EVOS ANNUAL PROJECT REPORT

Project Number: G-040635

Project Title: Trophic dynamics of intertidal soft-sediment communities: interaction between top-down and bottom-up processes

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Time Period Covered by Report: 1-September 2005 to 1 September 2006

Date of Report: 25 September 2006

1. Work Performed: Our overall hypothesis is that the distribution, abundance and production of benthic invertebrates residing in intertidal sediments of the Copper River Delta are controlled by a combination of top-down (predators) and bottom-up (nutrient and primary production) processes. To evaluate the central predictions of this hypothesis, a comprehensive sampling program was adopted to address four objectives. Objectives are designed under a multi-year project that leverages EVOS-GEM funding with funds provided by the Prince William Sound Oil Spill Recovery Institute (OSRI). At the time of this report, much of the 2006 lab work is ongoing. In this report, we highlight those activities completed in 2005 and in the spring of 2006.

Objective 1: *Characterize the spatial abundance of macrobenthic species inhabiting intertidal sediments within the Copper River Delta and Orca Inlet, Southeast Prince William Sound.*

Objective 1 of the project is funded primarily from EVOS-GEM. Core sampling (10-cm diameter) for invertebrates was conducted in September 2005 and April 2006. Areas sampled included low, mid-and high-tide plots near the outflows of Eyak River and Pete Dahl Slough, and low, mid, upper mid and high tide plots at Hartney Bay. All 90 core samples from September 2005, have been sorted, with all marine invertebrates identified, measured, and enumerated. The April 2006 samples are currently being processed. Despite its low diversity (4 species account for the majority of animals and 1 species, Macoma balthica, account for >80% of the biomass), mudflats of the Copper River Delta support high densities of Macoma clams (~4,000 clams/m2; Fig. 1), amphipods, and polychaetes that serve as prey for numerous species of migratory and resident species. Diversity of benthic invertebrates is significantly higher within mudflats of Orca Inlet compared to the Copper River Delta. This higher diversity likely results from the more saline conditions within Orca Inlet and the lower frequency of ice scour. Biomass and density estimates of the dominant infaunal benthic invertebrates (*Macoma balthica* and *Mya arenaria)* are relatively stable over the 5 years of benthic data collection.

Glenn Miller, a Ph.D. candidate at Dauphin Island Sea Lab and the University of South Alabama, came to Cordova from 24 April - 16 May and 7 - 28 June 2006 to perform a set of top-down predator experiments. At the end of April, Miller installed 1.2 x 1.2m cages constructed of PVC and plastic mesh at Hartney Bay and at Pete Dahl Slough. Cages were arranged in blocks with the following treatments: total predator exclusion, bird exclusion only, partial cage, and control (open). Six blocks were at each location. Cores were taken for benthic invertebrates, sediment grain size, and total carbon at both sites during installation, 2 weeks later, and in mid-June when the experiment ended. Cores from this experiment are being processed at the Dauphin Island Sea Lab.

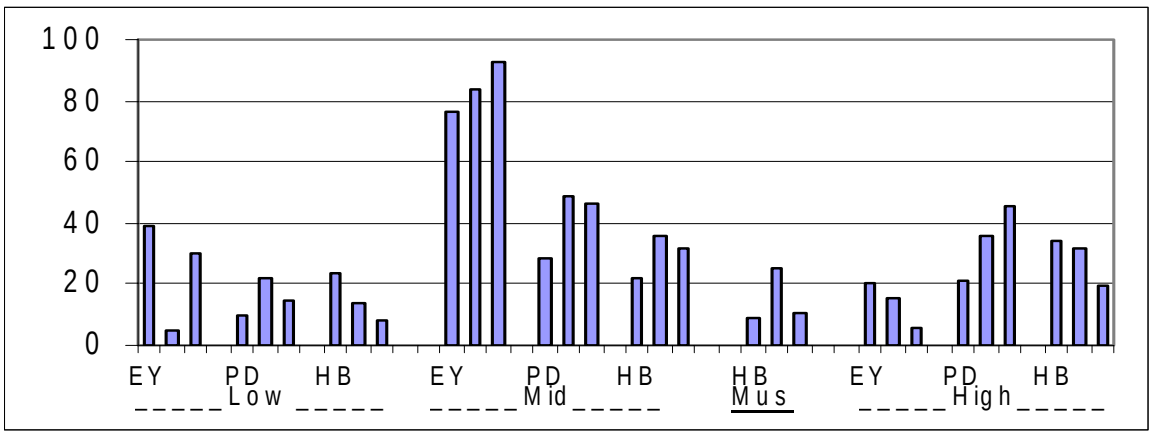

Fig. 1. Average number of *Macoma balthica* per 10 cm diameter core by area (Ey=Eyak, PD=Pete Dahl, and HB= Hartney Bay), tidal elevation (low, mid, mussel – HB only, and high), and plot (n = 3 replicates/plot).

Objective 2: Determine and quantify those factors that best serve as predictors for primary production in the overlying water and within the sediments of tidal flat communities.

In October 2005, we completed the third year of oceanographic observations for the inside waters of the Copper River Delta. For 2005 and 2006, from March to October, in conjunction with our monthly fish trawls, we conducted a series of conductivity-temperature-depth (CTD) profiles and fluorescence at 11 sites in the major channels of the western Copper River delta and close to our benthic invertebrate core sampling areas. As of 1 September 2006, all the 2005 casts and the 2006 March through July casts have been processed, and are being analyzed. Salinity data has been entered in GIS format for 2005. The CTD data document the temporal and spatial influence of the Copper River's freshwater discharge on the intertidal waters and on adjacent water masses (Gulf of Alaska and Prince William Sound). Surface (Fig. 2) and bottom water salinities throughout the Delta and Orca Inlet are significantly reduced during the summer in response to the large input of freshwater from the Copper River Delta. At the Delta sites, lowest salinity values for both surface and bottom were recorded during July 2005, as compared to August in 2004.

We analyzed all nutrients and chlorophyll *a* samples from monthly samples obtained from 2005 and through August 2006. The Copper River is a major source of nitrate to the Delta ecosystem as well as a source of nitrates to the Gulf of Alaska through exchanges between Egg Island and Pete Dahl channels (Fig. 3). Phosphate concentrations appear to be influenced by both oceanic and riverine sources.

Objective 3. Characterize the spatial and temporal abundance of demersal and avian consumers and assess the role of epibenthic predation on recruitment of intertidal macroinvertebrates.

In an effort to document the abundance and distribution of demersal fish and crabs we conducted replicate otter trawl surveys every 3 weeks around our study areas for a total of 8 trawl surveys between March and October 2005. The 2006 trawl surveys began in April and will be finished in October. All animals caught in trawls were identified and measured for TL (total length) and weighed. Distinct spatial variation (Fig. 4) are evident in the demersal fish and crab distributions: CPUE is highest near the outflows of Pete Dahl and Eyak River. A strong spatial pattern repeated in all four trawl years (2002-

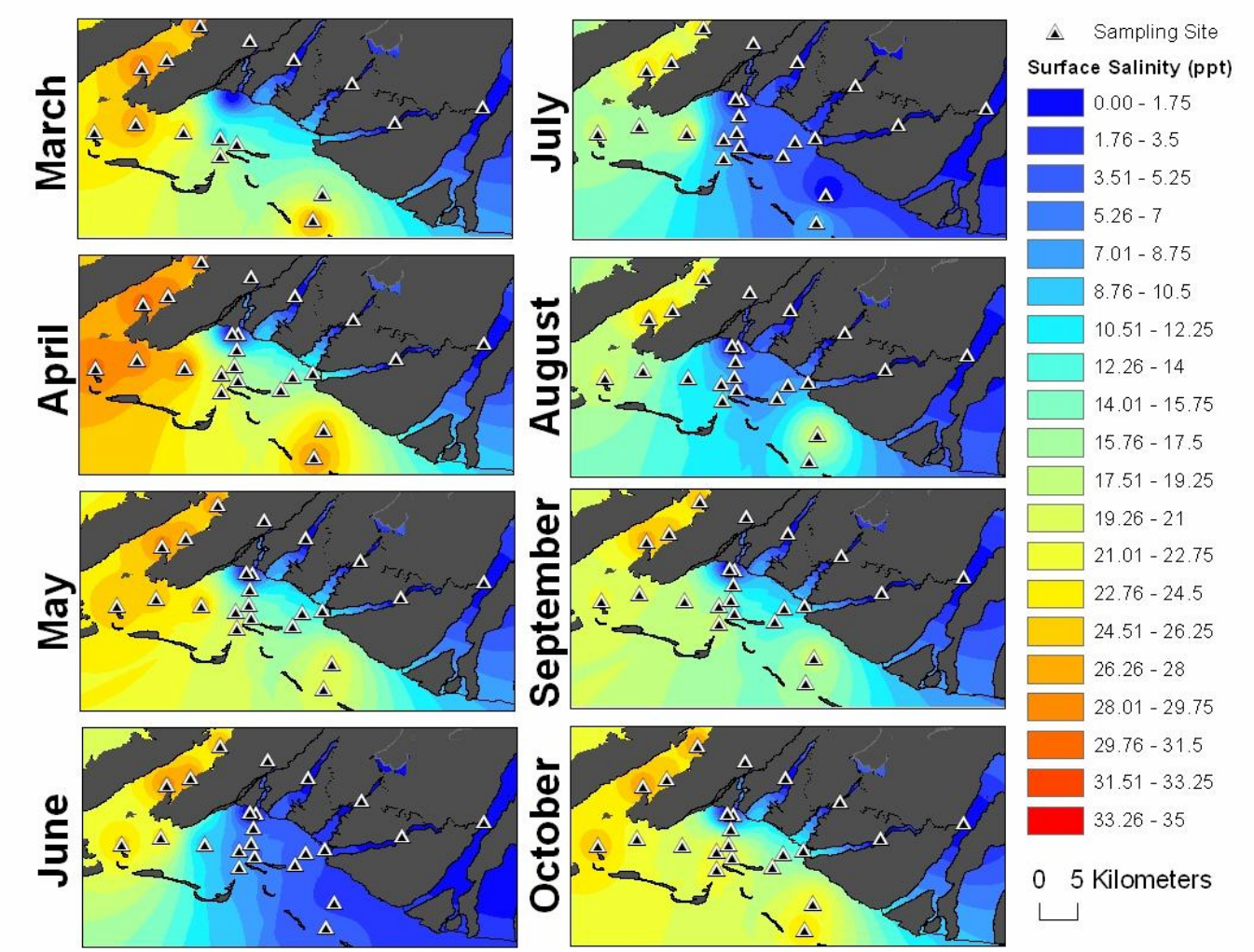

Fig. 2. Interpolated surface salinity maps by month, March – October 2005, for the Copper River Delta study area. Note the large influence of the Copper River outflow (river at far-right in images) during June and July, the period of peak outflow.

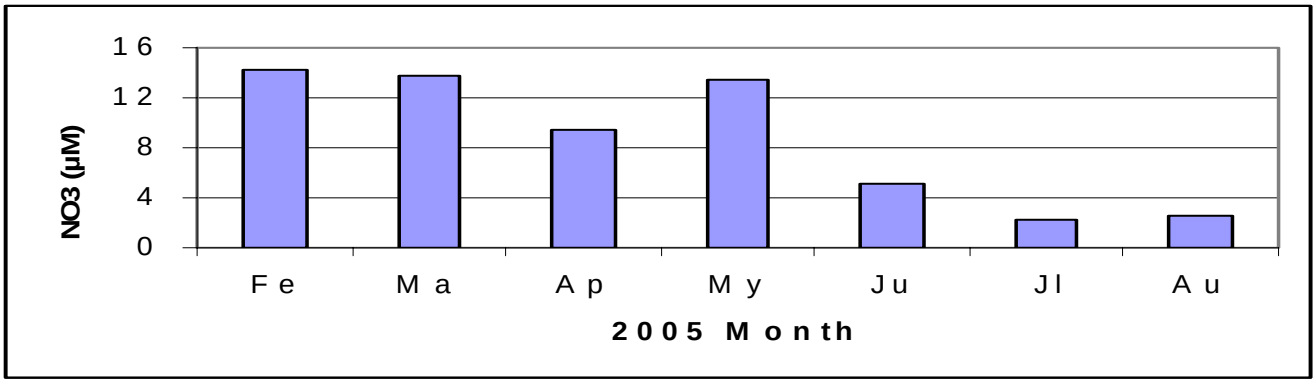

Fig. 3. Average monthly nitrate (NO_3) concentration (µM) in the Copper River. February – August 2005 at the 26 mile bridge.

2002-2005) is the absence of Dungeness crabs west of the Seal Bar site, and the high quantities of shrimp from Seal Bar site and eastward. In an effort to learn more about fish movement patterns, we also tagged more than 360 and 507 large (>200mm) starry flounder in 2005 and through 1 September 2006, respectively. As of 1 September 2006, we had received 4 returns from commercial fishers.

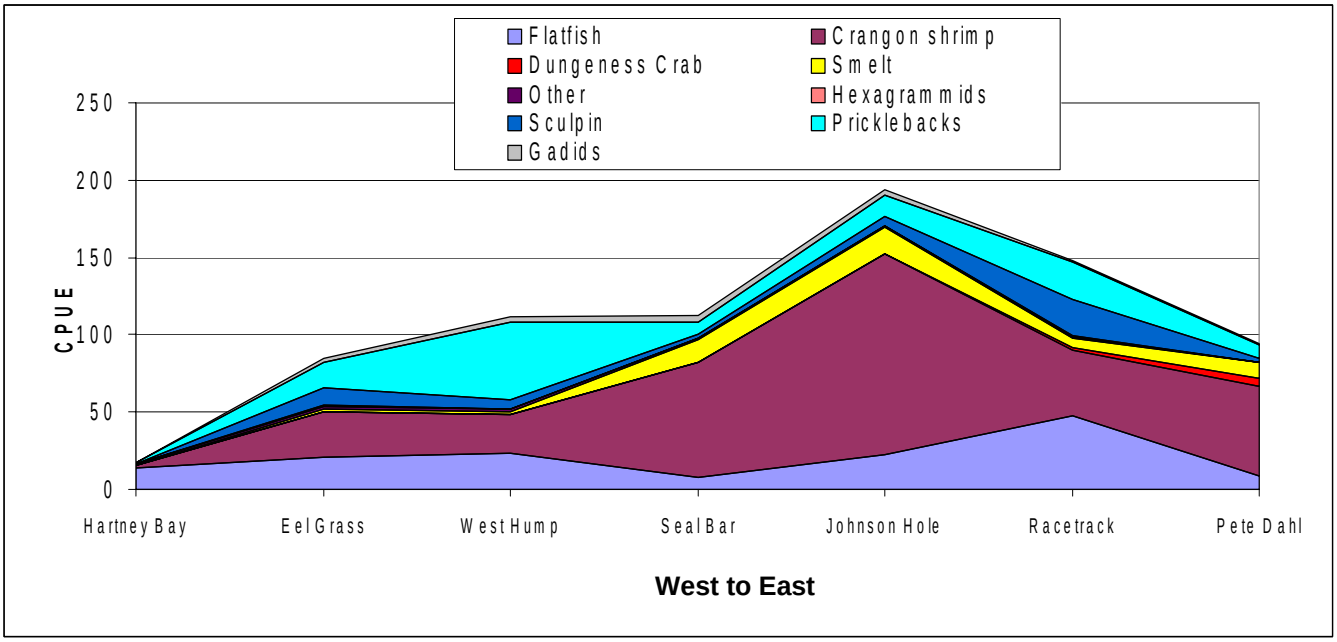

Fig. 4. Spatial changes in the demersal fish community from March to October 2005. Stations on the x-axis are arranged from west to east from Hartney Bay (Orca Inlet) to Pete Dahl (near the Copper River). Each data point represents the average catch per unit effort (CPUE) for trawls collected over all sampling dates. One of the most striking patterns is near absence of Dungeness crabs west of the Seal Bar site, and the high quantities of shrimp east of the Seal Bar site.

Objective 4. Develop a cost-effective strategy and sampling design for long-term monitoring of the intertidal sedimentary habitats.

Objective 4 requires completion of the four years of field collections according to the observation program detailed in the proposal. We will continue to evaluate future monitoring activities as data from the current OSRI/GEM program are analyzed.

2. Future Work: Field work will be completed at the end of November 2006. Lab work and data analyses will continue throughout the 2006-2007 winter.

3. Coordination/Collaboration: Describe efforts undertaken during the reporting period to achieve the coordination and collaboration provisions of the proposal, if applicable.

This study is a multi-year project that couples funding from EVOS-GEM and the Prince William Sound Oil Spill Recovery Institute (OSRI). All data will be archived by the project staff in accordance with GEM standardized procedures. Our project also complements and benefits from the North Pacific Board supported project "Estuaries as essential fish habitat for salmonids: Assessing residence time and habitat use of coho and sockeye salmon in Alaska estuaries", which is just now being completed by the principal investigators.

Our project has actively collaborated with 2 EVOS projects during this report period: Our project provided continued to logistical support, samples, and data to the GEM sponsored project G-040712 "Research for nutrient-based resource management in watersheds and estuaries". This project is being jointly conducted by Dr. Carol Woody (USGS Alaska Science Center) and Dr. Tom Kline (Prince Willam Sound Science Center). We provided fish from our monthly fish trawls and macroinvertebrate samples from our invertebrate plots. Our project also provided nutrient sample results from Orca Inlet to the GEM sponsored project G-040725 project, "Impacts of Seafood Waste Discharge in Orca Inlet, Prince William Sound. This project is being jointly conducted by Drs. Richard Thorne and Mary Anne Bishop, Prince William Sound Science Center, in cooperation with Kenwyn George, Alaska Department of Natural Resources.

Our project began collaborative efforts with the Alaska Department of Fish & Game, Invasive Species Program, in July 2005. We have been collecting data on any and all invasive species collected during this project and provide it to the program. In particular, we have been monitoring for the presence of green crab (*Carcinus maenas*), and Mitten Crab (*Eriocheir sinensis*). In July 2006, Bishop met with Bob Piorkowski, Invasive Species Program Coordinator for ADFG. Piorkowski accompanied the Science Center crew on 2 days of the monthly bottom trawl sampling.

4. Community Involvement/TEK & Resource Management Applications: Describe efforts undertaken during the reporting period to achieve the community involvement/TEK and resource management application provisions of the proposal, if applicable.

Because of the extensive knowledge of local fishers and the historic knowledge of native Alaskans, an interactive exchange with local fishermen is of great benefit to the project. Direct input to the project is provided through public presentations (see below) as well as direct fishermen involvement on the project including returns of tagged fish and chartering our field work with local fishers. In September 2005, over 20 high school students from the communities of Tatitlek, Chenega Bay, Valdez, Cordova, Whittier and McCarthy came to Cordova for a weekend to learn about our research as part of the Youth Area Watch. In July 2006 Bishop was a workshop instructor for the Copper River Barrier Island Ecology Workshop. The workshop was sponsored by the US Forest Service and the Prince William Sound Science Center's Environmental Education program. Ten people, including 6 from the local community attended the 2-day workshop that included an overnight at Egg Island. This course was offered through the University of Alaska Anchorage, and teachers that attended this workshop received credit.

5. Information Transfer: List (a) publications produced during the reporting period, (b) conference and workshop presentations and attendance during the reporting period, and (c) data and/or information products developed during the reporting period.

(a) Publications:

Powers, S.P., M.A. Bishop, J. Grabowski and C.H. Peterson. 2006. Distribution of the invasive bivalve Mya arenaria L. on intertidal flats of southcentral Alaska. Journal Sea Research 55:207-216.

Powers, S.P., M.A. Bishop, S. Moffitt, and G.H. Reeves. 2006. Variability in freshwater, estuarine and marine residence of sockeye salmon (*Oncorhynchus nerka*) within the Copper and Bering River Deltas, Alaska. American Fisheries Society Symposium 53: *In press*.

Kline, T.K., C.A. Woody, M.A. Bishop, S.P. Powers, E.E. Knudsen. 2006. Preliminary assessment of marine-derived nutrients in the Copper River Delta, Alaska using stable isotope analysis. American Fisheries Society Symposium 53: *In press*.

2005 Technical Reports

S.P. Powers, M.A. Bishop and E. Clesceri. 2005. Characterization of energy and potential contaminant pathways in subarctic estuarine habitats: ecology of tidalflat communities of Copper River Delta, Alaska. Final Report to Prince William Sound Regional Citizen Advisory Council. 25pp.

(b) Public Outreach Activities

PRESENTATIONS & POSTERS

- September 2005. Poster. The effect of riverine discharge on the distribution of marine & estuarine fishes and crabs of the Copper River Delta, AK. M. Powers, S. Powers & M Bishop. American Fisheries Society 135th annual meeting. Anchorage Alaska.
- September 2005. Poster. Estuaries as essential fish habitat for salmon: assessing estuarine residence time and habitat use of coho and sockeye. Powers, Reeves, and Bishop. American Fisheries Society 135th annual meeting. Anchorage Alaska.
- September 2005. Presentation. Ecology of the Copper River Delta. Bishop & Powers. Given by Bishop for Youth Area Watch, for their Cordova field visit.
- December 2005. Presentation. Fall shorebird migration at the Copper River Delta's Barrier Islands. Bishop and Gates. Alaska Shorebird Group Annual Meeting. Anchorage, Alaska.
- January 2006. Poster. Ecology of the nearshore areas of the Copper River Delta. Bishop and Powers. Marine Science in Alaska, 2006 Symposium. Anchorage, Alaska.
- January 2006. Poster. Utilization of estuarine habitat by sockeye and coho salmon on the Copper River Delta, Alaska. Powers, Bishop, and Reeves. Marine Science in Alaska, 2006 Symposium. Anchorage, Alaska.
- January 2006. Poster. Preliminary assessment of marine-derived nutrients in the Copper River Delta, Alaska using stable isotope analyses. Kline, Woody, Bishop, Powers, Reeves, and Knudsen. Marine Science in Alaska, 2006 Symposium. Anchorage, Alaska.

- February 2006. Poster. Utilization of estuarine habitat by sockeye and coho salmon on the Copper River Delta, Alaska. Powers, Bishop, and Reeves. Native Village of Eyak Copper River Fisheries Meeting. Cordova, Alaska.
- Feb 2006. Poster. Southbound Migration of juvenile shorebirds on barrier islands of the Copper River Delta, Alaska. Bishop and Gates. Alaska Bird Conference. Juneau, Alaska & Shorebird Science in the Western Hemisphere. Boulder, Colorado.
- March 2006. Poster. Utilization of estuarine habitat by sockeye and coho salmon on the Copper River Delta, Alaska. Powers, Bishop, and Reeves. Copper River Salmon Workshop II. Anchorage, Alaska.
- May 2006. Presentation. Ecology of the Copper River Delta. Bishop. Denali Foundation. Cordova, Alaska.
- June 2006. Presentation. The Copper River Delta, Its Shorebirds and the 1964 Earthquake. Bishop. Cook Inlet Historical Society. Anchorage, Alaska.
- July 2006. Presentation. The Ecology of the Copper River delta and its barrier islands. Bishop. Barrier Island Ecology Workshop. Cordova, Alaska.

WORKSHOPS ATTENDED

- March 2006. Copper River Salmon workshop II. Anchorage, Alaska. (Bishop).
- April 2006. EVOS - *Clupea pallasi* Herring Workshop. Anchorage, Alaska (Bishop).
- July 2006. Barrier Island Ecology Workshop. Cordova, Alaska (Bishop).

6. Budget: Explain any differences and/or problems between actual and budgeted expenditures, including any substantial changes in the allocation of funds among line items on the budget form. Also provide any new information regarding matching funds or funds from non-EVOS sources for the project. [**PLEASE NOTE:** Any request for an increased or supplemental budget must be submitted as a new proposal that will be subject to the standard process of proposal submittal, technical review, and Trustee Council approval.]

For FY06 Prince William Sound Oil Spill Recovery Institute (OSRI) provided $75,000, down $25,000 from the originally budgeted $100,000. The Prince William Sound Science Center provided oceanographic equipment.

Report Prepared By: **Drs. Mary Anne Bishop & Sean Powers**
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