AGRICULTURAL RESEARCH FOUNDATION
FINAL REPORT
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TITLE: Do Oregon's marine reserves provide fishery benefits through the export of fish larvae?

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COOPERATORS: (if any) Port Orford fishermen, Tom Calvanese

SUMMARY: Understanding dispersal pathways for newly born larval fish, and in particular how that movement relates to Oregon's new set of marine reserves, is key to understanding whether the reserves will serve as a source population that provides benefit to adjacent fisheries as well as provide sufficient recruitment to maintain populations inside of the reserves.

OBJECTIVES: The goal with this work is to track potential dispersal paths of rockfish larvae born within the RRMR. My working hypothesis is that wintertime larval transport will be northward and of relatively short distance, but we don't know exactly how this process will reveal itself regarding distance and rate of dispersal from the RRMR. This work will be the first step towards solving that mystery. Specific objectives are to: (1) track the maturation status of rockfish during the winter larval release period in order to establish proper timing to study larval movement, (2) deploy Surface Velocity Profile (SVP) drifters (described below) at the RRMR during the time of peak larval release so that they are located in the same ocean currents in which the larvae are located, and (3) track these drifters during the approximate 90-150 day pelagic (free-floating) larval period.

PROCEDURES: The RRMR is the best location for this work for biological, logistical, and collaborative reasons: Cape Blanco, just north of the RRMR, is a potential barrier to dispersal, we already have active research projects in the RRMR, and marine research enjoys support among many in the Port Orford community. This work was is being pursued in conjunction with local community groups and resource managers, including ODFW, the Port Orford Ocean Resources Team (POORT), and the RRMR Community Team, all of which have identified larval dispersal as a research question of primary interest. The ODFW and POORT will be unofficial cooperators for this work, providing some in-kind contributions to support logistics. Because PI Heppell is already collaborating with ODFW on active RRMR projects, we have direct communication with the ODFW Marine Reserves planning team and through them will document our work on Oregonocean.info, Oregon's clearinghouse for marine science and policy information.

As part of ongoing work at the RRMR we will be sampling female black rockfish on a weekly basis during the winter. Black rockfish are the most commonly caught bottom fish on the Oregon coast and therefore are the most appropriate species on which to base this dispersal work. Reproductive stage will be determined for each female sampled. When 50% of the fish in a weekly sample have females with larvae that are ready to be released, we will use that as our marker that parturition ("birthing") season has begun and we will start tracking larval dispersal.

We will use Pacific Gyre™ Surface Velocity Profile (SVP) drifters for this work. A drifter is a device that allows us to track ocean surface currents. Each drifter consists of a 30cm diameter hard plastic surface float that contains a battery pack, a Global Positioning System (GPS) unit, and a Globalstar® satellite phone. This is attached by a 10 meter long stainless steel cable to an 8 meter long, 1 meter diameter

drogue –basically a wind sock that hangs down in the water column and is pushed along by the current. The GPS unit acquires a position on a predetermined schedule (like once per hour) and the phone subsequently sends a text message that contains position information to the Pacific Gyre™ website, where I can download the data. In this way we can track the path of a drifter, with a high degree of accuracy because of the GPS unit, from the point of release to the end point of the study several weeks later, without having to do anything more on the water than the initial drifter release. There is no other way to generate such detailed data.

Three SVP drifters will be released simultaneously in the RRMR (likely on or around February 1st, 2014 based on data from previous years). Each drifter will be released in a different depth zone on the north side of the RRMR (Figure 1), one at a depth of 20 meters and the others at 40 meters and 60 meters, respectively. Each drifter will report its position 24 times per day, ensuring resolution fine enough to define the larval dispersal space. Because we will have accurate position information we may even be able to recover drifters in the event that they run aground, and will have the ability to redeploy them at the RRMR should that happen. The drifters will be tracked for approximately four months, which is the period of time that elapses between birth and when they transition from their free-floating, pelagic phase to their benthic (bottom dwelling) phase, a process called settlement.

While it should be acknowledged that drifters are not fish larvae, they do give us our best estimate of potential dispersal distance from a specific location. By incorporating drifter data specific to the area in question, we will be able to verify and improve the current mathematical ocean circulation models to specifically reflect processes occurring in the near-coast waters of the RRMR in Oregon.

Figure 1: The Redfish Rocks Marine Reserve and Marine Protected Area, with planned release sites (blue dots) for drifter release at the 20m, 40m, and 60m isobaths. Three drifters (one in each location) will be released during the peak wintertime black rockfish larval release period, as described in the field methods.

While the drifters are active (February to June) I will create a live-action website that will allow the public to follow the drifters in real time. This website will be modeled on a similar website that we used for related drifter work in the Caribbean (Figure 2). That website, sponsored by Disney, the Lenfest Oceans Program, the Cayman Islands Government, and OSU, was extremely popular, especially with kids, and definitely contributed to increasing ocean literacy among the general population. In addition to having real-time mapping of the drifters, the website will have sections on the significance of our work, descriptions of how the drifters and models function, and provide links to other relevant information about Oregon's coastal ocean (such as Oregonocean.info). Viewers will be able to predict where they think a drifter will end up, with a small prize (OSU baseball cap or similar) being awarded to each individual who picks a point closest to the actual 150-day endpoint of each of the three drifters.

SIGNIFICANT ACCOMPLISHMENTS: We succeeded in releasing drifters on eight different dates between the beginning of March and the middle of May. This is in part significant because we only had funds to purchase three drifters. The reason we were able to accomplish this feat is because the oceanographic circulatory patterns were such that our drifters kept running aground and we were able to recover them and conduct additional work.

Most significantly, throughout our drifter releases we found that drifters remained at large for from 3-13 days before running aground (with one drifter leaving the system), and they traveled from 3 to 131 km before doing that. Furthermore, there is a positive correlation between when the drifter is released

and how long it stays adrift, although there is no relationship between time of drifter release and total distance traveled (Figure 2).

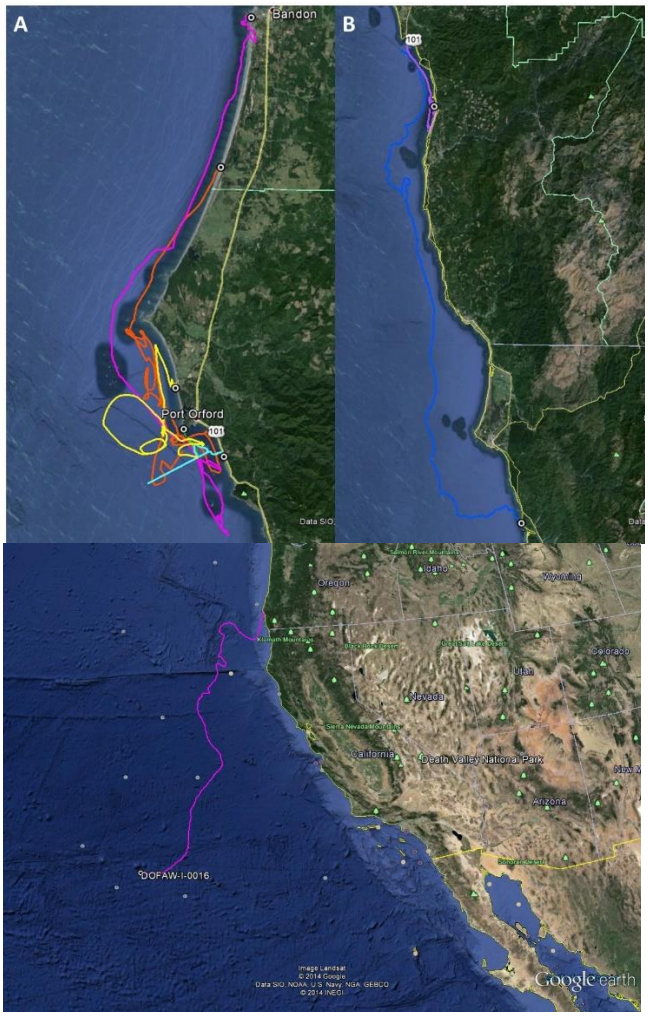

Figure 1 –Drifter paths for (A) five drifters that traveled north and (B) two drifters that traveled south from their release point at the Redfish Rocks Marine Reserve adjacent to Port Orford, OR. An eighth drifter traveled southwest and left the system (lower panel). Drifters were serially released between March 1 and May 15 2014. Drogues were set at 15m depth. All seven drifters shown beached within 13 days of release.

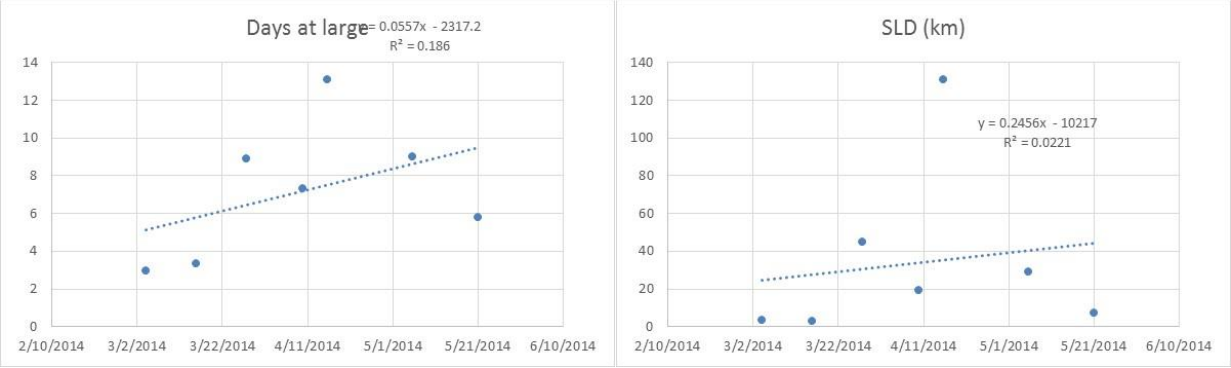

Figure 2: The relationship between days at large (upper panel) and total straight line distance (SDL, lower panel) traveled by drifters released from the Redfish Rocks Marine Reserve from March-May 2015. If the outlier from mid-April is excluded both relationships remain the same.

BENEFITS & IMPACT: This work demonstrates that fish recruitment processes are likely local, which is of interest to the Oregon Department of Fish and Wildlife Marine Reserves Team. An additional major benefit/impact is that this work was conducted in collaboration with local fishermen was conducted through the new research facility in Port Orford, which Oregon State University has committed to supporting. This work would not have been possible without the cooperation of local fishermen, and has worked to develop a collaborative relationship that should prove beneficial in the future. Furthermore, as this was the first project to operate through the new research facility we have demonstrated that OSU's support of this facility is beneficial to our being able to conduct research along the coast of Oregon.

With regard to outreach and the popular press, this work will be featured as part of Oregon Public Broadcasting's Oregon Field Guide show, to be aired on February 19th at 8:30PM.

In conclusion, based on these initial results, it would appear that (1) larvae may not disperse very far from where they are born in Oregon's nearshore environment, (2) the previous work on ocean circulation done further offshore cannot be used to extrapolate to nearshore processes, and (3) there is likely to be some seeding effect to nearby areas from populations of fish within Oregon's new network of Marine Reserves, supporting the idea that Oregon's marine reserves have the potential to provide fishery benefits. We anticipate using the results of this work to fund a larger program further investigating ocean circulation patterns in the nearshore environment to understand how populations may be connected along the Oregon coast.

ADDITIONAL FUNDING RECEIVED: None

FUTURE FUNDING: A pre-proposal will be submitted to the Oregon Sea Grant College Program during this upcoming competition