Boons or Boondoggles: An Assessment of Salton Sea Water Importation Proposals

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Abstract

Several ways to address the looming ecological disaster that is the Salton Sea have been proposed—including ocean water importation proposals. We estimate the relative monetary costs for a "Cortés-to-Salton" proposal importing Sea of Cortés water to the Salton Sea and compare that with the costs of an "Ag-to-Environment" proposal transferring water from agricultural users to the Salton Sea. We find that transferring water from agriculture is substantially cheaper than the Cortés-to-Salton plan. Additionally, all the infrastructure for leasing water currently exists which means, physically, water transfers could begin immediately, an increasingly important characteristic given the present and increasing environmental and human health damages.

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1 The Salton Sea Crisis

The second lowest point in the United States, an ancient sea bed, was flooded at the turn of the twentieth century by Colorado River water being brought into California, forming the Salton Sea. Named "La Palma de la Mano de Dios" (the Palm of the Hand of God) by pre-statehood Mexicans (Cross and Signius Larson 1935), the sink has since continuously remained submerged. This was and is possible courtesy of agricultural drainage water, the vast majority of which is from the farmlands of the Imperial Valley—the location of the fingers of "la Mano". During the century after the Sea's formation, California and Northern México lost almost all of their wetlands—leaving the Salton Sea an incongruous combination of a drainage water sink and critical habitat for millions of migratory birds and several endemic endangered and sensitive species.

Critical habitat or not, as a drainage water fed terminal lake, the Sea has undergone significant deterioration due to both the quality and quantity of its inflows. Agricultural drainage, which provides nearly 85% of the inflows to the Sea, also imports fertilizers, pesticides, and salts which, over time, has left the lake with a present salinity level intolerable to most fish (Schwabe et al. 2008). Exacerbating these declines is a 2003 federal-state-local agreement—the Quantification Settlement Agreement (QSA)—which allowed additional ag-to-urban water transfers, lowering inflows to the Sea. In response, the QSA also mandated freshwater be sent directly into the Sea through 2017. This mitigation water was an attempt to buy time to develop solutions and avert damages caused by decreased volume and increased salinization.

One category of damages is habitat loss—the Sea is becoming too saline for fish populations, with all but one fish species having died off in the Sea's main body. This sole fish species, a hybrid Tilapia, serves as the primary food source for migratory bird populations (Bradley & Yanega, 2017). Unfortunately, winter 2019 fish surveys revealed few remaining Tilapia and,

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consequently, extremely low bird counts (Wilson 2019). If the current salinity trends continue, only brine shrimp and brine flies will be able to survive. These creatures can tolerant quite high salinity, but even their upper limit will be surpassed in roughly 15 years (Bradley 2018). At that point, algal and microbial populations will grow exponentially, leaving the Sea very biologically active but incapable of supporting its endangered, threatened, and migratory species (Bradley 2018; Cohen & Hyun 2006).

Human health damages are another significant concern. As the Sea recedes, former sea bottom, i.e., playa, is exposed. This playa is a source of airborne particulate matter, a precursor/exacerbator of asthma and other lung conditions, particularly affecting lower-income communities surrounding the Salton Sea, of whom a substantial portion have Latin and/or Native American heritage (Mayton 2015; Abrams 2017). Combined with decreased property and recreational values, total damages are estimated to be upwards of $70 billion over 30 years, which does not include damages to people in México (Cohen 2014; Schwabe and Baerenklau 2007).

"Fixing" the Sea will require a reversal of the habitat loss and playa exposure trends, which means addressing the quantity and quality of water in the Sea while understanding that quality is influenced by inflow volume. A central and controversial issue is where the water is going to come from to maintain the Sea. One proposal that the state is considering—the "Cortés-to-Salton" option—consists of importing ocean water from the Gulf of California. An alternative option, which builds upon the over 30-year history of agricultural-to-urban transfers in the region as well as the QSA's mitigation water transfer precedent, is an agricultural-to-environment water transfer, recently described in Levers et al. (2019).

While higher inflows from either of these options would prevent playa from being exposed—which would likely delay human health impacts—the fact that the Sea is a terminal lake means that eventually the rise in salinity would result in a dead Sea. As such, a permanent solution would require some machinations beyond simply bringing in more water. However, inflows could also be used with habitat and dust suppression projects. And, particularly important from a short-term perspective, solely increasing inflows would prevent immediate habitat loss and playa exposure.

Here we evaluate the costs associated with the ocean import scenario relative to those of an agricultural (ag)-to-environment voluntary, albeit compensated, transfer. While an understanding of the respective and relative costs of each solution is important in informing policy—which is the goal of this paper—costs are one of multiple factors to consider. Three other factors to consider include the respective legal and political issues surrounding each option, their respective benefits, and their potential environmental damages. Legal and political issues ultimately determine proposal feasibility and possible implementation. Both solutions—ocean import and ag-to-environmental transfers—will confront significant political and legal challenges, with a version of the latter (i.e., ag-to-Salton Sea) being implemented from 2013 to 2017. Such issues, though, go beyond the scope of this particular paper. From a benefits perspective, our analysis focuses on comparing the costs of different options to bring water to the Sea, a question raised in the Salton Sea Ten Year plan (CNRA, 2017a). As such, the benefits of these solutions to the state's charge are likely to be very similar. Of course, some of the ocean importation schemes broaden their scope to address water security in the Southwest, while also opening up the possibility of significant environmental damages to the Sea of Cortés. There are a different array of benefits associated with such a broader question, but such an analysis also goes beyond the more targeted scope of this paper.

Posted October 2019

2 Proposal Backgrounds

The idea to build a pipeline system to import ocean water to the Salton Sea has been around since at least the 1970s (Goldsmith 1971; Goolsby 2015). The two alternative locations for uptake are the Pacific Ocean near San Diego, and the Sea of Cortés (aka Gulf of California) in México. The American coastline is closer, approximately 100 miles compared to 160 miles from the Sea of Cortés. However, the elevation associated with the Peninsular Ranges, west of the Salton Sea, would complicate the water's journey if water were pumped from the Pacific—so, the Mexican route has been singled out as easier, i.e. cheaper, even though this would necessitate an international pipeline (Cohen 2015).

Any pipeline importing ocean water into the Salton Sea would fundamentally shift its habitat, keeping water levels high but concentrating salts. Some suggest linking expensive desalinization and/or purification systems to deal with salinity concerns (CNRA 2018a, 2018b). While building a return pipeline could export salts to the Gulf, this pipeline would also transport agricultural pollutants, of particular concern as parts of the Sea of Cortés are designated as UNESCO World Heritage Sites, including a Biosphere Reserve located at the northern edge of the Gulf. The Gulf is critical habitat for diverse endemic and endangered species—including the most critically endangered marine mammal in the world, the vaquita (United Nations, 2019).

Despite the pitfalls, the sheer volume of water available makes the Cortés-to-Salton plan tempting. In 2017, the California Natural Resources Agency requested proposals for ocean water importation (CNRA 2017b). They received eleven responses in 2018. A concern with the proposals is the lack of detailed cost information (Metz 2018). While three of the eleven proposals provided some cost information during a public workshop (CNRA 2018b), the proposals have not been independently assessed for accuracy or feasibility. However, they consistently suggest initial investment costs in the billions of dollars and maintenance costs in the millions. Given the lack of detailed cost information, we use cost information commissioned by the Salton Sea Authority (Tetra Tech 2013).

An alternative to ocean importation is to consider a water use transfer scheme, similar to those that have existed in the region for more than 30 years, including an agreement between IID and the Metropolitan Water District (MWD) to transfer approximately 100 thousand acre feet (TAF) of water to urban uses (the earliest example: 1988), an agreement between MWD and Palo Verde Irrigation District for approximately another 100 TAF, and the transfers outlined in the QSA between IID and the San Diego County Water Authority (SDCWA) culminating in 200 TAF of water being transferred to the SDCWA (IID & SDCWA 2003; United States Bureau of Reclamation 2018). The "transferred" water is generated through the lining of canals (reducing seepage), land fallowing, and improving irrigation system efficiency. The transfers have mostly consisted of agricultural-to-urban transfers, with some agricultural-to-agricultural transfers.

These programs formed the basis for the work in Levers et al. (2019) which described several schemes for transferring water from the Imperial Valley agricultural users to the Salton Sea. Physically, this is similar to the mitigation water dictated in the QSA. Levers et al. (2019) proposed three possible programs—fallowing, improving irrigation efficiency, and direct leasing—for which Colorado River water diversions by agriculture could be transferred to the Sea. To encourage reduced water use, the programs paid farmers for farm-level water savings through fallowing fields, implementing less water intensive irrigation methods, or via direct leasing which left the "how" up to the growers (i.e., through some combination of fallowing, irrigation improvements, or simply deficit irrigation). Using a linked bio-physical model coupled with an economic model, Levers et al. (2019) estimated Salton Sea inflows—consisting of transferred inflows and both drainage flows and tailwater runoff— and the opportunity costs to growers under the different programs.

Of the three programs evaluated, Levers et al. (2019) found that the direct lease program is the least-cost method for purchasing water, but as it causes the greatest reduction in drainage and tailwater of the three programs, it is not the most efficient at generating total Sea inflows. Land fallowing is found to generate the highest total inflows to the Salton Sea at the lowest cost. Irrigation efficiency improvement, alternatively, was not only the most expensive option but also the most limiting in generating total overall flows since from a hydrological perspective, water savings are achieved through reduced evaporation only.

Overall, though, their results suggested that a substantial amount of water could be purchased from agricultural users for a relatively low cost, particularly with fallowing and direct leasing. Below we examine and compare the cost-effectiveness of acquiring water from the ocean import (Cortés-to-Salton) option and the ag-to-environment option.

3 Proposal Cost and Water Import Estimations

To estimate costs and inflows for the Cortés-to-Salton solution, we used engineering and cost estimates provided to the Salton Sea Authority by Tetra Tech (Tetra Tech 2013). These costs include capital cost estimates to build the pipelines to import the water taking into account pipe diameter, pipeline length, intake structures, and energy for pumping. We assumed a length of 180 miles, which would put the pipeline intakes (and outputs) well south of the particularly ecologically sensitive area located at the northern edge of the Gulf. The route to the Gulf does not involve a mountain range, but the Salton Sea is still 250 feet below sea level, and the path to the

Sea of Cortés rises 270 feet above sea level, before dropping down into the ocean; consequently, significant pumping is necessary.

We estimated the costs for importing both 250 TAF per year and 500 TAF per year. We chose these values because they are physically feasible and in the range to increase the Sea's elevation to historic levels. Exporting water back to the Sea of Cortés would require more than doubling the costs. We calculated construction, yearly maintenance, and energy costs. Initial costs would be between $2.4 and 9.7 billion; annual costs would be between $8 and 46 million (Table 1). These cost estimates are similar in magnitude to the estimates provided in the three Cortés-to-Salton proposals submitted to the California Natural Resources Agency that included cost information. However, it is difficult to compare the proposals as their potential services differ: two included a desalinization component, and one included an export pipeline (The Binational Water Group 2018; GEI Consultants and Michael Clinton Consulting 2018; Cordoba 2018; Michael Clinton Consulting and GEI Consultants 2018).

For the ag-to-environment option, we focus on the fallowing and direct leasing options from Levers et al. (2019), using their model to estimate the costs to generate equivalent volumes of water imports. A central element of Levers et al. (2019) was the use of voluntary programs that growers could participate in depending on their crop profitability. Since the model does not account for heterogeneity within a crop type, at particular price points an entire crop might opt in to the program. This makes it difficult to generate a specific volume of water. Additionally, and following guidelines from the California Department of Water Resources, Levers et al. limited fallowing to 20% of baseline acreage for each crop due to concerns over third-party effects from reduced agricultural production that might arise from transfers. Twenty percent of alfalfa and Sudan grass acreage (the two crops most likely to be fallowed due to their lower profit margins) is about 45 thousand acres. For comparison, Figure 1 shows cropped area and unfarmed, but farmable, area in IID from 2003 through 2018. Cropped area ranges from 440 to 540 thousand acres. Unfarmed area has been 25 to 70 thousand acres -- a good portion of this unfarmed area was due to the QSA induced IID Fallowing Program, which has now ended. Unfarmed area in 2018 was the lowest is has been since 2003, over 40 thousand acres lower than its highest level in 2014.

Since the acreage fallowing constraint limits the amount of water that can be generated and, consequently, the comparisons that are possible with the importation option, we have increased the constraint on fallowed alfalfa acreage to 50% of baseline acreage to generate a wider range of purchased water. The 50% constraint increases the potential to fallow to over 110 thousand acres, yet would also likely lead to greater third-party effects on regional employment and income. The degree to which more fallowing leads to significant third-party effects within the region will depend on multiple factors, including the level of unemployment in the region, the strength of the linkages between the crop that is fallowed and upstream and downstream businesses, and how much of the compensation payment stays within the region, effects that we do not evaluate. However, to compare to the sheer volume potentially available from a pipeline, this 20% constraint must be relaxed since it limits the amount of water available under the ag-to-environment transfer, and thus comparisons, relative to the ocean import solution. Finally, because the opportunity cost of fallowing depends on crop prices, we have assumed the mid-level prices from Levers et al. (2019).

We estimate annual costs and total inflows (leased plus drainage and tailwater inflows) for a variety of scenarios. Table 2 gives *purchased water* volumes ranging from 200 TAF to 850 TAF. These scenarios result in *total inflows* ranging from about 870 to about 1,450 TAF. The annual costs (mainly the opportunity cost to growers) range from $6 to $69 million. As the conveyance system is already in place, there are no initial construction costs necessary. Since we focus on opportunity costs of changing baseline production practices, growers are compensated completely for any lost agricultural profits from enrolling acreage into the programs. Because of the relative profitability of vegetable (aka garden) crops versus field crops, the least cost solution consists of fallowing acreages of alfalfa and Sudan grass rather than any vegetable acreage. Given that the reduction in production represents only a small fraction of U.S. total alfalfa and Sudan grass production (Levers et al., 2019), there are likely no market or price effects.

Finally, it is important to emphasize that we do not estimate the transactions costs associated with either the Cortés-to-Salton solution or the ag-to-environment solution. For both cases, a formal agreement would have to be enacted—something akin to the QSA for ag-to-environment, and an international agreement for Cortés-to-Salton. Such agreements, along with their implementation, may incur significant transaction costs. To the extent the transaction costs are significantly different across these solutions, their inclusion may influence the conclusions of this research.

4 Proposal Evaluations

While there are many metrics that can be used to evaluate and compare possible solutions to the Salton Sea crisis, we briefly discuss the costs, benefits, timeliness, and political feasibility of ocean imports relative to the ag-to-environment transfer. As shown in Table 3, to achieve over a million acre-feet of inflows annually into the Sea—slightly lower than the long-term historic average—costs for Cortés-to-Salton would total between $2.4 and $4.9 billion initially plus $8 to $18 million per year. The costs for a similar quantity of water, if purchased from the agricultural users, is around $28 million per year. For 1.3 million acre-feet, the Cortés-to-Salton option would run

Posted October 2019

between $4.8 to $9.6 billion initially plus $16 to $33 million per year; for ag-to-environment, the cost is approximately $61 million annually.

It can be difficult to compare these sets of costs as they are not fully annualized. However, if we make a few assumptions for interest rate and pipeline lifespan, we can estimate the yearly costs for the pipeline as $171 million to $669 million (see Table 3), which does not include any land costs. Again, the comparative costs for the ag-to-environment scheme are $28 and $61 million, respectively.

Of course there is uncertainty with these values. For one, the values estimated for ag-to-environment assume mid-level crop prices representative of prices over the past decade. Lower crop prices would lower the lease price and program costs, while higher crop prices would increase both. However, the cost differences between the Cortés-to-Salton and ag-to-environment options are significant. To import one million acre-feet, the initial costs of the ocean importation proposal are 85 times the annual cost of the ag-to-environment option—this doubles if water exports are implemented.

Since good economic decisions are not made on costs alone, public benefits and nonmarket values need also be considered. Ocean importation may offer more benefits in the area of water scarcity and water quality. Many of the proposals include desalinization efforts and water supply augmentation opportunities that are intended to benefit the region through reducing overall water scarcity. As the Salton Sea is a terminal lake, any long-run solution needs to address salinization. Ocean water importation sans treatment may exacerbate the rate of salinization of the Sea, and may impact the biota given the Sea is not a marine environment, potentially causing more environmental damages. Additionally, potential environmental damages to the fragile Sea of Cortés are not minute and would need to be considered. While expensive desalinization would not address damages to the Sea of Cortés, it could help address these other issues and—as highlighted in many of the ocean importation proposals—offer the region another water supply source to address water scarcity that will only worsen under climate change and population growth.

As the Salton Sea does not exist in a vacuum, consideration of solutions that are proposed to address regional water scarcity should include a broader and geographically wider set of stakeholders, how the costs might be apportioned across a larger set of potential beneficiaries, and comparisons with other possible regional solutions, including possibly ocean importation from Californian waters. Any adjustments to water use in the increasingly populated Southwest warrant a more comprehensive discussion.

In terms of expediency, the damages associated with ecosystem deterioration and declining public health require both a long term sustainable solution but also immediate attention. So even if the calculus surrounding ocean importation from a regional perspective suggests benefits exceed costs, an analysis that has yet to be performed in a rigorous fashion, such a solution is a decade in the making. These concerns have been expressed by biologists, public health experts, and public officials. For instance, in 2018, the Assistant Secretary for Salton Sea Policy, Bruce Wilcox, alluded to such in the context of considering ocean importation projects (Metz 2018):

> "We don't want to delay building habitat and air-quality that's needed at the Salton Sea to spend two years evaluating something that may work but also may not."

While Assistant Secretary Wilcox is not dismissing water importation projects, he is likely highlighting the timeline concerns. A successful importation project would still take many years of construction—and that would only be *after* an international agreement was in effect. While an international agreement would not be necessary for the ag-to-environment solution, another multi-level agreement like the QSA surely would be required, a challenging task given the current system of water rights in California, past and ongoing agreements surrounding the use of Colorado River Water, and a nearly two-decade long drought impacting the Colorado River. Indeed, nearly all previous water transfers in the region have consisted of agricultural to urban transfers, not surprising given the high prices surrounding urban water use. Consequently, it is likely that an agreement to use agricultural water for an environmental purpose would be contentious.

5 Summary

The goal of this paper has been to highlight the cost differences between two possible solutions to bring water to the Salton Sea. Both likely involve significant legal and regulatory issues, a discussion that goes beyond the purpose of this article. The Cortés-to-Salton solution is expensive, both in terms of its development costs as well as the ecosystem and public health damages—damages that may be irreversible—that will occur over the ensuing years until completion. The degree to which the ag-to-environment scheme could serve as an effective long-run solution requires a more systematic analysis of the public costs and benefits of both it and alternative solutions and involvement with wider range of stakeholders. Yet, an ag-to-environment water transfer may be an attractive short-run alternative given the cost, the fact that all the physical infrastructure to implement it is in place, and its flexible potential, allowing it to be used in conjunction with smaller scale Salton Sea dust suppression and habitat projects.

So in considering the question referenced in the title of the paper, whether importation proposals are boons or boondoggles, the answer is somewhat indeterminate and depends on the purpose of the importation. If importation is primarily couched as a means to save the Salton Sea, immediate importation of agricultural water certainly seems to warrant the “boon” title, whereas importation of ocean water is deserving of the “boondoggle” moniker. Yet if ocean importation is seen as a possible long run solution to regional water scarcity in the southwest with the Salton Sea being a potential beneficiary, it is not so easy to assign either label—boon or boondoggle—without further analyses that consider a larger set of stakeholders and factors over a much broader region and timeline.

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Tables and Figures

Table 1: Cortés-to-Salton costs and Salton Sea inflows[1].

To import this much water (TAF)…	250	500
Construction Cost ($ millions)[2]		
Import Only	$2,430	$4,860
Import and Export	$4,860	$9,720
Annual Operation & Maintenance Cost ($ millions)[3]		
Import Only	$ 5	$ 10
Import and Export	$ 15	$ 30
Annual Energy Cost ($ millions)[4]		
Import Only	$2.8	$5.6
Import and Export	$8.2	$16.4
Salton Sea Yearly Inflows (TAF)	1,097	1,347

[1] This includes drainage and tailwater, assumed as a baseline of 847 KAF (Levers et al., 2019). Construction and Operation & Maintenance cost are adapted from Tetra Tech (2013), with dollar values converted to 2019 dollars.

[2] Construction cost would be $13.5 million per mile.

[3] Operation & Maintenance does not include energy costs.

[4] Energy costs are estimated with Federal Energy Regulatory Commission (2017) and Peacock (1996)

Table 2: Ag-to-Environment Costs and Salton Sea Inflows.

To purchase this much water (TAF)…	**> 200**	**> 350**	**> 400**	**> 650**	**> 750**	**> 850**
Choose this scheme:	**Direct**[1]	**Fallowing**[1]	**Direct**[1]	**Direct**[1]	**Fallowing**[2]	**Fallowing**[3]
With this water price ($/acre-foot)**:**	$30	$79	$88	$89	$79	$79
Total Cost ($ millions)[4]	6	28	37	59	62	69
Lost ag profit	2.4	1	16	22	2	2
Extra water profit	3.6	27	21	37	61	67
Total Inflows (TAF)	867	1,089	943	1,130	1,382	1,447
Purchased (TAF)	201	357	422	660	786	877
Drainage (TAF)	284	375	175	166	312	303
Tailwater (TAF)	383	356	345	305	283	268

[1] Fallowing limited to 20%, as in Levers et al. (2019).

[2] Fallowing of alfalfa limited to 50%; other crops are limited to 20%.

[3] Fallowing of alfalfa and Sudan grass limited to 50%; other crops are limited to 20%.

[4] Total costs are comprised of the lost profits from agricultural production that must be replaced for farmers to break even, and the added profit of the farmers who would have opted into the program at a lower price.

Table 3: Comparison of the Cortés-to-Salton and Ag-to-Environment proposals.

To achieve this total inflow (TAF)…	**≥1,000**			**≥1,300**		
With this proposal:	Cortés-to-Salton		Ag-to-Enviro[1]	Cortés-to-Salton		Ag-to-Enviro[2]
	Import	Import & Export		Import	Import & Export	
Costs (million $)						
Construction	2,430	4,860	0	4,860	9,720	0
Annual[3]	7.8	17.8	28	15.6	31.2	61
Land Costs	Unk	Unk	0	Unk	Unk	0
Annualized Costs[4]	165	334	28	332	663	61
Inflows (TAF)	1,097	1,097	1,089	1,347	1,347	1,382
Purchased	250	250	357	500	500	786
Drainage/Tailwater	847	847	731	847	847	595

[1] Fallowing limited to 20%, as in Levers et al. (2019)

[2] Fallowing of alfalfa limited to 50%; other crops are limited to 20%.

[3] Includes operation and maintenance and energy costs.

[4] Sum of amortized construction cost (interest rate is 5%, lifespan is 30 years), operation & maintenance, and energy.

Figure 1: Reported cropped acreage and unfarmed areas in the Imperial Irrigation District 2003 through 2018.[2]

Figure 1a: Cropped area vs. unfarmed area (See Figure 1b for breakdown of unfarmed areas).

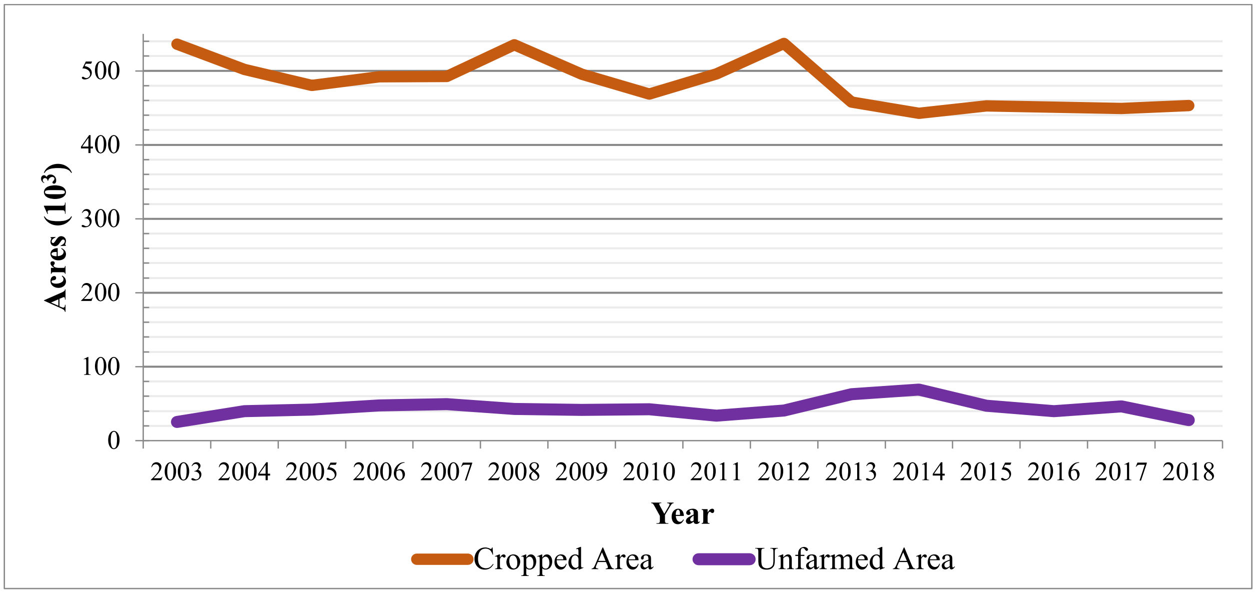
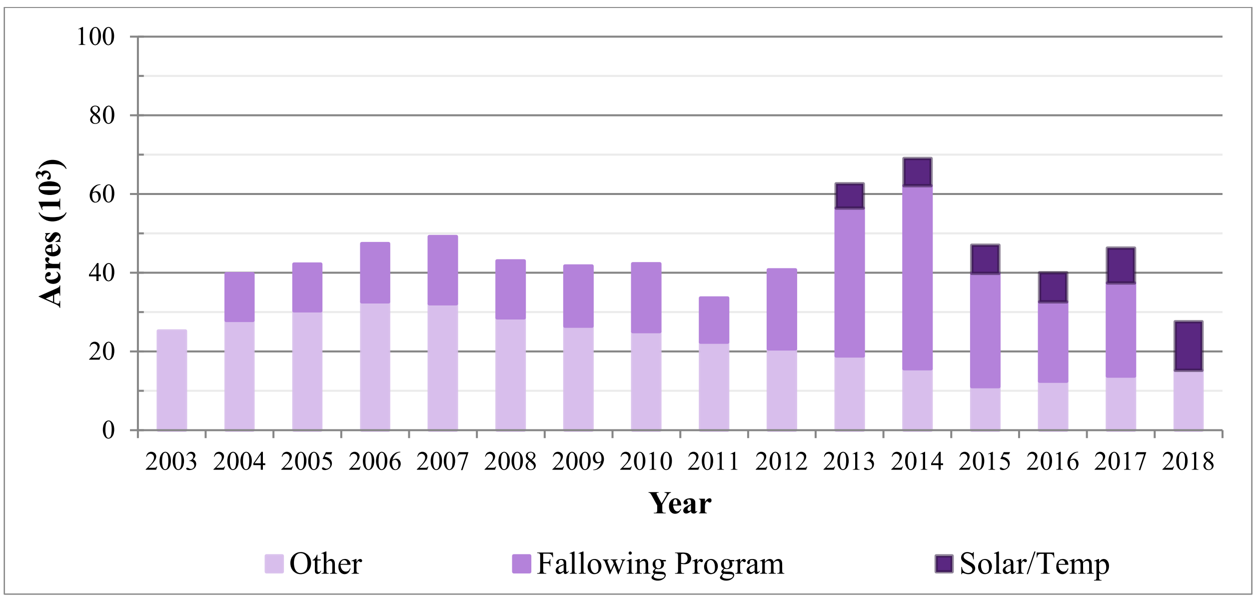


Figure 1b: Unfarmed area consists of acreage in the IID Fallowing Program, acreage in solar production or temporary conversion, and other acreage that is farmable, but not being farmed.



[2] Adapted from (Imperial Irrigation District 2005, 2008, 2012, 2019, 2016)