Assessing Social-Ecological Indicators in California State Agency Monitoring Programs

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Abstract

Social-ecological frameworks are a dynamic and conceptualized tool used to monitor the health of a community and its surrounding ecosystem. Programs that follow these frameworks consider human *and* ecological health, and implement monitoring and restoration programs to inform environmental management decisions. Additionally, social-ecological indicators provide timely insight on how management decisions impact communities and ecosystems, allowing management entities to respond and adapt appropriately. Our research analyzes opportunities to enhance California state monitoring and restoration programs by evaluating the social-ecological indicators currently being used in state programs. Social-ecological indicator implementation provides an improved understanding for environmental and community health. We identified 331 indicators within published monitoring plans, projects, reports, and initiatives to understand their geographic and intentional extent. Overall, our analysis demonstrates that across 38 agencies, 12 programs utilized social-ecological indicators. These indicators, whether social, ecological, or social-ecological, provided insight for the monitoring programs already in place, and the possibility to expand social-ecological indicator implementation across all management entities. We see a strong trend toward ecological data collection as it relates to human health as opposed to social indicator data relating to cultural, spirituality, or social health. Future directions include the addition of an economic indicator and creating some shared language between California state agencies for cohesive monitoring across programs.

Background

Social-ecological systems (SES) are complex networks that encompass species, ecosystem interactions with humans, management styles, and governance structures.[1] The interaction between humans and ecosystems creates challenges that add to the complexity of making informed environmental management decisions. In order to identify reasons for the dwindling health of a species or overall ecosystems, agency programs will typically monitor ecological indicators that provide information about the overall health of an ecosystem and its species, but not necessarily what human actions impact the ecosystem's well-being. Current monitoring programs less frequently apply social indicators despite the fact they provide valuable insight supplementing ecological indicator data. This calls for a larger scope of scientific knowledge to improve our understanding of social-ecological system connectivity. Presently, top-down environmental management decisions do not necessarily provide the most benefit for communities and related ecosystems.[1] Applying social-ecological indicators provides insight as to what interactions cause specific outcomes across ecosystems and communities, leading to more precise and impactful management adaptations.

Most environmental monitoring programs measure only ecological health indicators such as species abundance, water quality, and water temperature. Though monitoring ecological indicators can provide insight into larger trends and patterns about the health of an ecosystem, concentrating only on ecological data overlooks the opportunity to analyze how human behavior influences, and is influenced by, ecosystem health. Social indicators also identify trends and patterns pertaining to human health and behavior; however, focusing only on social indicators may fail to distinguish ecological drivers that

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[1] Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. *Science*, *325*(5939), 419–422. https://doi.org/10.1126/science.1172133

impact overall human health. There are several limitations that may prevent the addition of social science considerations into ecological monitoring and management. Complex systems such as the Sacramento San-Joaquin Delta lack social science integration into ecological management strategies due to the limited funding, the lack of a network of social scientists, capacity, and long term vision.[2] Combining social and ecological monitoring can provide an overall insightful and holistic approach to environmental management that benefits human health, livelihoods, and the environment. Social-ecological monitoring programs are not a relatively new concept, however, they are new in practice. Programs that measure both social and ecological indicators can identify how management decisions are impacting both human and ecosystem health, and identify if any additional measures should be taken.

Monitoring programs with social-ecological indicators measure both qualitative and quantitative data to inform integrative decisions. Both forms of empirical data can contribute to the understanding of uniform management practices that will allow for state agencies and outside researchers to compare data results across a complex scope of locations. Quantitative examples can include measurements such as number of species present, and the accumulation of toxins in fish. Ecological indicators measure things such as water quality and species abundance, which demonstrates important larger trends about the health of an ecosystem.[3] A social indicator provides insight to the health of a community, which can demonstrate a community's vulnerability to ecosystem drivers such as climate change and access to ecosystem services.[3] A social-ecological indicator incorporates a measurement that accounts for both a social and ecological component. Some examples of social-ecological indicators include 1) Number of beach days closed (social) due to sewage, biotoxins or pollution (ecological), 2) Vulnerability indicators (social) for climate change (ecological) such as sea level rise adaptation for ecosystems and communities, and 3) repetitive losses of buildings (social) due to flood events (ecological).

Rationale

Several benefits arise from implementing social-ecological indicators.[4] Examples of social indicator integration can include analytical studies of how many individuals are using ecosystem services that are prone to flooding, and how to implement management strategies for the safety of those individuals and the ecosystem.[2] Social-ecological indicators inform management entities to thoughtfully integrate measures based on ecological and social factors in tandem, heightening the positive effects of management decisions on multiple levels. Using social-ecological indicators provides context for a cause-and-effect relationship that societal actions have on both an ecosystem and the community. This cause-and-effect relationship is typically referred to as the DPSIR framework.[5] Generally, there are delays between a specific activity and a resultant environmental impact. If social-ecological indicators can be created thoughtfully, they can inform management decisions to halt, continue, or alter certain actions. Furthermore, ecosystem complexity complicates the prediction of ecological and social outcomes.[4] This

[2] Biedenweg, K., Sanchirico, J. N., & Doremus, H. (n.d.)., et al. *A social science strategy for the Sacramento-san joaquin delta - california*. Retrieved May 27, 2022, from https://deltacouncil.ca.gov/pdf/science-program/delta-social-science-task-force/2020-04-07-task-force-final-report.pdf
[3] Tam, J. C., Fay, G., & Link, J. S. (2019). Better together: The uses of ecological and socio-economic indicators with end-to-end models in marine ecosystem based management. *Frontiers in Marine Science*, *6*. https://doi.org/10.3389/fmars.2019.00560
[4] Azar, C., Holmberg, J., & Lindgren, K. (1996). Socio-ecological indicators for Sustainability. *Ecological Economics*, *18*(2), 89–112. https://doi.org/10.1016/0921-8009(96)00028-6
[5] Levin, P. S., Breslow, S. J., Harvey, C. J., Norman, K. C., Poe, M. R., Williams, G. D., & Plummer, M. L. (2016). Conceptualization of social-ecological systems of the California Current: An Examination of interdisciplinary science supporting ecosystem-based management. *Coastal Management*, *44*(5), 397–408. https://doi.org/10.1080/08920753.2016.1208036

complication identifies strengths within clearly identifying and utilizing social-ecological indicators. If an entity is monitoring indicators closely, as a defined task of their project it becomes easier to foresee, conceptualize, and fathom potential outcomes of their projects and programs.

Implementing effective social-ecological indicators is difficult due to the lack of data surrounding the effectiveness of significant indicators and how to implement them. Recent analysis of 2000 social ocean and coastal management indicators along the Pacific West Coast are limited in their ability to assess social equity and justice.[6] Resource access is defined as "the ability to benefit from nature and natural resources".[6] Self-determination is defined as "the ability for individuals and communities to shape their own lives and adapt to circumstances, here broadly connoting agency, free will, and autonomy, [...] indigenous sovereignty and participation in decision-making". Of the 2000 indicators, 19 were chosen as top indicators, and only 6 had enough data on the topic and region.[6] Of 36 self-determination indicators, only 6 had available data for the topic and region. These studies contextualize the need for additional social-ecological indicator integration, especially as it relates to social and environmental justice issues.

Our analysis provides a preliminary baseline of California State agency programs using social, ecological, and social-ecological indicators. Additionally our analysis provides recommendations and opportunities for social-ecological integration across California state agencies.

Methods

Frameworks

We utilized two main frameworks that incorporated both social and ecological indicators to inform a comprehensive database compilation.[6] We tailored these frameworks to specifically encompass coastal and estuarine regions. The tailoring process included adapting the initial indicator type definition to embody coastal California's ecological and social characteristics. Moreover, we tailored frameworks to engage with coastal ecosystems and densely populated communities along California's coast even though these attributes were not initially belted by the chosen frameworks. The framework derived from the Leong paper proposed several indicators such as cultural significance, and human health and well-being. The McManus paper presented both social and ecological classifications with which indicators could be classified. The Breslow paper provided a systematic review of how to choose indicators.

We created the database using the DPSIR framework. DPSIR depicts a Driver-Pressure-State-Impact-Response data collection methodology. An example often used for the DPSIR framework is whale watching.[7] Whales provide food for larger predators, rely on smaller invertebrates, and are impacted by the variability of habitat. Whales also battle dangerous ship speeds and harmful noise levels. The whale watching industry combines a culturally significant mammal with economic vitality. The DPSIR framework demonstrates that any change in this cause-and-effect chain can cause significant impacts to the habitat, and therefore reduce the whale population, further reducing the

[6] Breslow, S. J., Allen, M., Holstein, D., Sojka, B., Barnea, et al.(2017). Evaluating indicators of human well-being for ecosystem-based management. *Ecosystem Health and Sustainability*, *3*(12), 1–18. https://doi.org/10.1080/20964129.2017.1411767

[7] Levin, P. S., Breslow, S. J., Harvey, C. J., Norman, K. C., Poe, M. R., Williams, G. D., & Plummer, M. L. (2016). Conceptualization of social-ecological systems of the California Current: An Examination of interdisciplinary science supporting ecosystem-based management. *Coastal Management*, *44*(5), 397–408. https://doi.org/10.1080/08920753.2016.1208036

economic vitality and cultural significance. With the DPSIR framework in mind, monitoring entities can identify issues within a community and its surrounding ecosystem faster than relying on social and ecological indicators separately.[4]

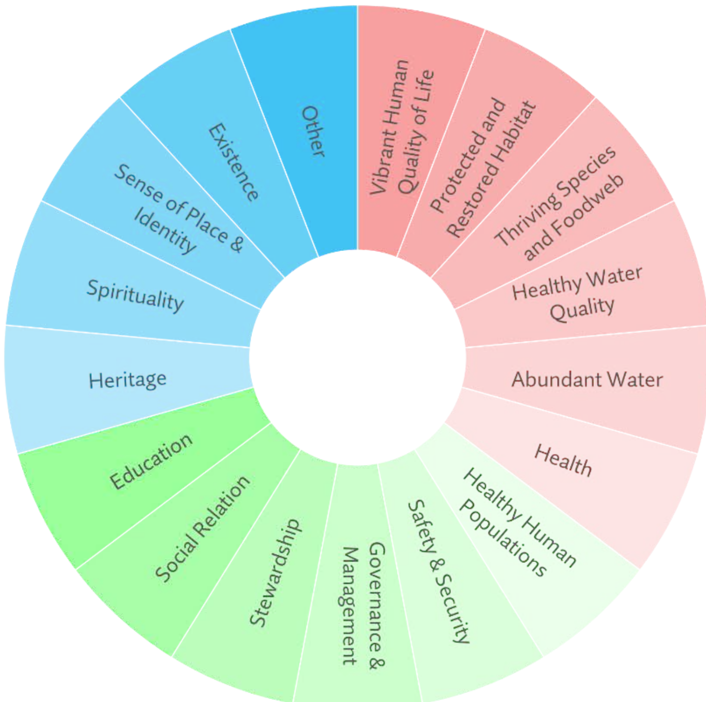

Figure 1: Domains organized by characteristics. Red variations represent environmental and natural resources, green variations represent human and societal management; blue variations represent cultural experiences

The database incorporates the DPSIR framework, where the driver of an ecological change is listed, an indicator to monitor and measure, and the social-ecological impact of measuring the indicator. The database contains specific links to fact sheets and reports and to the websites where reports were found. The database briefly mentions the social-ecological impact of monitoring indicators, the research method, and where the indicator has been applied.

Initial agency list and monitoring programs

We generated a list of California state agencies that focus on natural resource management and environmental regulation as well as their subsequent departments, conservancies, boards, and commissions. Then, we searched each agency website for monitoring programs specific to coastal and estuarine ecosystems. Though a website scraper searching for keywords would have been helpful to find monitoring programs and indicators used, the difference in language and terminology between programs and agencies burdened our ability to adequately find all programs. It is likely we were unable to find every monitoring program from each agency due to the high volume of extensive monitoring reports. The programs in the database clearly demonstrated definable social, ecological, or social-ecological indicators that were utilized as integrated measures. This initial search improved our understanding of which California state agencies involved in natural resource management currently utilize indicators and which agencies could improve indicator integration.

Categorization of indicators

We first classified indicators as social, ecological, or social-ecological. Then, we used “domains”, pulled from the Leong and McManus papers, to further categorize indicators (Figure 1). We classified an ecological indicator as an indicator that focused only on ecological measurements that fit under domains such as “Protected and Restored Habitat” and “Thriving Species and Food Web.” Indicators that fall under these domains could be habitat types and water temperature. We classified a social indicator measuring social metrics that fit under domains such as Safety and Security, and Health. Social indicator examples are unemployment rates and average commute time. Social-ecological indicators combined both of these measurements. Some examples of social-ecological indicators are annual acres burned from wildfires and waterway recreation. We developed a domain codebook further defining domains to ensure uniform indicator classification amongst our team. The codebook and domain definition page includes explanations of each indicator domain and examples so that researchers can crosscheck classification of their indicators before logging them into the database. Reports, publications, and factsheets varied widely in the data publically available, as well as definitions used for their indicator measurements. When we added information to the database, we utilized a binary approach; the indicators fit under a domain, and if they fit in two or more domains, they were temporarily placed in the Other domain for determination at a later date.

Database development

The database consists of several data sheet pages, all in support of the main data sheet titled *Indicator Database*. The metadata sheet was created to detail the purpose of the database, common terminologies used within the database, and descriptions of each alternative datasheet. The *Column Code Book* sheet provides detailed explanations of each column within the main *Indicator Database*. The indicator and definitions codebook sheet is a table that provides the references used for the database framework, and a large table containing the domains, examples that can fall under those domains, and specific indicators that are categorized under the domains. The main *Indicator Database* sheet catalogs social, ecological, and social-ecological indicators across various California state agency programs. With a focus on coastal and estuarine regions, we've found ~331 indicators across ~20 agencies. An important column to note within the indicator database is the Complete/Incomplete/or Partial column in which a 'Y' is selected if the researcher found information completeness, 'N' was selected if information was deemed incomplete, and 'Partial' was selected if the researcher estimated the indicator information to be incomplete. The level of completeness is directly correlated with the extent to which the researcher was able to fill out the indicator information across all database columns. This is important to note for database users who wish to explore indicators with information completeness *only,* or for researchers who wish to interview respective agencies for more information. The *Breakdown of State Agencie*s sheet details the number of monitoring programs or initiatives that we found to include use of indicators within each department, conservancy, board, and commission. The contact list sheet was generated for future use. For step by step instructions on data entry, please refer to the appendix on page 24 of this report.

Prior to adding to the database, every researcher must thoroughly understand the meaning behind each Indicator Database column, to which the meaning of these columns can be found within the *Column Code Book* page of the database. The column definitions were extensively chosen to ensure the information pulled from agency documents was accurately and uniformly added into the database across all researchers. Overall, collaborators on this database may utilize a range of searching mechanisms to find monitoring programs and indicators but the information going into the database must be fully conceptualized and cataloged in a homogeneous manner.

After finishing the data entry process, we created a quality assurance-quality control (QA/QC) procedure to ensure consistency, cohesiveness, and clarity throughout the database. We checked the database for the following:

- Syntax: ensuring all data entries followed the same syntax, such as ("social-ecological" as opposed to "socio-ecological") for sorting purposes.
- Cohesiveness: updated column titles to clarify data collection methodology and input, and ensured the same language was used throughout the database.
- Notation: enlisted dashes (-) or "unavailable" to indicate whether data was not available because we were unable to find it, but it may exist (represented by a dash -), or if the data was unavailable because the report specifically said it was unavailable (represented by 'unavailable').
- Domain Placement: ensured that team members were in agreement about using consistent and uniform conceptualization to classify indicators under the various domains.

We QA/QCed the database to increase the integrity of the information collected, to enable future researchers to clearly see examples provided, and inform the future directions section of this paper.

Considerations: Methods

Out of 331 total indicators that were either social, ecological, or social-ecological in nature, 7 indicators fit into more than one domain. Some domain definitions were generally broad enough to encompass the same indicator, and unless the report explicitly stated the motivations behind measuring a specific indicator, we had to speculate the domain of best fit. For example, an indicator can fit into multiple domains, if an indicator contributes to both safety and security and also a healthy human population.

If indicators fit into multiple domains, then either the domains are large and inclusive enough or there is not enough detail for the motivation or data behind the indicator measurement to determine the exact domain. This can be seen as a strength, since the goal is to have more incorporation of considerations of both social and ecological measurements, it's highly likely that an indicator that fits in both domains is likely meeting that goal. Additionally, strict domain definitions can possibly exclude some indicators all together, and then placed in the "Other" category for sorting at a later date. However, if an indicator is placed in the "Other" category, there is no guarantee that it can be placed in any of the other domains due to their current definitions. Stricter definitions would only exacerbate this.

Results, Interpretation, and Discussion

Living Database: Results Disclaimer

We performed analysis on the dataset to determine preliminary results. Results exemplify the data *collected up to this point*. As noted previously, the database will change and grow as the assessment moves forward. Therefore, it is important to keep in mind that these numbers do not fully represent the spatial and temporal breadth of California state agencies. Accuracy and precision increases with more data collected, however we are excited to present our initial findings here.

Note: See section 'Indicator Definitions and Codebook' within the database for a list of definitions and conceptualization.[8]

[8] Database Link: Social-Ecological Ecosystems Management

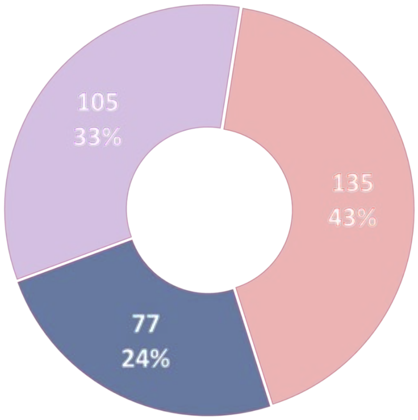

Figure 2: We categorized 317 indicators ecological (pink), social(blue), and social-ecological (purple)

Agencies

In total, we assessed 36 agencies of which 27 agencies had social, ecological, or social-ecological monitoring programs (Table 1).[9] Of the agencies, we found 38 monitoring programs to assess These programs varied in their degree of implementation, including those that are in progress (35 programs), those that are yet to be implemented (3 programs), and which are no longer running (10 programs).

Programs

We found 6 monitoring programs were exclusively social, 19 were entirely ecological, and 13 were either social and ecological or social-ecological (Table 1). In addition, 16 programs had exclusively quantitative indicators, 15 had only qualitative indicators, and 7 programs had a combination of qualitative and quantitative indicators (Figure 1).

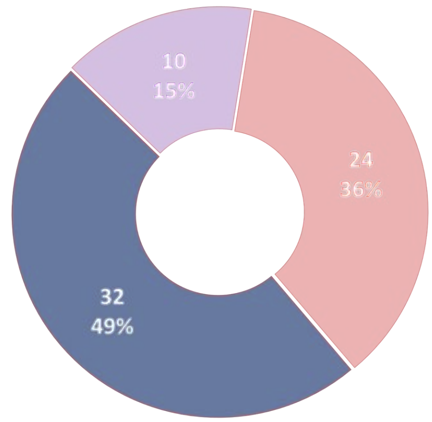

Figure 3: San-Joaquin Delta Conservancy represents the program with the largest number of indicators (66).

The program with the most indicators is the Sacramento-San Joaquin Delta Conservancy, as detailed in Figure 3. The San Joaquin Delta Conservancy's Ecosystem Restoration-Ecosystem Viability Program contained more than 8 times the average number of indicators per program (66 indicators vs 8.6 on average in the database). These indicators broke down to a higher level of social indicators as well (49% compared to 30% in the total database). These numbers are displayed in full in Table 5 of the Results section.

Indicators

Across these 38 programs, there are a total of 147 ecological indicators, 99 social indicators, and 85 social-ecological indicators (331 total). Of 331 indiators, 66 of these indicators are qualitative, 231 are quantitative, and 24 are both (301 total) (Table 1). The Sacramento-San Joaquin Delta Conservancy's Ecosystem Restoration-Ecosystem Viability Program contained the highest number of indicators with 66 indicators found.

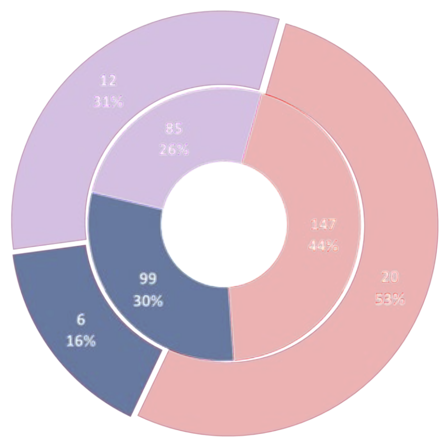

Figure 4: California programs (outer ring) portray a similar break down to ecological, social, and social-ecological as indicators (inner ring).

[9] Definitions for the terms used in the results can be found in the methods and background section of this paper.

Table 1: Indicator Type	Number of Indicators	Percentage of Total Indicators	Number Programs	Percentage of Total Programs
Ecological	147	44%	19	50%
Social	99	30%.	6	16%
Social-Ecological	85	26%	13	34%
Totals	331	100%	38	100%
Quantitative	231	71%	16	42%
Qualitative	66	22%	7	18%
Both	24	6%	15	40%
Total	321			

Drivers of social, ecological, and social-ecological monitoring programs

The main drivers of the programs and indicators were related to water (e.g., water availability & drought preparedness & groundwater); natural & human hazards (e.g., related to climate change & flood risk, sea level rise, invasive species); pollutants and water quality (e.g., HABs, harmful radioactive chemicals, pesticides/herbicides, oil spills, sanitation, toxin reduction); natural resource, ecosystem, and ecosystem services conservation and protection (e.g., preserve and restore a riparian and floodplain corridor, restoration for recreation/camping, understand wildlife & habitat connections); equity; assessing impacts of use (human use, land use, consumptive & non-consumptive uses- recreation/education, watershed projects, decommissioning, offshore drilling, development, fishing, energy/nuclear power); and Traditional Ecological Knowledge.

Temporal scope of monitoring programs

Ongoing programs have been running from 1976 until 2022. The majority of these programs were created after the year 2000. Most programs were created in 2018 (8 total programs) and in 2019 (7 programs). Trends increased specifically after 2017 where no less than 3 programs were created annually. Completed programs ran between 2004 and 2022. The most programs were completed in 2021, with 3 total. There were 4 total programs that had yet to begin, all which were created in 2018 by different agencies. Although the data were sparse for the sampling frequency of monitoring programs, programs tended to sample on variable intervals, such as 4 year, annual, seasonal/quarterly, or weekly cycles.

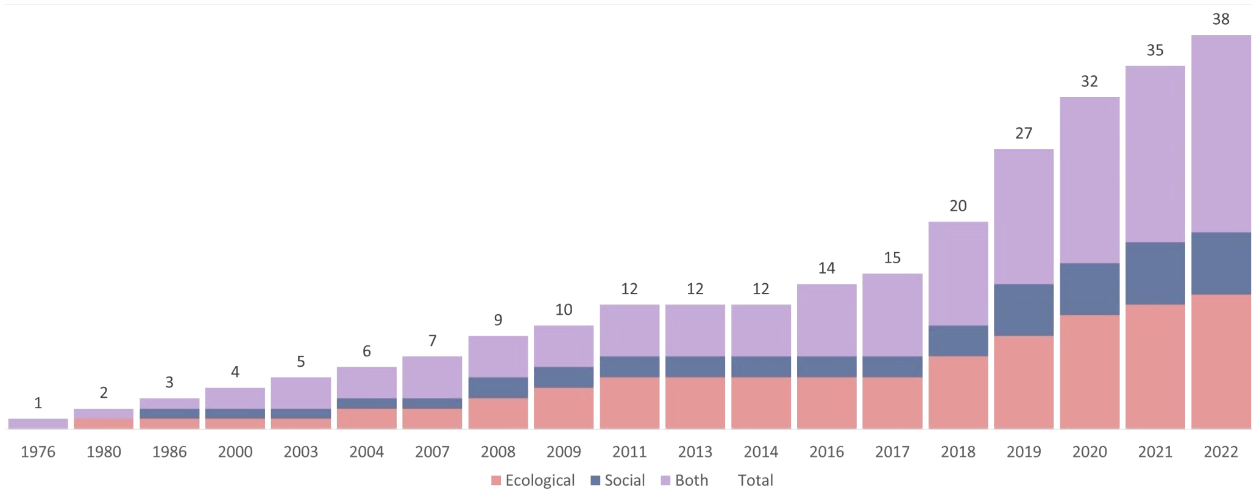

Figure 5: California programs introduced overtime. We assessed 38, which originated in 1976 through 2022.

The earliest social-ecological program was the California Coastal Commission's Local Coastal Program, which first began in 1976. California ratified Article 10 section 4 of the State Constitution protecting beach access across the state and limiting private ownership on beaches.[10] Additionally, the California Coastal Act charged the Coastal Commission to create plans with local governments delineating coastal development plans.[11] This plan led to the development of Local Coastal Programs, which facilitate the regulatory process within the coastal zone.[11] The Local Coastal Program fits under the Governance and Management domain. The only indicator being tracked was 'Permit Analysis', classified as a qualitative indicator. The social-ecological impact was stated as the following: "Many of the 76 coastal counties and cities have elected to divide their coastal zone jurisdictions into separate geographic segments, resulting in some 126 separate LCP segments. As of 2016, approximately 73% of the LCP segments have been effectively certified, representing about 87% of the geographic area of the coastal zone, and local governments are issuing coastal permits in these areas," and "The Commission retains permanent coastal permit jurisdiction over development proposed on tidelands, submerged lands, and public trust lands, and the Commission also acts on appeals from certain local government coastal permit decisions. The Commission reviews and approves any amendments to previously certified Local Coastal Programs."
California Conservation Corps' produced the next earliest program, the Salmon Restoration Program, in 1980. The program is ongoing, with all ecological indicators including quality of instream habitat, stream bank stabilization, fish passage, native riparian ecosystem, and CCC workforce development in watersheds. All indicators were qualitative.

Spatial scope of monitoring programs

Almost all programs were exercised on a statewide level. The second most common application was to the Central Valley Floodplains, followed by various coastal regions, lakes, rivers, and sloughs. Other areas where programs were exercised include the Channel Islands in Southern California, Federally Recognized

[10] *Code section group*. Codes Display Text. (n.d.). Retrieved May 26, 2022, from https://leginfo.legislature.ca.gov/faces/codes_displayText.xhtml?lawCode=CONS&division=&title=&part=&chapter=&article=X
[11] *Public Resources Code Division 20 California Coastal Act*. (n.d.). Retrieved May 27, 2022, from https://www.coastal.ca.gov/coastact-print.pdf

Tribal Lands, and forest or mountain communities. In total, over 50 different types of areas were considered amongst all the projects.

Exemplary social-ecological monitoring program: Marine Protected Area (MPA) monitoring program (California Department of Fish and Wildlife)

The state-wide Marine Protected Area (MPA) monitoring program, administered by the California Department of Fish and Wildlife (CDFW), is a program that integrates social and ecological indicators exceptionally well. CDFW's regional marine protected area program organizes relevant MPA monitoring documents regionally, pursuant to the Marine Life Protection Act.[12] CDFW works collaboratively with other state agencies such as the Ocean Protection Council and the Coastal Commission to conduct research illustrating how an MPA impacts marine environments.[12] We highlight the MPA monitoring program as an exemplary program due to their clear language, readily available report information, and condensed formatting. In addition, the Marine Monitoring Program uses regional scopes to inform its monitoring practices, leading to higher data integrity through keeping the specificity associated with local reports and applying it to connected geographic areas. The newest report also included tribal consultation and traditional ecological knowledge qualitative indicators. These inclusions represent a significant progression in monitoring program management.

Some reports measure aspects such as species richness and how population data changes among photic zones.[13] The MPA Monitoring Program also assessed social indicators such as commercial and recreational fishing.[14] Social-ecological indicators included scientific use tracking, which was defined as "Sanctuary research permittee and Department scientific collecting permit databases will be used to track annual numbers of researchers at the islands."[15] We found 29 indicators from the MPA monitoring program, which breaks down into the following summary statistics:

Table 2: Comparing CDFW to the Average	Total Dataset		MPA Monitoring Program (CDFW)	
Ecological Indicators	135	43%	9	31%
Social Indicators	77	25%.	7	24%
Social-Ecological Indicators	105	33%	13	45%

The high comparison of social ecological integration (45% out of the total indicators found within the MPA monitoring program on the CDFW website) demonstrates one of the reasons we chose to showcase CDFW's MPA Monitoring program. As discussed more thoroughly in the overall methodology and anecdotal summary, it was rare to find a program that included social-ecological indicators fully in their monitoring.

[12] *MPA Monitoring*. CDFW. (n.d.). Retrieved May 26, 2022, from https://wildlife.ca.gov/Conservation/Marine/MPAs/Management/Monitoring#537132130-monitoring-plans-by-region

[13] See "indicator database" sheet, cell R219

[14] See "indicator database" sheet, cell R252

[15] U.S. Department of the Interior. (n.d.). *Marine Protected Areas*. National Parks Service. Retrieved May 26, 2022, from https://www.nps.gov/chis/learn/nature/marine-protected-areas.htm

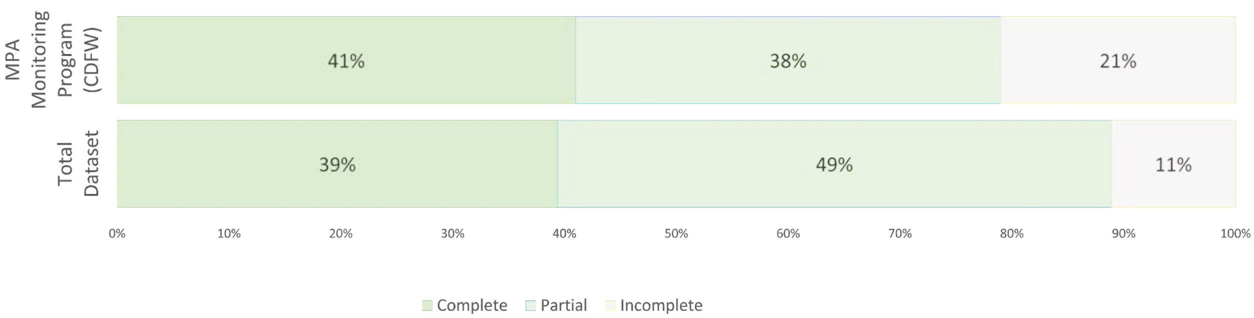

Figure 6 The MPA Monitoring Program demonstrates a similar break down of data availability to the overall average.

Additionally, we assessed the MPA monitoring program for data availability and completeness (column E in the (Figure 7).[16] The CDFW contained 41% complete (Y) and 38% partial (Partial) data completion. This indicates that we were able to find key components of our database within the information available online. Overall the dataset's scores of 39% , and 49% (respectively) indicate a similar breakdown of data/information availability. Combining partial completeness and completeness (partial + yes), the CDFW monitoring reports provided adequate information to fuel our study 79% of the time, compared to 88% of the time on average. This is a highly successful program with regards to detailing indicator motivations, indicator types, defining indicators, providing time-frame or project duration, and detailing how the indicator is socially integrated.

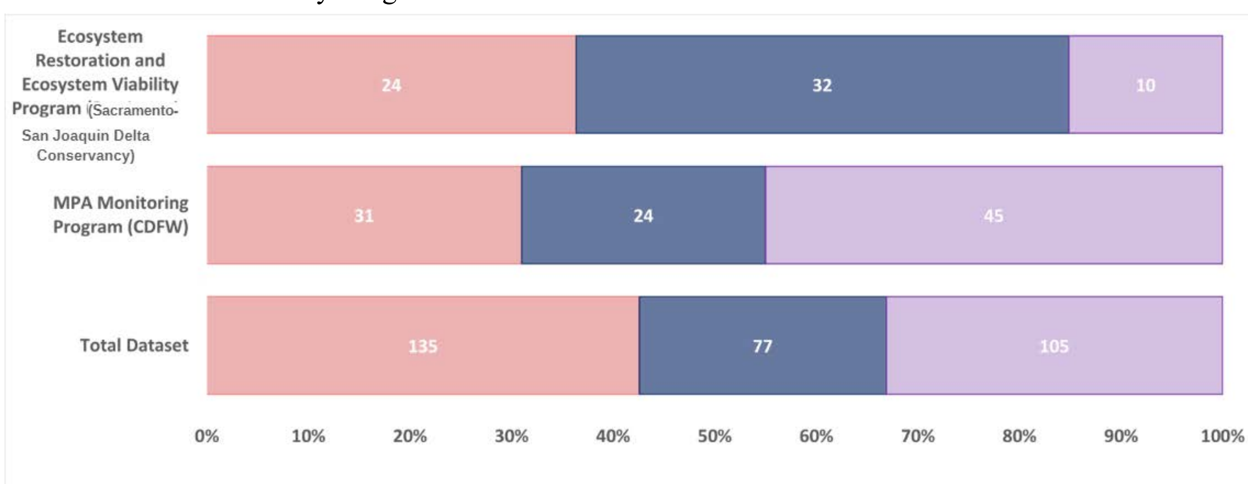

Figure 7: The MPA Monitoring Program demonstrates a similar breakdown of indicator types compared to the total dataset, while the Ecosystem Restoration and Ecosystem Viability Program shows more social indicator than the average.

[16] Database Link: Social-Ecological Ecosystems Management

Types of Indicators and Domains

The 16 domains, tabulated below, represent how we categorized indicators in the database (Leong et al., 2019, McManus et al., 2020). The number of indicators refers to how many indicators were originally sorted into this domain, a simple count. "Number of repeated indicators'" shows how many indicators were repeated within the domain, i.e. "water quality" was repeated twice in the Abundant Water domain due to the fact these indicators came from different agencies, programs, or reports. The final column in Table 3 looks to control for the double-indicators.

Due to a simple count in the database, we found 331 indicators. However, 238 were unique, or not repeated, throughout the database. While 238 may be a "unique" count, it is hard to say whether this result comes from purely unique, or different, indicator monitoring; more likely than not, the programs use different terminology to refer to similar indicators. We discuss this finding further in the "recommendations" section.

We found that most indicators fell within the Protected and Restored Habitat (36), Safety and Security (27), and Governance and Management (22) domains. In addition, our "Other" category, which housed indicators that could possibly fit into three or more domains, or were otherwise unable to sort, was in the top three domains with the most indicators (26). The average number of indicators per domain is 14.24. While the domain with the most indicators is more than triple the average, it is important to note that sense of Place and Identity (1), Existence (2), and Spirituality (4) all had less than 5 indicators each. These numbers may further skew the data, and it would be interesting to see how the assessment changes if the results only looked at programs with social-ecological, social, or ecological indicators. At this time, we did not feel it was accurate to break down the agencies as solely "social", "ecological", or "social-ecological" due to the sample size thus far. Our data collection strategies did not screen programs, and more data is needed to fully assess agencies and programs at this level.

Table 3: Indicator type sorted by domain	Number of Indicators	Number of Repeated Indicators	Number of Unique Indicators
Protected and Restored Habitat	36	1	35
Safety and Security	27	0	27
Other	26	0	26
Governance and Management	22	1	21
Vibrant Human Quality of Life	19	0	19
Abundant Water	18	2	18
HealthyWater Quality	16	0	16
Thriving Species and Foodweb	15	0	15
Healthy Human Populations	13	0	13
Health	11	0	11
Education	10	0	10
Heritage	9	2	7
Social Relation	7	0	7
Stewardship	6	1	5
Spirituality	4	0	4
Existence	2	0	2
Sense of Place and Identity	1	0	1
Total	481	7	238

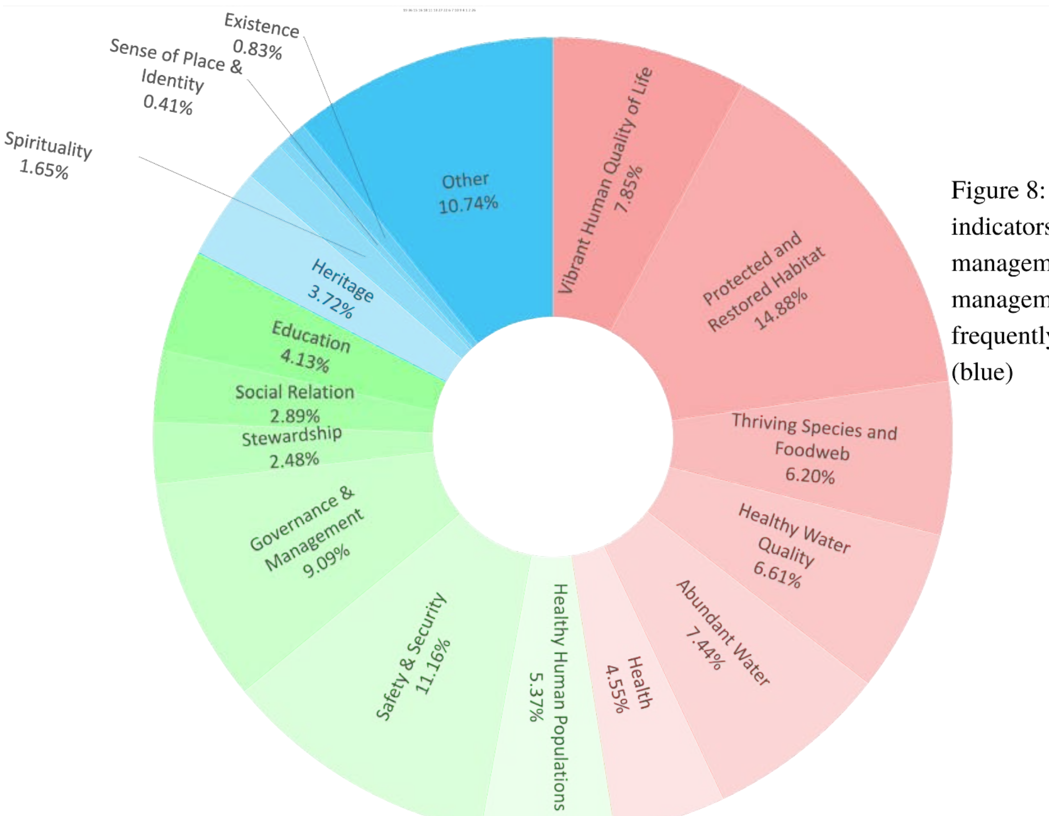

Figure 8: California agencies assess indicators categorized in resource management (red) or social management (green) domains more frequently than cultural domains (blue)

There is a strong trend towards ecological data collection as it relates to human health, as opposed to social indicator data relating to cultural, spirituality, or social health. With this result, however, it is important to keep in mind that these conclusions may be fueled more by the breakdown of our domains.

Additional Program Analysis

We analyzed the programs for the number of ecological, social, and social-ecological indicators found in each (Table 4, summary stats table 5).[17] These results provide preliminary insight into which programs look at solely ecological, social, or social-ecological indicators; and which look at a combination of the three. We were interested to see that the programs displayed a combination of indicator monitoring. Some programs, such as the UC Davis Center for Regional Change under the Delta Protection Commission only looked at social indicators; while the Climate Change Adaptations program under the California Tahoe Conservancy considered a mixture of the three. These analyses gave rise to a program-level breakdown of indicator assessment (figure 8) We see the trend of a solely-ecological focused programming making up the majority of state programs assessed. On the other hand, it seems that programs are less structured around solely monitoring social indicators. This suggests that programs include social monitoring in

Table 5: Summary Stats of Table 4	
Average number of ecological indicators per program	3.79
Average number of social indicators per program	2.5
Average number of social-ecological indicators per program	2.3
Average number of indicators found per program	8.6
Max Indicators	66
Min Indicators	1

[17] Table 4** Full Table in Appendix.

addition to other studies or reports, as opposed to it being the sole purpose of the program.

Results Discussion

Overall, our assessment illuminates the potential for increased social indicator monitoring across state programs. Social monitoring, categorized in our Cultural domain group, provides valuable insight in projecting holistic management decisions. Social indicators were the least common indicators collected in programs with all three indicators, which suggests a gap in valuable data. This gap in turn leads to possible mismanagement of natural resources, an incomplete view of human health, and an overall limited view of California's resources. Additionally, we found that state agencies are not using the same language to articulate what they are monitoring, and that they are monitoring a large variety of social, ecological, and social-ecological subjects. This makes matters complex when considering social interaction with resource management; if everyone is looking at different things, how do we make informed management decisions?

Gaps, Recommendations, and Future Directions

The results demonstrated that agencies tend to assess ecological health as it relates to human physical health rather than cultural relation. Additionally, the main geographical scope for social-ecological indicators identification were specific to coastal and estuarine locations. Due to these two focal points, the data is skewed towards assessing the presence of social and social-ecological indicators throughout the state agencies. As mentioned previously, many state agency monitoring programs are focussed on ecological indicators, but lack a presence in social-ecology, which is why this report draws attention to a generalized scope of mixed programs. Additionally, many ecologically specific programs specialized on species details that were not included in the analysis, but rather generalized with the overarching title of "species". This factor, coupled with the knowledge that human populations rely on habitats both ecologically and economically is a simple explanation for the Protected and Restored Habitats domain being the largest category.

As a general overview, even though there were underlying biases for which reports and programs were assessed, the data collected provides a good representation of common terms between agencies, and which agencies frequently use terminology with differing definitions. Furthermore, it is a foundational meta-analysis for which agencies, programs, and indicators are being monitored and reported.

During the analysis of state agencies, we encountered multiple gaps among the programs, indicators, and information that are available surrounding social-ecological concerns. Understandably, statewide agencies monitoring 163,696 square miles of diverse ecosystems lead to drawbacks, however opportunities exist to enhance collaboration for holistic ecosystem management. The database contains a map of the complex connections between California's state agencies, labeled *Breakdown of State Agencies*. This network becomes more elaborate when considering the responsibilities of each agency and collaborations between agencies. For example, the California Department of Public Health has eight separate centers, which then divide into divisions, and further broken down into branches. These centers, divisions, and branches are formed to tackle complex issues that involve collaboration among multiple sectors. This elaborate system created balanced reports, but there are still many areas that require improvement, such as the addition of social-ecological monitoring programs. The following section will provide insight to where these gaps can be easily mended, how to locate indicators, and recommendations for implementing social-ecological programs.

Gaps

The available information on monitoring indicators varied greatly within and throughout the state agencies. We encountered many barriers during the research process, such as: 1) expired or absent links to programs and reports, 2) articles in place of monitoring reports, 3) general reports with no monitoring data provided, 4) programs found with no indicators listed, 5) collaborations between agencies and no specifications on report status, 6) Degree of program/indicator implementation (in progress, completed, or plenary stages), 7) lack of similar indicator definitions, 8) variations in indicator specificities (i.e. locations and species level), 9) unquantifiable social indicators, 10) varied measurement styles (i.e. data frequency collection, methods, and time periods).

Agencies without updated report links impeded our ability to collect accurate data. Multiple programs could not be included in the database due to missing information surrounding indicators and monitoring practices. This lack of accessible or sufficient documentation led to a gap in the reported data and thus the programs that included indicators and clear definitions were not captured. We also identified inconsistencies as we inputted entries into the database. Certain columns were more difficult to enter than others, and follow up interviews will be needed to address these since there were no additional reports to which the team could refer. In addition to missing data, publications frequently left out citations or links depicting where the research came from.

The number of programs that tracked social-ecological indicators varied between agencies. Some departments analyzed key indicators surrounding a specific location, but would not apply it to a statewide program. Other programs would provide educational materials, while still others offered detailed monitoring efforts that assisted in state and national reports. For example, the California Coastal Commission provided numerous public materials surrounding marine debris, but does not actively monitor this indicator. However, they provide both public information and monitoring efforts around sea level rise. Both supply vital data to local governments, but only one is actively monitored by this agency.

Programs researching social and social-ecological indicators varied in implementation, as well as continued monitoring application. Some monitoring programs and the application of social-ecological programs were a response to state legislative policies. However we consistently found ecological monitoring programs rather than social ones. This disconnect was addressed with AB 2616, which requires an Environmental Justice component in planning strategies allowing for stakeholder input. However our research demonstrates that few social-ecological indicators are utilized with an environmental justice consideration.[18] The Central Valley Flood Protection Plan provided four potential social-ecological indicators with an environmental justice component.

We found significant gaps in the terminology used in reports, definitions of indicators, and what those agencies monitored . The lack of consistent terminology led to redundant terms across state agencies with differing definitions of what they were monitoring, indicating that they were not uniform statewide. Due

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[18] *Assembly bill no. 2616*. (n.d.). Retrieved September 24, 2016, from https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160AB2616

to inconsistent language, there are few unique indicators used across agencies. Additionally, the frequency and form of measurement lacked uniformity , and therefore leading to skewed data . Similarly, we identified gaps amongst the programs when programs would report on data, but would not supply the indicators that were monitored. This missing information causes agencies to seek out this information elsewhere, rather than providing a collaborative environment for statewide reporting.

Recommendations

We identified key areas that facilitated the database development to inform improving monitoring programs. This project has the potential to connect California's state agencies and improve the research and application of social-ecological information to mitigate climate change and facilitate social well being. It is important to note that finding and assessing indicators is a time consuming process that involves analyzing assessments, reports, factsheets, and many more forms of publications. State agencies have diverse programs that are dedicated to specific locations or species, requiring multiple forms of research. It is important to stay within each program and note which departments are partnering with one another. Analyzing the data that is provided via the database columns will allow the user to identify areas with missing data. Additionally, the Database is a key resource to refer to during follow up interviews and to provide context for the missing information.

Recommendation 1: Developing a Management Informed Priority Science Needs & Questions

Expanding monitoring programs to encompass ecological, social, and social-ecological indicators allows for a better understanding on how these systems directly relate to human health. This is important to note and should continue to be addressed by an informed management practice. First, developing a list of key stakeholders that could be involved in gathering information and questions from the public or other key resources. Second, identifying key indicators for successful implementation and progression. And thirdly, developing monitoring designs and measurements.

Determining key stakeholders is a reasonable possibility for implementation of effective social-ecological programs and indicators. State agencies already collaborate with one another and attend conferences in multiple capacities. This fluidity of communication can be improved with non-governmental organizations (NGOs) and private companies who specialize in assessments of social-ecological management. Strengthening this organizational structure streamlines monitoring, coordination, and decision making. This list of stakeholders can be built from the "Person of Contact" and "Data Source for Indicator) columns within the Database (Columns V and AD).

Identifying key indicators for successful implementation and progression is another simple possibility since multiple agencies implement monitoring programs successfully in conjunction with one another. Interviewing agencies that have experience developing similar monitoring projects can be helpful in determining key components to success. Some state agencies such as CDFW are in the plenary stages of their programs. The CA Coastal Commission currently has a program in place for monitoring and permitting coastal projects developments. The permitting program, Local Coastal Program (LCP) is longstanding. However the program does not specify the type of indicators assessed. The agency links many of their findings back to the Coastal Act for reference. In addition, CDFW currently monitors a Marine Protected Area (MPA) program assessing all indicators. Although they recently started assessing the overlap in the programs, they are establishing more social-ecological indicators within those assessments and defining how to measure them for future research.

One of the main gaps of information that was recorded was the lack of data collection and measurement methods (columns L, M, and X). Reports cited a mixer of collection methods or none at all, as well as the frequency at which data was collected. These columns are a valuable resource to inform other agencies for future research. We recommend forming a flexible monitoring design that is structured from the important questions and needs reported by stakeholders and through interviews.

Recommendation 2: Scope

As stated above, our original scope focused on assessing California state programs monitoring estuaries and coastlines. However, our findings show that many of the programs throughout the state have indicator monitoring programs in place that are not necessarily related to watershed and coastline programs. Once we broadened our scope to include a larger geographical area, we reduced the specificity of the defined indications. Reducing the specification of the indicators while assessing a larger geographic region leads to a better understanding of overall indicators throughout the state. We demonstrated this by assessing multiple programs within departments and commissions, as well as analyzing agencies that monitor across the state and not just the coast. For example, the California Energy Commission and the California Department of Public Health.

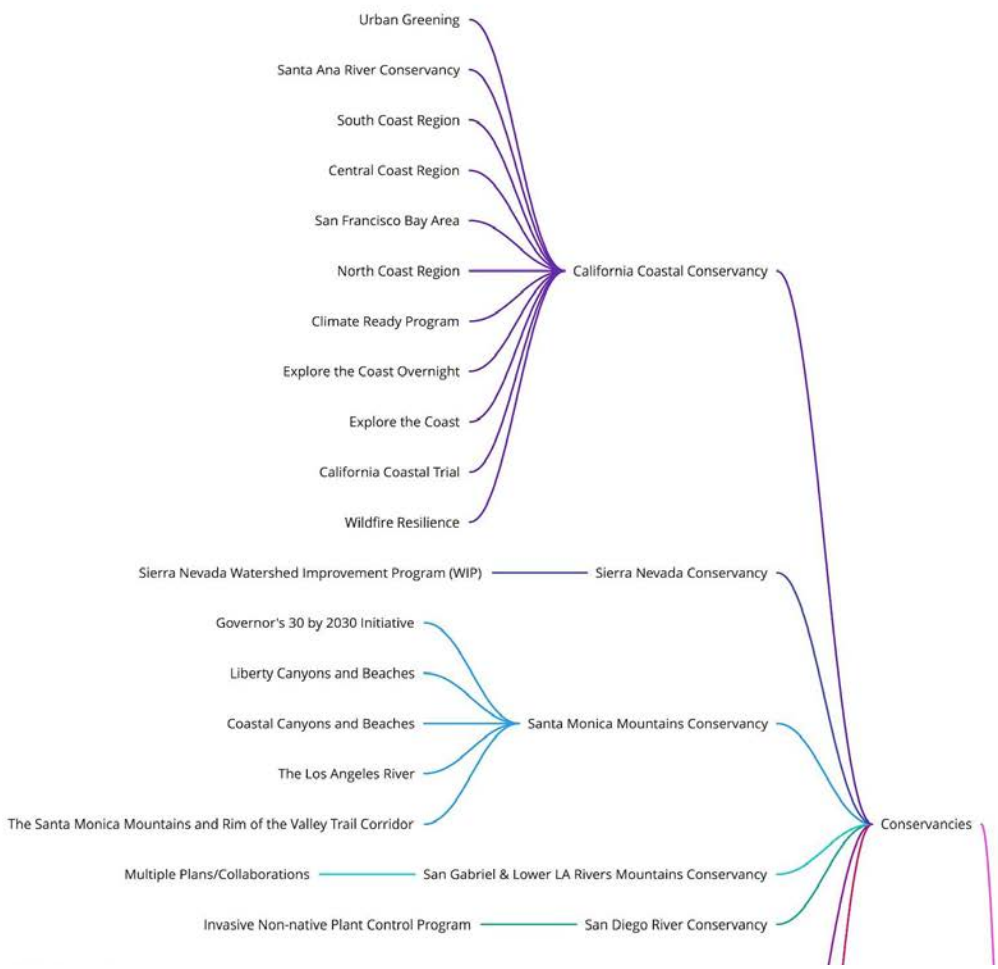
By expanding our scope, we were able to report on a generalized understanding of which agencies are considering social-ecological indicators. However, due to this large scope we were unable to assess all programs and forms of publication within the allotted time for this project. We recommend reviewing all departments, commissions, and conservancies to conduct a full data analysis of indicators and programs. We focused more on social and social-ecological programs instead of ecological programs because of the abundance of ecological monitoring programs in place. Due to this consideration, our data was biased toward social and social-ecological programs and indicators. A full assessment of all programs within an agency would provide a clear and unbiased amount of social and ecological indicators being monitored. A major consideration is gathering this mass of information and being unable to apply it since agency publications can extend as far back as their creation date. We recommend defining the scope with strict boundaries whether that involves time periods, one specific agency or a specific location.

Recommendation 3: Universal Definitions and Common Terminology

We recommend that California state agencies use the same language when adopting social-ecological programs and indicator monitoring. It is critical to document the exact definition that is used. These definitions for the specific indicator are the characteristics that direct which domain the indicator is placed into, and also provides an overview of which social-ecological indicators are frequently monitored. However, the inconsistent terminology arises when departments do not have an open channel of communication. Forming a shared document for universal definitions and common terms, agencies can minimize the confusion of what indicators are measuring and reduce the need to assign multiple domains to one indicator. In conjunction with this uniform language, it can aid in the development of identifying key indicators and monitoring designs from the streamlined process of calculating specifics from the database.

Future Directions

In continuation of this project, we have outlined a few methods to expand this project to encompass all of the valuable data gathered. These suggestions include a Tree Diagram of the state agencies and a visualization of collaboration between departments, potential agencies to assess that have the potential to be exemplary examples of social-ecological monitoring programs, conducting interviews within agencies, adding an economic flagging component, and utilizing Driver data to identify trends.



Interactive Tree Diagram

As a blueprint, we included an example of what an interactive tree diagram forCalifornia state agencies would encompass within the database. The above diagram is a section of the Interactive tree for reference.This diagram would assist in understanding the intricate branches, divisions, etc of each state agency as well as their programs. The diagram details how many programs fall under a department, commission, and conservancy and the collaborative agency working groups. The diagram could also include links embedded in the map that lead directly to the agency program website. This creates an ease of access to the management plans while also displaying the interconnected agency partnerships. Many of these programs and reports were difficult to find, and adding a level of ease can create more opportunities for successful management plans.

Potential Agencies to Assess as Exemplary Examples

Implementation of social-ecological indicators improves environmental management decisions and the impact on ecosystems and communities. Agencies looking to continue this research initially should understand the structure of the indicators and domains. Reviewing the reference materials within this document provides oversight to better understand how to identify indicators and domains. As recommended above, once agencies have a clear understanding, they must clearly define their indicators and domains. Distinctly stating definitions for each indicator ensures that it won't fall across multiple domains. In addition, there needs to be consistency among the indicators, for ease of analysis. We found that many of the state agencies used different terminology, but contained the same scope of work.

Throughout this process the we analyzed many of the state management programs, recognizing overlap between indicators with the potential for further integration. During the research process we were able to construct a running database overlooking California state agencies' use of ecological, social, and social-ecological management plans. We acknowledge this is a running document that includes recommendations as to which agencies should be further assessed. Programs to further assess were determined based on 1. Whether or not they were assessed, 2. On-going research, 3. Active participation within interagency programs, 4. High numbers of indicators found within the agency, 5. Availability of data, 6. Programs yet to be implemented with considerations for future assessments, 7. Participation in social-ecological study conferences. These agencies include: California Conservation Corps, California Department of Public Health, California Department of Fish and Wildlife, Delta Stewardship Council, Fish and Game Commission, Department of Toxic Substances Control, Central Valley Flood Protection (for future implementation), Department of Water Resources, and the Wildlife Conservation Board.

Conducting Interviews

Conducting interviews with key agencies currently using these monitoring programs can be crucial to project success, As some state agencies have long-term studies expanding over a decade. They are successfully implementing management programs that are monitoring ecological indicators, andare starting to integrate social indicators to merge the two disciplines. Reaching out to those agencies in the plenary stages allows an agency in the plenary stages to structure their programs based on the success of other programs with similar scopes. For example an agency working on coastal development permitting contacts like the California Coastal Commission.

When conducting interviews it is also beneficial to ask where to locate missing reports and publications. This data is difficult to locate, and there are inconsistencies in timeliness which can be another issue. By speaking with an agency representative, you will be able to locate missing or unavailable reports, as well as have the opportunity to question why certain data is not included. Interviews will allow you to expand the Contact List tab, and create an opportunity to ask questions on terminology and data collection methods.

Analyzing Indicator Trends

We found that the database compiled critical information and some indicators displayed trends that could be used for further categorization. This included data on the motivations behind creating indicators as well as methods for monitoring those indicators. For example, some indicators were initiated by legal obligations. Other management plans were created based on public complaints or potential funding opportunities. These motivations, or drivers, can lead to further social-economic analytic information. By answering the "why" to the complex problem at hand, organizations interested in implementing social-ecological indicators can find this information useful for management decisions. Drivers can be categorized by patterns or themes. Some suggestions include creating a "driver code book page" defining the different driver categories derived from the data. Followed by creating a column in the indicator code book that denotes which driver belongs to which category, following the driver definition. The connection between drivers and indicators can be assessed and analyzed by referring to the following questions:

I. What drives California agencies to implement social, ecological, and social-ecological indicators?
II. How many of each?
III. What drivers arose from the data collected?

Answering the previous questions can lead to opportunities for program implementation. For example, if most regulatory entities implement indicators due to a law requiring them to do so, then this would indicate a potential need for more laws to clarify the need to monitor integrated social-ecological indicators as opposed to one or the other.

Expanding Indicator Categories

We also found that within the three indicators defined: social, ecological, and social-ecological, there was an opportunity to implement an economic component. The majority of programs that included social indicators were monitoring social-economic impacts. Whether or not to include economics as a fourth indicator was discussed during our meetings with DSC/CA Sea Grant and we determined this should be considered in future studies.

Most state agencies utilized three main categories, however we noted that some federal agencies expanded to include stressors as a defined category. Aside from the three major categories, it's noted that agencies like the Environmental Protection Agency (EPA) also use subcategories to encourage a diverse selection of categories.[19] Expansion of categories to include subcategories that are all related provides supplemental evidence for estimating differences in ecosystems and any implications for management alternatives. Identifying key indicators are the initial steps to implementing successful management plans. Determining whether to expand to include subcategories should be assessed in future studies.

[19] Environmental Protection Agency. (n.d.). EPA. Retrieved May 26, 2022, from https://www.epa.gov/rps/overview-selecting-and-using-recovery-potential-indicators

Appendix

Database entry step by step:

1. Identify the agency to analyze.
2. Search the agency's website for monitoring programs, pertaining to coastal and estuarine areas.
    a. Look for keywords like sustainability, monitoring, management, etc. Agencies tend to use different terminology.
3. Monitoring programs may offer fact sheets, reports, and powerpoint presentations, but not always. If the monitoring program has little to no information, please add that information to the database so others do not waste time looking at that particular monitoring program.
4. If some type of documentation is offered, here are things to look out for when analyzing a report:
    a. ***The driver***– This should be the main motivation for the report or for a specific indicator, some examples could be floods, climate change, coastal reef depletion, air pollution, etc.
    b. The driver should be a motivating fact and should be the reason why something needs to be measured.
    c. ***The indicator-*** This what is being measured. Some examples of indicators are extreme heat events, number of repetitive losses and vector borne diseases.
    d. Define how the specific indicator is being measured. (Extreme heat events are measured by the statewide trends of extreme heat days and nights; repetitive losses are measured by the number and costs of buildings lost in flood events; vector borne diseases are measured by the number of cases of West Nile Virus in California)
    e. Classify the indicator as social, ecological, or social-ecological.
    f. ***The domain-*** Under which broad domain does the indicator fit? Reports usually go into depth about how they're measuring a specific indicator, which should provide insight as to which domain the indicator may be placed.
    g. ***Progress of the program-*** Is it yet to be carried out, in progress, or completed?
    h. ***Explanation of why or how it is an integrated measure-*** provide an explanation of why this program is needed.
    i. ***Social-ecological impact-***If the report does not define/explain this impact, make a note, and provide your educated understanding of the implications for this indicator being monitored.
    j. ***Data Source for Indicator-*** If the report has a separate link for underlying data, add that information to this column.
    k. ***Qualitative/Quantitative-*** Is the indicator quantitative or qualitative? If you can identify how this indicator is measured, this should provide an indication of quantitative or qualitative.
    l. ***Research method-*** How was the data collected? Did the researchers utilize surveys, databases, interviews, etc?
    m. ***Physical location-*** Where was the indicator measured?
    n. ***Intended location-*** Where else can this measurable indicator be applied?
    o. ***Driver for the indicator-*** This is different from the specific driver column. What requirements does it meet? (The driver could be to meet regulatory or policy requirements and you could list the specific legislation, if it applies. There can be more than one driver, please provide as many as you find.)

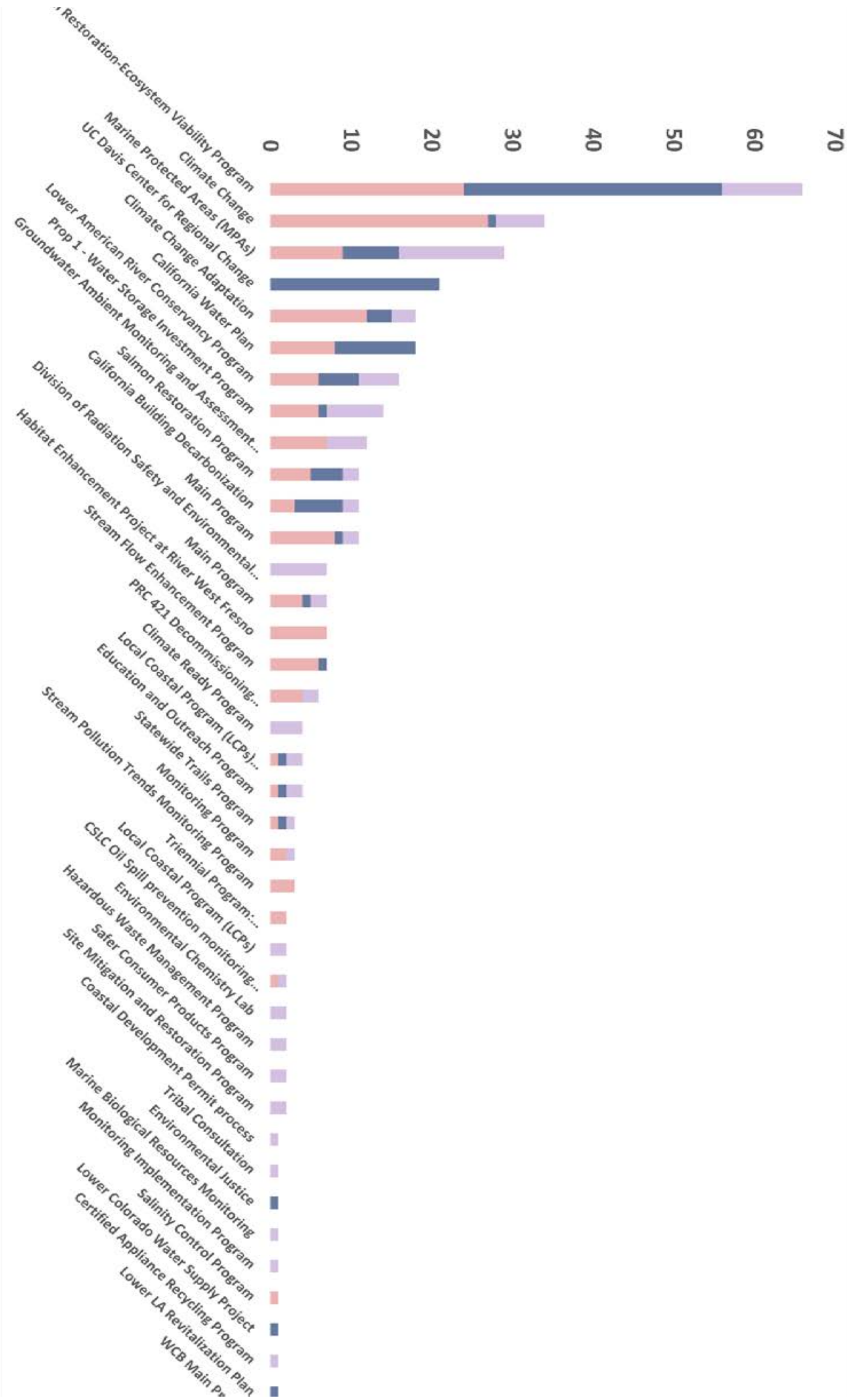
p. ***Person of contact-*** Is there a point person that could be contacted for an interview to provide further clarification, insight as to how the program was created, etc.

q. ***Info completeness-*** Were you able to find all the above information? Were you able to find information for the indicator, domain, indicator definition and driver columns? If so, a Y will suffice to indicate yes, partial means you only found information for a few columns, and N indicates no, that you couldn't find information for most columns.

Appendix 2: Full Figures

Table 4: Number Indicators Agencies & Programs		Ecological Indicators	Social Indicators	Social-Ecological Indicators	Total
California Boating and Waterway Commission	Triennial Program: Grants	2	0	0	2
California Coastal Commission	Climate Ready Program	0	0	4	4
	Local Coastal Program (LCPs) & Coastal Development Permit Process	1	1	2	4
	Local Coastal Program (LCPs)	0	0	2	2
	Coastal Development Permit process	0	0	1	1
	Tribal Consultation	0	0	1	1
	Environmental Justice	0	1	0	1
California Conservation Corps	Salmon Restoration Program	5	4	2	11
	Statewide Trails Program	1	1	1	3
California Department of Fish and Wildlife	Marine Protected Areas (MPAs)	9	7	13	29
California Department of Pesticide Regulation	Monitoring Program	2	0	1	3
California Department of Public Health	Division of Radiation Safety and Environmental Management (DRSEM)	0	0	7	7
California Energy Commission	California Building Decarbonization	3	6	2	11
California Office of Environmental Health Hazard Assembly	Climate Change	27	1	6	34
California State Lands Commission	Marine Biological Resources Monitoring	0	0	1	1
	PRC 421 Decommissioning Project	4	0	2	6
	CSLC Oil Spill prevention monitoring program	1	0	1	2
	Monitoring Implementation Program	0	0	1	1
California Tahoe Conservancy	Climate Change Adaptation	12	3	3	18
California Water Commission	Prop 1 - Water Storage Investment Program	6	1	7	14
Colorado River Board of California	Main Program	4	1	2	7
	Salinity Control Program	1	0	0	1
	Lower Colorado Water Supply Project	0	1	0	1
Delta Protection Commission	UC Davis Center for Regional Change	0	21	0	21

Department of Toxic Substances Control	Environmental Chemistry Lab	0	0	2	2
	Hazardous Waste Management Program	0	0	2	2
	Safer Consumer Products Program	0	0	2	2
	Site Mitigation and Restoration Program	0	0	2	2
	Certified Appliance Recycling Program	0	0	1	1
Department of Water Resources	California Water Plan	8	10	0	18
Sacramento San Joaquin Delta Conservancy	Ecosystem Restoration-Ecosystem Viability Program	24	32	10	66
	Education and Outreach Program	1	1	2	4
San Gabriel and Lower Los Angeles Rivers and Mountains Conservancy	Lower LA Revitalization Plan	0	1	0	1
Santa Monica Mountain Conservancy	Main Program	8	1	2	11
State Water Resources Control Board	Groundwater Ambient Monitoring and Assessment Program	7	0	5	12
	Habitat Enhancement Project at River West Fresno	7	0	0	7
	Stream Pollution Trends Monitoring Program	3	0	0	3
Wildlife Conservation Board	Lower American River Conservancy Program	6	5	5	16
	Stream Flow Enhancement Program	6	1	0	7
	WCB Main Program	0	1	0	1
Averages		3.79	2.54	2.36	8.69


0
10
20
30
40
50
60
70
Restoration-Ecosystem Viability Program
Climate Change
Marine Protected Areas (MPAs)
UC Davis Center for Regional Change
Climate Change Adaptation
California Water Plan
Lower American River Conservancy Program
Prop 1 - Water Storage Investment Program
Groundwater Ambient Monitoring and Assessment...
Salmon Restoration Program
California Building Decarbonization
Main Program
Division of Radiation Safety and Environmental...
Main Program
Habitat Enhancement Project at River West Fresno
Stream Flow Enhancement Program
PRC 421 Decommissioning...
Climate Ready Program
Local Coastal Program (LCPs)...
Education and Outreach Program
Statewide Trails Program
Monitoring Program
Stream Pollution Trends Monitoring Program
Triennial Program:...
Local Coastal Program (LCPs)
CSLC Oil Spill prevention monitoring...
Environmental Chemistry Lab
Hazardous Waste Management Program
Safer Consumer Products Program
Site Mitigation and Restoration Program
Coastal Development Permit process
Tribal Consultation
Environmental Justice
Marine Biological Resources Monitoring
Monitoring Implementation Program
Salinity Control Program
Lower Colorado Water Supply Project
Certified Appliance Recycling Program
Lower LA Revitalization Plan
WCB Main

	CA NATURAL RESOURCES AGENCY	Acronym	Assessed (Y/N)	# of programs w/ social & ecological indicators Assessed
Departments	CA Department of Conservation	DOC	N	0
	CA Department of Fish and Wildlife	CDFW	Y	1
	CA Department of Parks and Recreation	DPR	N	-
	CA Department of Water Resources	DWR	Y	1
	CA Conservation Corps	CCC	Y	2
Commissions	California Coastal Commission	CCC	Y	4
	California Energy Commission	CEC	Y	1
	California State Lands Commission	SLC	Y	4
	San Francisco Bay Conservation and Development Commission	BCDC	N	-
	Delta Protection Commission	DPC	Y	1
	Colorado River Board of California	CRB	Y	3
	Central Valley Flood Protection Board	CVFPB	N	-
	Fish and Game Commission	F&GC	N	-
	Native American Heritage Commission	NAHC	N	-
	Parks and Recreation Commission	SPRC	N	-
	State Historical Resources Commission	SHRC	N	-
	California Water Commission	-	Y	1
	California Boating and Waterways Commission	DBW	Y	1
	Wildlife Conservation Board	WCB	Y	3
Conservancies	California Tahoe Conservancy	CTC	Y	1
	Sacramento San Joaquin Delta Conservancy	SSJDC	Y	2
	San Diego River Conservancy	SDRC	N	-
	San Gabriel & Lower LA Rivers Mountains Conservancy	RMC	Y	1
	San Joaquin River Conservancy Board	SJRC	Y	1

	Santa Monica Mountains Conservancy	SMMC	Y	1
	Sierra Nevada Conservancy	SNC	N	0
	California Coastal Conservancy	SCC	Y	1

	Cal EPA	Acronym	Assessed (Y/N)	# of programs w/ social & ecological indicators Assessed
Boards/Offices	Office of Secretary		N	0
	Office of Environmental Health Hazard Assessment	OEHHA	Y	1
Departments	CA Air Resources Board	CARB	N	-
	California Department of Pesticide Regulation	CDPR	Y	1
	Dept. of Resources, Recycling and Recovery	CalRecycle	Y	-
	Department of Toxic Substances Control	DTSC	Y	5
	State Water Resources Control Board	SWRCB	Y	3
	CA Dept. of Food & Ag	CDFA	N	-

	CA Health & Human Services	Acronym	Assessed (Y/N)	# of programs w/ social & ecological indicators Assessed
Departments	Dept. of Public Health	CDPH	Y	1

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