 acres transitioned from traditional soybean-winter wheat rotation to soil enrichment plan with cover crops and seaweed. Sorghum, a gluten-free grain, scheduled for planting for animal feed markets and urban bakeries.

Agriculture: Kegotank-UDE. Halophyte trial to explore the feasibility of salt-tolerant plants on land bordering saltwater. Implications for rising sea levels. Novel uses of marsh mallow.

State of Delaware
South Bethany Canals. Coordinated Biomass Program with the State of Delaware Secretary of the Environment, Town Council to gain approval to conduct macroalgae harvest, analysis and recommendations for economic uses in the South Bethany canals.

RESEARCH APPOINTMENTS
Marine Biology Lab (MBL). Woods Hole, MA. 2011. Visiting Researcher
Designed and tested macroalgae growing devices for depth, flow and growth. Gracilaria culture.

Virginia Tech- Advanced Research Institute (VA TECH-ARI) 2009 - Researcher

EDUCATION
Duke University, Durham, NC. MA, Environmental Management, current.
Yale University, New Haven, CT. 2013. Conservation Finance.

Wesleyan University, Middletown, CT. 1981. BA with majors in Political Science, English Literature. Graduate courses in business. Columbia University, Paris, France. 1980. Courses in accounting and L'Universite Catholique (French language).

7.c. ENVIRONMENTAL POLICY ADVISOR

Jim Stewart, Ph.D.
Vice-President, Environmental Policy, PODenergy, Inc.
Los Angeles, California
JimStewart@PODenergy.net; 213-820-4345

EDUCATION
M.S. Urban Studies, Southern Connecticut State Univ., New Haven, Connecticut
Ph.D. Physics, Yale University, New Haven, Connecticut
M.S. Physics, Yale University, New Haven, Connecticut
B.S. Physics, Iowa State University, Ames, Iowa

PROFESSIONAL EXPERIENCE
Vice President, PODenergy, Ventura, CA (present)
Adjunct Professor, University of the West, Rosemead, CA (present)
Previous Experience
Organizing Director, Earth Day Los Angeles
Chief Environmental Scientist, Best Technology Company, Santa Monica, CA
Executive Director, People for Parks, Los Angeles, CA
Sustainability Consultant, Loreto Bay Company
Associate Director, Southern California Council on Environment and Development
Planning Director, Campaign for the Earth, Boulder, CO
Consultant, Washington, DC
Senior Consultant, Technology Transfer, Toronto, Ontario
Curriculum Developer, Training Inc., Chicago, Illinois
Executive Director, Connecticut United Labor Center, Hartford, Connecticut
Executive Director, Connecticut Human Services Reorganization Commission, Hartford, CT
Assistant Professor, Physics Department, University of New Haven, Connecticut
Captain, U.S. Army Signal Corps Research Laboratory, Ft. Monmouth, New Jersey
Assistant in Research, Department of Physics, Yale University, New Haven, CT

PUBLICATIONS
2012. N'Yeurt, A.D.R., Chynoweth, D.P., Capron, M.E., Stewart, J.R., Hasan, M.A. Negative Carbon via Ocean Afforestation. *Process Safety and Environmental Protection* 90 (2012) 467-474.

Dynamic Polarization of Fluorine by Selected Free Radicals, E.H. Poindexter, J.R. Stewart and P.J. Caplan, *J. Chem. Phys*. 47, 2862 (1967).

Dynamic Enhancement of Fluorine Nuclear Magnetic Resonance: Some Effects of Chemical Environment, J.R. Stewart, E.H. Poindexter, and J.A. Potenza, *J. Am. Chem. Soc.* 89, 6017 (1967).

Dynamic Polarization on Hexafluorobenzene Solutions, E.H. Poindexter, J.R. Stewart, R.J. Runge, and D.D. Thompson, *J. Chem. Phys*. 44, 4059 (1966).

Photodisintegration of He^4, H.G. Clerc, J.R. Stewart, R.C. Morrison, *Phys. Rev. Letters* 16, 316 (1965).

Photodisintegration of He^3, J.R. Stewart, R.C. Morrison, J.S. O'Connell, *Phys. Rev.* 138, B372 (1965).

VOLUNTEER EXPERIENCE
Co-chair, Sierra Club California Energy-Climate Committee
Chair, Sierra Club Angeles Chapter Global Warming, Energy, and Air Quality Committee

7.d. INTELLECTUAL PROPERTY AND COMPUTER SECURITY

Frank W. Sudia, JD
Vice President, Corporate Development, PODenergy, Inc.
Washington, D.C.
FrankSudia@PODenergy.net; 202-350-7726

Education
J.D., American University, Washington College of Law, 1983
B.A., Social Science, University of Michigan, Ann Arbor, 1979
LES Fundamentals of Intellectual Asset Management, Certificate, October 2001

Membership
DC Bar Association, American Bar Association, Licensing Executives Society, IP Society, Lifeboat Foundation
Standards Organizations (1990s):
American Bankers Association, X9.F1 Cryptography Standards
American Bar Assn, Section of Science and Technology, Info-Sec Committee
American Society for Testing and Materials, ASTM E-31.20 Medical Records

Experience
University of Georgia Marine Institute, Sapelo Island, GA, Summer Intern, 1969-71
Consultant to various U.S. Federal Government agencies on social and environmental programs in 1980s, including HHS, FDA, EPA, HUD, NIH, National Park Service, Minerals Management Service, and Office of Surface Mining, including: Roy F. Weston, Inc., Washington, DC, Analyst for environmental consulting firm with major EPA contracts.
Wall Street, mainly at Bankers Trust Co. (now Deutsche Bank) developing financial and security systems during the 1990s.

Cofounded BT Electronic Commerce, spun off as CertCo, Inc. (1996), and then worked at BT Strategic Ventures incubating other bank spinoff companies.
Since 2000, consultant to over 30 clients, mostly Silicon Valley and renewable energy startups.

Achievements
Advised Network Solutions on eventual $22 billion merger with Verisign, 1999
Designer of Identrus, LLC security system serving 65+ large banks, 1998
Staff Sponsor, CoVar (credit risk management) incubation project, 1998
Staff Sponsor, Operational Risk, Inc. incubation project, 1998
BTEC spun out as CertCo, Inc., $30 million Series A at $150m valuation, 1996
Co-founded Bankers Trust Co. Electronic Commerce (BTEC) Dept., 1994

Lead negotiator on 7 fully executed patent licenses.
Programmer on 12 business database tracking / accounting systems
Inventor and/or lead designer on 10 novel online security technologies
20 invited talks and panels on online security

Patents
Steam via catalytic combustion and 12 other patents, mainly in the field of online security

Publications
"An Overview of Structured Licensing," Les Nouvelles, Vol. XXXVI, No. 4, December 2001 (Journal of the Licensing Executives Society)
"A Jurisprudence of Artilects: Blueprint for a Synthetic Citizen," Journal of Futures Studies (Taiwan, 2001), Law Update (Dubai, 2004)
"Data Content Monitoring for Security, Integrity, and Availability," September 2002
"Digital Signature Guidelines," American Bar Association, Ed. Committee, 1994

Awards
Future Banker Magazine, "#1 Tech Deal of the Year" (Identrus), December 1998
KurzweilAI.net, "Big Thinkers List," 2001

Advisory Boards
Lifeboat Foundation, Legal Advisory Board, 2006 – present
Global Consciousness Project, Theory Committee, 2002