Report of the Planning workshop of the SASCA- Project (February 28- March 14, 2013)

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1. Participants

Fig. 1 SASCA- workshop participants
First row (from left to right): Marc Taylor, Ivonne Vivar, Stefanie Bröhl, Bruno Arroyo
Standing (from left to right): Maria Miglio, Luis Sánchez, Lotta Kluger, Luis Ysla, Danella Matheus, Matthias Wolff, Pamela Cabezas, Jaime Mendo, Patricia Gil, Rámon Filgueira, Jorge Vélez.
## 2. Overview on activities

<table>
<thead>
<tr>
<th>Day</th>
<th>Dates</th>
<th>Time</th>
<th>Activity</th>
<th>People involved</th>
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<tbody>
<tr>
<td>1</td>
<td>Wednes.27.2</td>
<td>17:05-19:00</td>
<td>Start &amp; arrival; Accommodation and dinner</td>
<td>M. Wolff, L. Kluger, M. Taylor;</td>
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<td>2</td>
<td>Thurs., 28.2</td>
<td>08:00-19:00</td>
<td>To La Molina (UNALM); Meeting with Dean; Short Talk for Professors and Students; visit to laboratory; Lunch; SASCA Meeting; preparations</td>
<td>M. Wolff, L. Kluger, M. Taylor; J. Mendo, Patricia Gil Kodaka, Luis Ysla, Mary Miglio</td>
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<td>3</td>
<td>Frid. 1.3</td>
<td>07:00-17:00</td>
<td>Trip to Trujillo (bus); Arrival in Trujillo</td>
<td>M. Wolff, L. Kluger, M. Taylor; J. Mendo, Luis Ysla,</td>
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<td>4</td>
<td>Satrud., 2.3</td>
<td>07:00-17:00</td>
<td>Trip to Piura (bus); Arrival in Piura; Workshop Preparations</td>
<td>M. Wolff, L. Kluger, M. Taylor; J. Mendo, Luis Ysla,</td>
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<td>5</td>
<td>Sund., 3.3</td>
<td>09:00-19:00</td>
<td>Workshop preparations in Piura; Lunch; Workshop preparations in Piura; Arrival of S. Broehl and R. Filgueira</td>
<td>M. Wolff, L. Kluger, M. Taylor; S. Broehl, J. Mendo, Luis Ysla; Stefanie Broehl arrives at 18:00; R. Filgueira arrives 23:15</td>
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<td>6</td>
<td>Mond, 4.3</td>
<td>09:00-19:00</td>
<td>Students arrival from Lima; SASCA Workshop; Lunch; SASCA Workshop preparaations; Project presentation to stakeholders; Dinner</td>
<td>M. Wolff, L. Kluger, M. Taylor; S. Broehl, R. Filgueira, J. Mendo, Luis Ysla, Mary Miglio joins the group at 18:00</td>
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<td>7</td>
<td>Tuesday, 5.3</td>
<td>09:00-17:00</td>
<td>P. Gil arrival from Lima; SASCA Workshop; Lunch; SASCA Workshop; Trip to Sechura</td>
<td>M. Wolff, L. Kluger, M. Taylor; S. Broehl, R. Filgueira, J. Mendo, Luis Ysla, Mary Miglio &amp; students; Patricia Gil arrival at 08:00</td>
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<td>8</td>
<td>Wednes, 6.3</td>
<td>09:00-20:00</td>
<td>Trip to Parachique; Field trip and dive in Study area; calibration of manta sensors; test of current meters and oxygen loggers; Trip to Sechura; Trip to Los Organos; Students return to Lima</td>
<td>M. Wolff, L. Kluger, M. Taylor, J. R. Filgueira, J. Mendo, Luis Ysla, Mary Miglio, Steffi Broehl, Patricia Gil &amp; students</td>
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<td>9</td>
<td>Thursday, 7.3</td>
<td>09:00-17:00</td>
<td>SASCA Meeting; discussion of projects, logistic, financial support, etc</td>
<td>M. Wolff, L. Kluger, M. Taylor, J. Mendo, Luis Ysla, Mary Miglio, Steffi Broehl, Patricia Gil, R. Filgueira Ramon Filgueira</td>
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<td>10</td>
<td>Friday, 8.3</td>
<td>09:00-17:00</td>
<td>Project planning; R. Filgueira returns to Piura and Ottawa; Project planning</td>
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<td>Saturday, 9.3</td>
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<td>Recreation</td>
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<td>12</td>
<td>Sunday, 10.3</td>
<td>08:00-17:00</td>
<td>Recreation</td>
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<td>13</td>
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<td>15</td>
<td>Wednesday, 13.3</td>
<td>11:15-14:00</td>
<td>Flight Piura-Lima</td>
<td>M. Wolff, and M. Taylor; J. Mendo, Luis Isla, Lotta Kluger</td>
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<td>16</td>
<td>Thursday, 14.4</td>
<td>19:10-20:00</td>
<td>Flight Lima-Bremen</td>
<td>M. Wolff, and M. Taylor</td>
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</table>
3. Activities, day by day

Piura (Peru),

Saturday (March 2), 18:00, 30°C and humid

After a 20 hours flight to Lima and a whole day of work at the Agriculture University of La Molina in Lima we (Matthias Wolff, Marc Taylor, Jaime Mendo, Luis Ysla, Lotta Kluger) started our bus trip to the workshop in Piura (Northern Peru) yesterday morning. Now, after two days of bus ride we have finally arrived.

Monday (March 4), 23:00, 25°C, wet outside due to heavy rain

On Sunday evening Stefanie Broehl and Ramon Filgueira (the expert, who we had invited from the Dalhousie University, Canada) arrived in Piura by plain and today our workshop could start at 10:00 here at the Hotel Esmeralda after the students had arrived by bus from Lima.

We had several presentations given by the colleagues from the Agriculture University of La Molina (Luis Isla and Jaime Mendo) on the present situation of scallop culture activities in Sechura bay and on the research that has been conducted over the last years. These talks were followed by a short presentation of the SASCA-Project by myself. Thereafter Marc Taylor and Ramon Filgueira exposed their work on modeling approaches for carrying capacity estimates, and Stefanie Broehl and Jaime Mendo gave overview talks on the techniques used for respiration measurements in the laboratory and in-situ, respectively. We then defined our research themes of the SASCA –Project and split the 15 people group into two groups that were going to work during the next day on the “fine-tuning” of the different student's projects to be developed during SASCA.
At 19:30 we presented our SASCA-Project to the local stakeholders that had been invited by our Peruvian counterparts. These included representatives from governmental institutions, universities, NGOs and fishermen cooperatives. About 40 participants filled the room almost completely and listened with great interest to Ramon Filgueira’s talk on the relevance of carrying capacity studies for bivalve cultures and to my talk on the SASCA-Project. The lively discussion thereafter reflected great interest in our project. Many participants offered their help for the field work in Sechura Bay. We ended our first workshop day with a glass of wine and “chifles” (banana slices fried in oil) for all participants. It was a great day!

Tuesday (March 5), the rain has ceased a bit

We started early at 9:00 with the continuation of our workshop and worked until 17:00 hours, only interrupted by a lunch break. The main objective of this day was to revise the project outline and to further specify themes and objectives of the different student projects to be developed during the SASCA-Project period 2013-2015. At 17:00 hours a big bus of the Universidad de Piura was send to the hotel to pick us (15 people) up for the trip to Sechura, where we arrived an hour and a half later at our Hotel to stay over night and to start our field trip early in the morning of the next day.

![Fig. 3 Trip to Sechura bay; centre and right: boat that took us out](image)

Sechura

Wednesday (March 6), sunny and warm (30°C)

In the early morning hours two cars took us from the Hotel Sechura to Parachique, a little harbor at the bay of Sechura. Here a boat was waiting for us to take us out to an area where scallops are grown in bottom cultures. After 1.5 hours of boat ride, the Hookah system was started, two divers went down to collect scallops and to revise the bottom conditions, and Stefanie Broehl and the students tested the Hobo oxygen logger and Manta multiprobe-sensors. Having the computer on board, we were able to check the recorded in situ-data. The Manta multiprobe worked well, while the oxygen logger did not. So we decided to do a further test later in Los Organos, the next stop on our trip. The two fishermen who took us out, were scallop cultivators themselves and their description of the culture activities in the bay allowed us to get quite a complete picture
about the present ecological and economic conditions of the scallop bottom cultures in the bay.

Around lunchtime we returned to the pier, some of us with heavy sunburn and exhausted from the sea ride. After a quick lunch in a harbor restaurant, the same bus of the day before picked us up and took us to Piura again. Here our groups split up - the students stayed in Piura overnight to travel back to Lima the next day and our group (Ramon Filgueira, Marc Taylor, Stefanie Broehl, Lotta Kluger, the university colleagues Luis Ysla, Partricia Gil, Maria Miglio and Jaime Mendo and myself) continued travelling with a small bus to the 2.5 hours distant town of Los Organos, where we had planned to stay to further analyze the group work of our workshop days in Piura and the expedition to Sechura bay.

**Fig. 4 Working in Los Organos: left: Hobo oxygen logger and Manta multiprobe testing**

**Los Organos**

**Thursday (March 7)**

Heavy rains and a loud sound of the waves had made the sleeping difficult in the large house at the beach, where we were accommodated by our project partner, Jaime Mendo for the further project planning.

We started to arrange the large room for our study purposes, connected the beamer and started to work after breakfast until dawn, when the groups’ work results were presented. During that time, Stefanie again tested and calibrated the oxygen loggers and Manta multiprobe.

The evening was then closed with a good-bye barbecue for Ramon who had to leave the next day at noon to Canada.

**Friday (March 8)**

Electricity went down in the early morning hours and we had to work on batteries, hoping that the electricity would come back before all energy was gone. At 16:00 the electricity came back. We discussed project logistics and finances and decided to go for 8 seasonal sampling campaigns at four stations of the bay, characterized by differences riverine (fresh water) input and depth. A total of 8 different projects were defined as well as the periods during which these projects are to be developed (see 4. Products below).

**Saturday (9) and Sunday (10)**

Weekend break-

Stefanie, Patricia and Maria leave for Lima (and Germany in the case of Stefanie) on Sunday.
Monday (11), very hot outside (>35°C), no wind

After breakfast we continued to work until the afternoon discussing logistics and project organization and made an effort to integrate the single project descriptions into a research plan; Available literature data were sighted and the use of models and GIS was discussed.

Tuesday (12), as hot as the day before

We continued to work during the morning hours, wrapped up our stuff and went to the bus station at 15:00, the bus left 15:20 for Piura, where we arrived at 19:00.

Piura, Lima, Bremen

Wednesday (13)

The flight to Lima left Piura at 11:20 as scheduled, and Marc Taylor and myself were to continue to leave Lima for Bremen the same day, but the flight was cancelled due to snow chaos in Paris.

Thursday (14) & Friday (15)

Around 19:30 the flight left for Paris, from where our connection to Bremen worked fine and we arrived in Bremen at 17:30.
4. Products/ research plan

Sustainability analysis of scallop culture in Sechura bay (Peru)

Research Topics & Project Plan
## A: Schematic overview on project activities

<table>
<thead>
<tr>
<th>Theme/survey month</th>
<th>5/13</th>
<th>8/13</th>
<th>11/13</th>
<th>2/14</th>
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<th>8/14</th>
<th>11/14</th>
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<td>M1: Results of P.3</td>
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<td>M2: Results of P.1.1</td>
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<td>M3: Results of P.5</td>
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<td>M5 (6/2015): Results of P.1.3</td>
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<td><strong>Project 1</strong></td>
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<td>1.2-EwE Ecological scenario simulations</td>
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<td>1.3-EwE bioeconomic scenario simulations</td>
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<td>GIS-mapping, productive CC</td>
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<td>Scallop growth &amp; mortality studies at different densities, sites and depth</td>
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<td>Community analysis in cultivated and un-cultivated areas; 5.1 Macrobentos 5.2 Infauna</td>
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<td>Ecophysiology 2. Tolerance studies in laboratory</td>
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**B: Project descriptions**

**Project 1. Ecological and socio-economic feasibility of a long-term scallop bottom culture in Sechura Bay, Northern Peru**

- **PARTICIPANTS**
  - L. Kluger, M. Wolff

- **BACKGROUND & EXISTING DATA**
  - IMARPE surveys of benthic community (N, biomass) [pre-culture 09/1996]
  - Ecopath model of pre-culture conditions (Taylor et al., 2008)
  - Carrying capacity model of Tam et al. (2012, IMARPE Informe)

- **AIMS**
  - Assess the impact of scallop culture on the ecosystem of Sechura bay
  - Determine CC of the system incorporating information of physical, ecological, and socio-economic carrying capacity

- **HYPOTHESIS**
  - The present level of scallop culture is not sustainable because it exceeds ecological and socio-economic carrying capacity (too many culturists involved).

- **METHODS**
  - Compare steady state models of pre- and present- culture situations (ECOPATH)
    - Based on IMARPE benthic evaluations (1996 vs. 2011)
    - Addition of bacteria functional group
    - Separate group for scallops culture by method
  - Follow methodologies on "Ecological Carrying Capacity" provided in the literature (Wolff 1994, Jiang and Gibbs 2005, Byron et al. 2011a,b)
  - Use the ECOPATH reference model of 2013 to simulate (using ECOSIM and historical time series of environmental conditions) changes in a) primary productivity and b) total cultivated biomass in order to define critical limits for ecological carrying capacity under different states of the ecosystem
  - Explore bio-economic scenarios of culture development (ECOSIM)

- **CONNECTIONS TO OTHER TOPICS**
  - All

- **EXPECTED RESULTS**
  - Trophic model of present situation
  - Simulation scenarios for calculation of carrying capacity under different ecosystem states
  - Simulations of scallop cultivation under different socio-economic scenarios
• TIME TABLE
  o Trophic reference model 2013 to be developed and state of the “cultivated” ecosystem shall be compared with the “uncultivated” state (1996-2000) (September 2013)
  o Scenario simulations and model updates using SASCA field data to be done in 2014.
Project 2: Physical / Productive Carrying Capacity

- PARTICIPANTS
  - 1 MSc [Mary]
  - 1 BA

- BACKGROUND & EXISTING DATA
  - IMARPE, ESCAES, Remote sensing products

- AIMS
  - Define physical and productive carrying capacity – What is the extent of physical area appropriate for aquaculture? How much production is possible on the total area?

- CONNECTIONS TO OTHER TOPICS
  - Socio-economic, Trophic modeling

- HYPOTHESIS
  - (Physical) Area limited by depth, O2 conc., other uses (boat traffic corridors), minus nearshore buffer, minus nucleos, etc.
  - (Suitability) There are differences in suitability in the bay - these are due to:
    - Retention time of water
    - Food + O2 as function of depth, currents, anthropogenic influence (nutrients, contamination), river discharge.

- METHODS
  - Revision of historical data
  - Creation of GIS "layers" of parameters of interest for the bay
    - Parameters:
      - Physical: Bathymetry, Coastline, Residence time / currents, Salinity (river discharge), Chla, contamination (ITP), Red tides, O2 (summer and winter), Sulfites (pH), Sedimentation, location of extreme mortality events (ITP)
      - Socio-economical: Concessions, Industry, location of ports
  - Cluster analysis (physical characteristics)
    - Define areas of field studies (ecophysiology, growout studies (densities), benthic monitoring (community [infauna, epifauna], waste accumulation[REDOX, Sulfites, etc.]), oceanographic monitoring (O2, T°C, pH, turbidity, Chl, salinity)
  - Categorization based on socio-economic characteristic (operational costs due to distance to port etc., growout)
  - Categorization based on hygienic characteristics (Fecal coliform bacteria, red tides)

- NEEDS / LOGISTICS
o Data mining using IMARPE Report (2012), Baseline Report (2007) and other literature sources
o Implementation of GIS Program work platform

• EXPECTED RESULTS
  o Creation of thematic maps of the bay
  o Define areas using basic suitability categories (e.g. stoplight) (possible factors: physical conditions, operational cost, hygienic conditions)
  o Preliminary estimate of physical & productive carrying capacity

• TIMETABLE
  o 3 months collection of historical data (IMARPE)
Project 3: Analysis of the production chain for the cultivation of the Peruvian bay scallop.

- **PARTICIPANTS**
  - 1 BSc/MSc economy; UNALM (Jaime Mendo / Luis Ysla), ZMT (Achim Schlüter / Matthias Wolff / Lotta Kluger)

- **BACKGROUND & EXISTING DATA**
  - ITP, Onudi, Baseline report IMARPE, Strategic Plan of Piura, ESCAES, Fincyt, Inei

- **AIMS**
  - Identify the different stakeholder groups involved in the production chain.
  - Investigate the costs and benefits of each group and compare among groups.

- **SCIENTIFIC QUESTION**
  - Which are the groups directly and indirectly benefitting within the production chain of the scallop cultivation.

- **CONNECTIONS TO OTHER TOPICS**
  - Socio-economic and ecological modeling

- **HYPOTHESIS**
  - The cultivatores represent the group that benefits the most within the production chain.

- **METHODS**
  - Literature review of the production chain of scallop cultivation.
  - Identification of local contact persons.
  - In-situ identification of the stakeholder groups representing the different steps of the production chain (cultivators, port assistants, transporters).
  - Workshop with focus groups.
  - Elaboration and conduction of interviews with members of each group in order to obtain information about the production chain.

- **NEEDS / LOGISTICS**
  - Travels to Sechura / Piura
  - Visits at institutions (IMARPE, ITP, Produce, Escaes, companies (Prisco), fisheries associations, Sunat)

- **EXPECTED RESULTS**
  - Institutional analysis
  - Diagram of the production chain
  - Value fluxes within the chain

- **TIMETABLE**
  - 3 months for analyzing information already available and preparing questionnaires
  - 3 additional months to complete the study (e.g. conduct interviews)
Project 4: Growth and mortality of the Peruvian bay scallop in bottom culture at different densities in Sechura bay

- PARTICIPANTS (Luís Ysla, JM, MW, 2 students (BSc /MSc)
- BACKGROUND & EXISTING DATA (Proyecto Fincyt, IMARPE, Escaes)
- AIMS
  - Compare growth and mortality in cultivation of different densities and depths in two zones in Sechura Bay.
- QUESTION
  - Are there differences in growth and mortality of scallops cultivated at different densities in two areas (Parachique and Vichayo) and two depths (6 and 10m)
- HYPOTHESIS
  - Growth of scallops is inversely related to density and depth, and directly related to salinity. Parachique is exposed to period intrusions of riverine, low salinity waters.
- CONNECTIONS TO OTHER TOPICS
  - Ecophysiological projects (rate of respiration, and ingestion)
  - Productive carrying capacity
  - Ecophysiological projects (respiración rate, depletion and ingestion rates)
- METHODS (Experimental design, statistics)
  - Two zones: Parachique and Vichayo.
  - Two densities: 30, 60, 90 ind/m² (ref fincyt)
  - Two depths: 6m y 10m
  - Three initial sizes: 40, 60, 80mm (in total: 36 experimental units)
  - Cages ("Linternas") as experimental units
  - Biweekly evaluations of sizes and weight, weight of gonads, aductor muscle, parameters of size-weight relation.
- EXPECTED RESULTS
  - Growth and mortality curves for each location and depth
  - Biomass, gonad, muscle curves
  - Biometric relations
- NEEDS / LOGISTICS
  - Scallops of different sizes
  - 10 linternas, lines
  - One week of preparing and installing experiment
  - 12 travels
- TIME TABLE
  - Start of experiment in May 2013
  - Time of conduction (2x 3 months):
    - Autumn-winter (May-August) [5/2013 + 8/2013]
    - Spring-summer (November-February) [11/2013 + 2/2014]
**Project 5.1 The impact of scallop cultivation on the biodiversity of macroepibenthos in two depths in front of Parachique, Sechura Bay**

- **PARTICIPANTS**
  - Paty Gil, Jaime Mendo, Matthias Wolff, 1 MSc

- **BACKGROUND & EXISTING DATA**
  - IMARPE, Base line, Escaes

- **AIMS**
  - Compare the biodiversity between areas with and without scallop cultivation:
    - Compare number, biomass and size frequencies of individuals and species per area.
    - Determine dominant taxa.

- **SCIENTIFIC QUESTION**
  - Are there differences in the community structure of macroepibenthos in zones with cultivation when compared to zones without cultivation.

- **CONNECTION TO OTHER TOPICS**
  - Trophic modeling
  - Definition of mediation function between scallops and other functional groups.

- **HYPOTHESIS**
  - The biodiversity is greater in zones with scallop cultivation than in zones without cultivation and differs with depth in cultivated and un-cultivated areas.

- **METHODS**
  - Pre-sampling for determining area required for sampling (in front of Parachique).
  - Two areas (with and without culture) at different depths (6 and 10m) in the same zone of Sechura Bay.
  - Using the methodology of IMARPE and supplement with transects analyzing the macrofauna.

- **EXPECTED RESULTS**
  - Multivariate analysis of the community in differente locations.
  - ABC curves of i communities (Warwick et al.)
  - Identification of key species.

- **NEEDS / LOGISTICS**
  - Fieldtrips in boat, every 3 months
  - Plastic bags, formol, taxonomic identification keys, balance
  - Bags, formol, taxonomic keys, caliper, balance

- **TIMETABLE**
  - Start in May 2013, end February 2014
PROJECT 5.2 The impact of scallop cultivation on sediment characteristics and infauna biodiversity in two depths in front of Parachique, Sechura Bay

- **PARTICIPANTS**
  - Paty Gil, Jaime Mendo, Matthias Wolff, 1 MSc

- **BACKGROUND & EXISTING DATA**
  - IMARPE, Baseline, ASC bivalve standard (methodological description)

- **AIMS**
  - Compare sediment characteristics and biodiversity between areas with and without scallop cultivation:
    - Compare number, biomass and size spectrum of species per area.
    - Determine dominant species.
  - Compare sediment characteristics:
    - Granulometry
    - DBO
    - Redox, \( \text{H}_2\text{S} \) concentration
    - Nutrients and organic material

- **SCIENTIFIC QUESTION**
  - Are there differences in the infaunal community structure in zones with cultivation when compared to zones without cultivation?
  - How do sediments differ from respective sites considering biogeochemical parameters?

- **CONNECTION TO OTHER TOPICS**
  - Project 5.1 (macrofauna)
  - Trophic modeling
  - Definition of mediation function between scallops and other functional groups.

- **HYPOTHESIS**
  - Infauna community composition is less diverse and dominated by different species in zones with scallop cultivation.
  - In zones with scallop cultivation DBO and \( \text{H}_2\text{S} \) values are higher and granulometric fractions of fine sand/mud are more pronounced.
  - In higher depths the differences between sites with and without cultivation are more pronounced.

- **METHODS (Experimental design, statistics)**
  - Pre-sampling for determining the exact areas of sampling (in front of Parachique).
  - Two areas (with and without culture) at different depths (6 and 10m) in the same zone of Sechura Bay.
  - Sampling should be conducted using the same rhythm and sampling stations as defined for project 5.1

- **EXPECTED RESULTS**
  - Multivariate analysis of the infaunal community in differente locations.
- ABC curves of infaunal communities (Warwick et al.)
- Identification of key species
- Granulometric and biogeochemical characterization of sediment

**NEEDS / LOGISTICS**
- Fieldtrips in boat, every 3 months
- Plastic bags, formol, taxonomic identification keys, balance

**TIMETABLE**
- Start in May 2013, end February 2014
Project 6: Respiration and clearance rates of *Argopecten purpuratus* in relation to organism size and location in Sechura bay

- **PARTICIPANTS**
  - MSc, Jaime Mendo, Paty Gil, Matthias Wolff

- **BACKGROUND & EXISTING DATA**
  - Growth differences have been observed in different parts of the bay by fishermen, possibly due to differing salinity and depth.
  - Previous experiments conducted by UNALM & IMARPE
  - Global reference data

- **AIMS**
  - Define respiration under variable conditions in field locations
  - Define clearance rates curves under variable conditions in field locations (requires estimation of phytoplankton cell counts, phytoplankton doubling time correction)

- **HYPOTHESIS**
  - Oxygen consumption is a function of organism size and temperature; e.g. lower consumption with increased depth due to lower T°C.
  - Clearance time is a function of plankton density and type

- **METHODS**
  - Use of respiration chambers (see Mendo et al. 2011) using three different sizes of organisms (40, 60, 80 mm) in 2 locations (Parachique and Vichayo) at 2 depths (6 & 10 m). 2 seasonal experiments (winter and summer).
  - 1 hr closed system; Sampling done initially and at end. Oxygen concentration and T°C measured continually with HOBO data logger (5 min. intervals). Multiple replicates can be conducted through opening and closing of chamber.
  - Statistical analyses
    - Exponential depletion model comparison on oxygen consumption and clearance rate. An analysis of the residual sum of squares (ARSS) (Ratkowsky, 1983). The F-statistic can be calculated as described in Chen et al. (1992).

- **CONNECTIONS TO OTHER TOPICS**
  - Growout studies in different areas of Sechura bay
  - Physical CC – clearance rate and respiration rate could be incorporated into GIS layers
  - Initial productive carrying capacity calculations following the methodology of Dame and Prins (1997) which incorporates clearance time, water residence time (based on currents etc.), and phytoplankton turnover time.
• EXPECTED RESULTS
  o Respiration and clearance rates for different organism sizes, locations, depths and seasons (possible daily cycle)
  o Define survival time under conditions of anoxia
  o Approximation of energy budget based on growth, mortality, respiration, and ingestion.

• TIMETABLE
  o August and February – 2 weeks of experiments.

• COSTS
  o Phytoplankton cell counts (UNALM, MPI?) (ca. $20 / sample)
  o Habitation and food costs for 30 days
  o Boat trip costs (x20)
  o Respiration chambers, water pump
Project 7. Environmental stress thresholds for *Argopecten purpuratus*

- **PARTICIPANTS**
  - BA / MSc?

- **BACKGROUND & EXISTING DATA**
  - Evidence of effects to growth and mortality rates under conditions of variable culture densities (Mendo et al.)
  - Differences in growth characteristics in different regions of Sechura bay – e.g. as a function of depth, proximity to river input etc.
  - Mass mortalities have occurred in several years possibly either due to ENSO (i.e. salinity, T°C) and during several summers (possibly due to low O2 conditions)

- **AIMS**
  - Determine stress thresholds of *Argopecten* with regard to the factors Temperature, Salinity and Oxygen

- **HYPOTHESIS**
  - Extreme mortality events are a result of extreme abiotic conditions outside the environmental tolerance range of *A. purpuratus*.

- **METHODS**
  - Experimental design
    - Experiments of oxygen consumption and behavioral changes will be monitored using the respiration chambers designed by the ZMT. Variable combinations of salinity and temperature will be used to observe the rates of oxygen consumption and the occurrence of behaviors indicative of respirative stress (e.g. gaping, clapping)
    - More aggressive experiments to measure mortality under prolonged conditions of stress?
  - Análisis estadístico
    - 3-way factorial ANOVA (O2, salinity, T°C)
    - Multiple regression (stress behaviour ~ T°C + O2 + Salinity)

- **CONNECTIONS TO OTHER TOPICS**
  - Physical carrying capacity – results will help define spatial limits of suitable culture areas in the bay using information on °T and O2 limits.
  - Physical carrying capacity (GIS): The GIS analysis of cultivated areas shall provide an environmental envelope for suitable areas; outside this envelope, environmental conditions in the bay may be critical surpassing tolerance ranges for the scallop as demonstrated by the laboratory stress experiments.

- **EXPECTED RESULTS**
  - Determination of tolerance levels for oxygen
  - Determination of stress levels under different combinations of oxygen, temperature and salinity
PARTICIPANTS (to be defined; Jorge Tam)

• BACKGROUND & EXISTING DATA
  o ROMS modeling / OMZ project (IMARPE – J. Tam, D. Gutierrez)
  o Focused surveys (2012)

• AIMS
  o Describe larger scale oceanographic conditions that lead to periods of low O2 in Sechura Bay.

• HYPOTHESIS
  o Low O2 conditions often occur in summer months when waters are warmer and are of lower saturation capacity. Lower winds in summer may also prevent the oxygenation of waters via mixing.

• METHODS (Experimental design, statistics)
  o Review of historical data as to presence of low oxygen conditions and periods of scallop mortalities.
  o Monitoring of O2 conditions using data loggers in several locations of interest in the bay.
  o Statistical exploration of links between large scale oceanographic dynamics and O2 concentrations at monitoring locations - Empirical Orthogonal Function Analysis [EOF/PCA] combined with Canonical Correlation Analysis [CCA] or other multivariate models (Redundancy analysis [RA], Generalized Additive Model [GAM])

• CONNECTIONS TO OTHER TOPICS
  o Ecosystem modeling

• EXPECTED RESULTS
  o Possible early warning system for presence of low O2 conditions.
  o Optimal management scenarios under variable conditio