

A Comparison of Irrigation Water Rights and Crops

December 10, 2016

NOTE FROM CEBR

Our Center is often asked to connect students with off-campus organizations to facilitate student research. In this case, we connected students in the Spatial Analysis program at WWU with groups off campus to organize data on water use, water rights, and related topics in Whatcom County. (As a disclaimer - CEBR did not select the research topic or design the research approach.)

The following report is an on-going effort that began in the fall of 2015. The initial question was to determine if it was possible to use existing data sources to understand if it was possible to use existing data sources to understand the prevalence of unpermitted water use within the agricultural sector. The initial findings were shared with groups like the WA Dept. of Ecology and the Lummi Tribe.

The current report, created by Dan Ashley and Ben Larson, students within the Spatial Analysis program at Western Washington University represents the most recent modeling and analysis in this effort. The students identify multiple issues that need attention and steps to take in future reports. We anticipate the next round of work will be conducted in spring 2017.

This report states that up to 36% of irrigated crop land in Whatcom County is irrigated without a permit. The report clearly states that this number is most likely higher than reality due to data limitations that may indicate a portion of a farm not being permitted while other portions are. Future reports will continue to work with the various regulatory agencies to refine this analysis to produce a more accurate number.

It is our hope that, once complete, this model may be applied throughout Washington State. Water rights and habitat are key issues that deserve strong and accurate data to drive policy discussions.

The Center for Economic and Business Research is an outreach center of Western Washington University located within the College of Business and Economics. The Center connects the resources found throughout the University to assist for-profit, non-profit, government agencies, quasi-government entities and tribal communities in gathering and analyzing useful data. We use a number of collaborative approaches to help inform our clients so that they are better able to hold policy discussions and craft decisions.

The Center employs students, staff and faculty from across the University as well as outside resources to meet the individual needs of those we work with. Our work is based on academic approaches and rigor and not only provides a neutral analysis perspective but also provides applied learning opportunities. We focus on developing collaborative relationships with our clients and not simply delivering an end product.

The approaches we utilize are insightful, they are useful, and they are all a part of the debate surrounding the topics we explore, however, none are absolutely fail-safe. Data, by nature, is challenged by how it is collected and how it is leveraged with other data sources; following only one approach without deviation is ill-advised. We provide a variety of insights within our work – not only on the topic at hand but the resources (data) that inform that topic.

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A Comparison of Irrigation Water Rights and Crops Utilizing Irrigation in Whatcom County, Washington

Dan Ashley and Ben Larson; December 9, 2016

Western Washington University

Introduction

Whatcom County struggles with regulating the proper amount of water flow in the Nooksack River and its tributaries. Water levels during the summer of 2016 were approximately 30% lower than the minimum flow levels required by the State of Washington (Jefferson, 2016). Unfortunately, the summer of 2016 is not an isolated event. “From 1986 to 2009, flows in the Nooksack River failed to meet instream flow-rule requirements 72% of the time during the July-September flow period,” (Rio Digby, 2016, p. 1-2). Maintaining minimum stream flow is essential for water supply, water quality, and for wildlife within the Nooksack.

In the summer months, irrigation of agricultural land accounts for 70% of total water use in the county. Water flows and water quality are at their lowest, and fish species are the most threatened during this time. Additionally, a significant portion of crops in Whatcom County might be using irrigation without a water right granted by the Washington State Department of Ecology and may be watering crops via illegal piping into the Nooksack River or wells drawing from the water table. With the aid of geographic information system (GIS) software, our analysis attempts to refine and expand on the work of WWU alumni Rio Digby (2016) to determine the acreage of crop parcels in Whatcom County recorded as using irrigation without an associated water right.

Methods

Data

This study relied heavily upon two primary data sources and several additional sources. The Washington State Department of Agriculture’s (WSDA) 2015 crop distribution dataset was used to determine the spatial distribution of crops as well as the use of irrigation throughout Whatcom County. To determine the spatial distribution of water rights approved by the Department of Ecology the Geographic Water Information System (GWIS) dataset was used in addition to the Ecology database on water rights in the Nooksack Basin. In addition, GIS datasets showing the extent of Whatcom County and the extent of Tribal Reservations within the county were sourced from Western Washington University’s Spatial Analysis Lab and Washington Department of Ecology, respectively. It was with the aid of these sources the analysis was able to be conducted as detailed below.

Analysis

To begin the analysis, all input datasets were projected into NAD 1983¹, NSRS 2007² State Plane Washington North FIPS 4601 (US Foot) to ensure spatial accuracy. To establish the extent of the study area, a dataset representing Whatcom County was used along with a dataset detailing the location of tribal lands within the county's extent.

Once the preprocessing was complete, we began refining the WSDA crop distribution dataset to isolate only the crops within Whatcom County utilizing some form of irrigation. The dataset was then clipped to the extent of Whatcom County and the previously identified tribal lands within the county were erased to represent only crops within Whatcom County. The dataset was then joined to a "crop type" table provided with the WSDA dataset based on the township, range, and section identifier, or 'TRS,' which was common between the two tables. This yielded a dataset showing the distribution of crops in Whatcom County, classifying them by crop type, crop group, and irrigation method. This was then processed further to remove features which were identified as using no form of irrigation or if irrigation was unknown for the crop. In addition, several crop types that were not applicable to this study were removed as noted in Table 1. The final step in processing the crop data was to calculate the acreage of each crop. The final result was a dataset which identified the spatial distribution of crops in Whatcom County, classifying their respective crop type, crop group, acreage, and irrigation method.

Table 1: Detailing the crops which were removed from the WSDA crop distribution dataset during processing.

| Crops Types Removed |
|------------------------------|
| Christmas Trees |
| Conservation Reserve Program |
| Developed Land |
| Golf Course |
| Nursery |
| Poplar Farms |
| Unknown Crop |

¹ NAD 1983: North American Datum of 1983

² NSRS 2007: National readjustment of the North American Datum (1983) which was conducted in 2007 to increase accuracy.

The next step was to determine the spatial distribution of current water rights within Whatcom County, according to the Department of Ecology, in order to identify crops without a water right. Using a table obtained through the Department of Ecology’s Water Resources Explorer (2015) identifying water rights in the Nooksack Basin, records representing current water rights applicable to irrigation were isolated, maintaining each record’s document number, water

Table 2: Summary of the number of irrigation water rights within the Nooksack Basin according to the Department of Ecology.

| <u>Current Irrigation Water Rights by Document Type</u> | | |
|--|------------------|----------------|
| Document Type | Frequency | Acres |
| Certificate | 1,163 | 86,656 |
| Claim | 1,468 | 35,140 |
| Permit | 12 | 3,074 |
| Total | 2,643 | 124,870 |

right, instantaneous rate of flow, and annual usage information. That table was joined to the GWIS dataset based on water right document numbers and the resulting dataset was clipped to the extent of Whatcom County and had tribal lands erased similar to the crop distribution dataset. At this point the acreage of current irrigation water rights within the study area was calculated. As shown in Table 2, certificates constitute the most water rights recognized by the Department of Ecology followed by claims and finally permits.

Determining the Acreage of Irrigated Crops Lacking an Associated Water Right

At this point, the derived irrigated crop distribution and the irrigation water rights datasets were combined together using a union tool³ which yielded a single dataset containing both crop data and water rights data. From this dataset only records with a crop type were selected, yielding a dataset showing only crops using irrigation. This selection was further refined to include only records that also contained a document number indicating a current irrigation water right. The resulting dataset indicated the spatial distribution of crops using irrigation with an associated water right to irrigate. This was then erased from the irrigated crop distribution initially derived to determine the acreage of irrigated cropland which does not have an associated water right to irrigate. Figure 1

³ A GIS tool used to combine multiple datasets into a single dataset while maintaining all attributed information.

illustrates how this process accomplished the isolation of irrigated crops with associated water rights. Map A in Figure 1 shows the spatial distribution of the crops located in Township 39, Range 01, and Section 12, which are using irrigation (in green). Map B illustrates the same crop parcel as Map A; however, overlaid on the top is the associated irrigation water rights (in blue), which does not line up with the boundaries of the crop. This lack of spatial correlation will be discussed in detail in the discussion. By conducting a union and identifying polygons that have both crop data and water right data, we can isolate crops that are using irrigation with a right to do so, shown by the original green in Map C, in addition, we can also identify the crops lacking a water right, shown by purple.

Results

The analysis determined that Whatcom County contains 36,529 acres of cropland utilizing irrigation. It is estimated that 13,287 acres (36%) within the county are irrigating without an associated water right. Table 3 shows the acreage of irrigated crops lacking a water right classified by crop group with vineyard and cereal grain crop groups experiencing the highest percentages of acreage lacking water rights. In addition, Table 4 conveys the same information as Table 3, classified instead by crop type which is a generalized classification of crop type determined by WSDA.

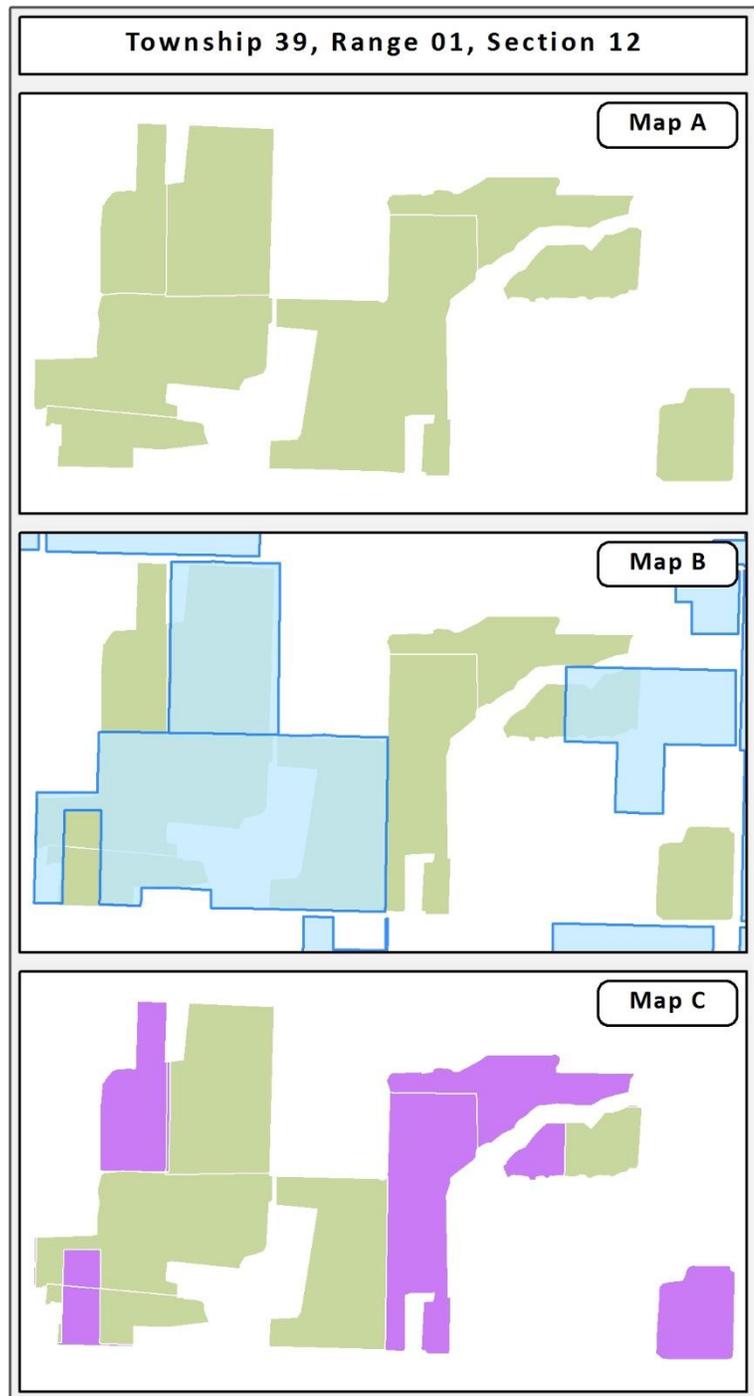


Figure 1: Map A shows an example of a single-entity crop parcel located within the study area. Map B indicated the same crop parcel overlaid by the associated water right (blue), not that the parcels do not line-up. Map C shows the same crop parcel classified based on a current water right (green) and no associated water right (purple).

When classified by irrigation type, as shown in Table 5, big gun/ sprinkler and wheel line irrigation types constitute the highest margins of crops estimated to be irrigating without an associated water right for irrigation.

Table 3: Comparison of the total number of irrigated acres within Whatcom County and number of acres with no associated water right for irrigation, classified by Crop Group.

| <u>Acreege of Irrigated Crops With No Associated Water Right by Crop Group</u> | | | |
|---|--------------------------------|--|------------------------------------|
| Crop Group | Irrigated Crops (Acres) | No Irrigation Water Right (Acres) | Percent without Water Right |
| Vineyard | 8 | 4 | 54.4% |
| Cereal Grain | 10,430 | 4,433 | 42.5% |
| Hay/Silage | 11,488 | 4,432 | 38.6% |
| Vegetable | 956 | 343 | 35.9% |
| Berry | 12,333 | 3,775 | 30.6% |
| Other | 1,263 | 297 | 23.5% |
| Orchard | 52 | 3 | 6.7% |
| All Crop Groups | 36,529 | 13,287 | 36.4% |

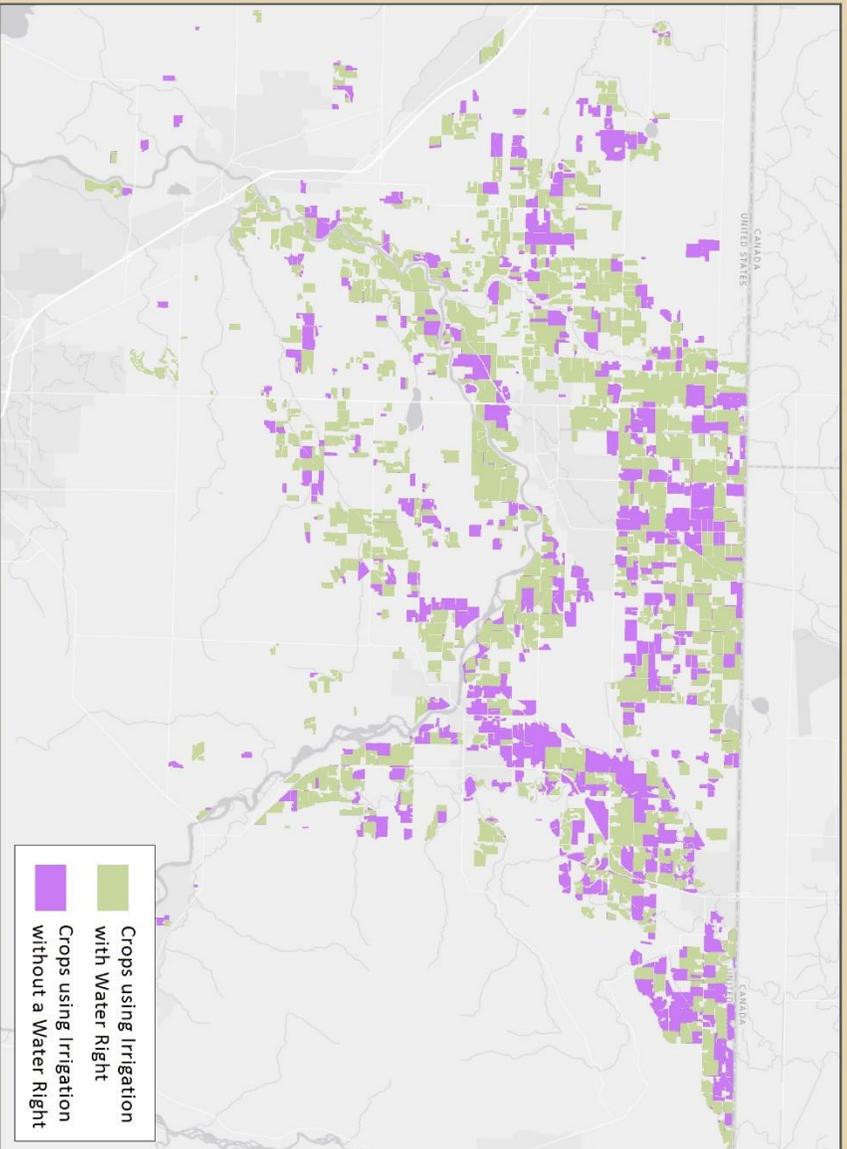
Table 4: Comparison of the total number of irrigated acres within Whatcom County and number of acres with no associated water right for irrigation, classified by Crop Type.

| <u>Acreege of Irrigated Crops With No Associated Water Right by Crop Type</u> | | | |
|--|--------------------------------|--|------------------------------------|
| Crop Type | Irrigated Crops (Acres) | No Irrigation Water Right (Acres) | Percent without Water Right |
| Grape, Wine | 3 | 3 | 100.0% |
| Market Crops | 490 | 309 | 63.1% |
| Apple | 94 | 52 | 55.2% |
| Corn | 12,130 | 4,765 | 39.3% |
| Blueberry | 3,476 | 1,273 | 36.6% |
| Grass Hay | 12,991 | 4,694 | 36.1% |
| Caneberry | 6,331 | 1,998 | 31.6% |
| Potato | 533 | 137 | 25.7% |
| Other | 482 | 58 | 12.0% |
| All Crop Types | 36,529 | 13,287 | 36.4% |

Table 5: Comparison of the total number of irrigated acres within Whatcom County and number of acres with no associated water right for irrigation, classified by Irrigation Type.

| <u>Acreege of Irrigated Crops With No Associated Water Right by Irrigation Type</u> | | | |
|--|--------------------------------|--|------------------------------------|
| Irrigation Type | Irrigated Crops (Acres) | No Irrigation Water Right (Acres) | Percent without Water Right |
| Big Gun/Sprinkler | 692 | 372 | 53.7% |
| Wheel Line | 526 | 241 | 45.9% |
| Big Gun | 21,718 | 8,780 | 40.4% |
| Drip | 10,786 | 3,316 | 30.7% |
| Drip/Big Gun | 435 | 96 | 22.1% |
| Sprinkler | 2,262 | 481 | 21.2% |
| Big Gun/Wheel Line | 50 | 1 | 1.9% |
| Big Gun/Drip | 22 | 0 | 0.8% |
| Micro-Sprinkler | 34 | 0 | 0.4% |
| Hand/Sprinkler | 5 | 0 | 0.0% |
| All Irrigation Types | 36,529 | 13,287 | 36.4% |

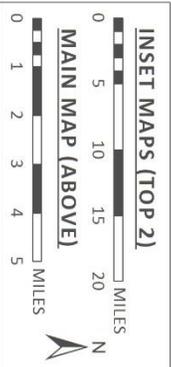
IDENTIFYING UNPERMITTED IRRIGATION: WHATCOM COUNTY, WASHINGTON



The main map shows the area of crop-land within Whatcom County which has been identified by the Washington State Department of Agriculture as using the various forms of irrigation for water, shown by both green and purple. This area totals 36,529 acres.

Green symbolizes the 23,242 acres of crop land which uses irrigation and according to the Washington State Department of Ecology, has a water right (certificate, claim, or permit) to do so. As a result, the remaining 13,287 acres (36%), which is symbolized by purple, are crops which are identified to be using irrigation but do not have a corresponding water right filed with the Department of Ecology.

■ Crops using Irrigation with Water Right
■ Crops using Irrigation without a Water Right



Dan Ashley | December 8, 2016
 NAD 1983 NDS 2007 StatePlane Washington
 North FIPS 4601 US Feet
 Data: WSDA, 2015; Lummi Nation, 2016;
 WA Ecology, 2015; ESRI basemap, 2016

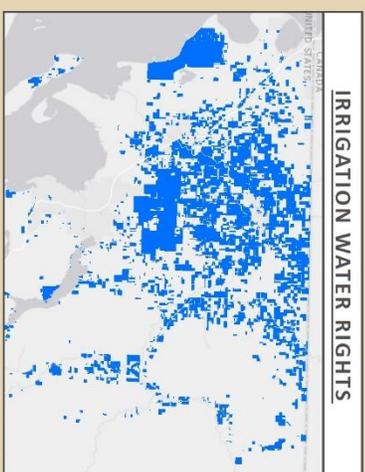
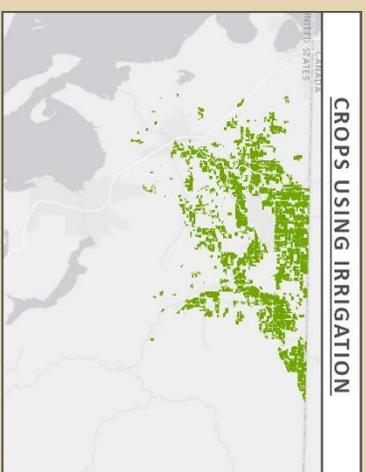


Figure 2: (*Pervious Page*) Illustrating the spatial distribution of Water Rights (according to the Department of Ecology), Crop distribution (according to WSDA), and calculated irrigated crops not encompassed by an associated irrigation water right in Whatcom County, symbolized by purple. The result was 36% of irrigated crops within the county did not correlate with an irrigation water right.

Discussion

Limitations

The biggest problem encountered throughout the course of this analysis related to the data obtained from the Department of Ecology and WSDA not correlating spatially. This presents an issue because in some circumstances a crop may be 90% within an associated water right but because 10% falls outside, that 10% is assumed to have no associated water right. Figure 3 provides an example of this problem where the green crop extent is overlaid by the blue water rights polygons and it is clear that the water rights do not completely encompass the respective crops. When calculating the acreage these little slivers of crops that were not encompassed by water rights end up adding up to a significant amount. This offers a considerable amount of improvement for future analyses such as finding the proportions of crop polygons within a water right with areal interpolation methods using GIS. Crop polygons with a high proportion of land within a water right, such as 90% or some other established threshold, could be excluded from counting for land without an irrigation water right. In

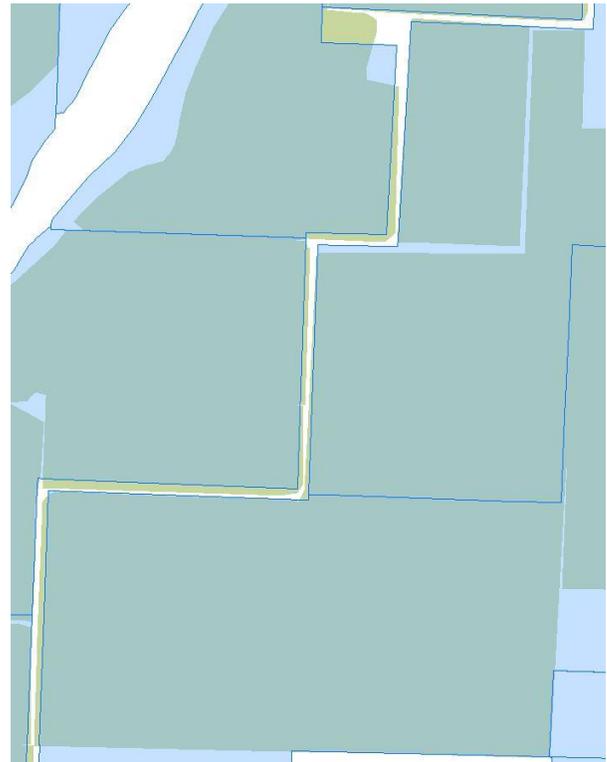


Figure 3: Example of the WSDA crop dataset not correlating spatially to the Department of Ecology’s GWIS dataset. This presented a problem in determining whether a crop had an associated water right or not. The green base layer indicates the distribution of irrigated crops within the extent while the semi-transparent blue layer overlaid represents the extent of irrigation water rights.

contrast, by exploring the quality of the crop and water rights data it may be determined that there is another potential way to better correlate the two datasets, possibly through the use of high-detail parcel data. This method seems to be effective because parcel data typically lacks gaps and would allow for a parcels with an associated water right for irrigation to be identified, and then it would be assumed that the entire parcel has the associated water right. At this point, if a parcel also has a crop within its bounds using irrigation, it would be assumed that the entire crop has the associated water right and would eliminate the issue of these slivers accumulating in acreage.

A second issue encountered by this study was the subjective refinement of crop types and irrigation types within the study area. Of course by altering the crop types selected to be applicable to the analysis, the end-result will change and therefore more region-specific research should be conducted into what specific crop types of interest are located within the study area and should be the focus of the study. In addition, selection of applicable irrigation types impacts the end-result of the study, and one irrigation type of specific concern to this analysis was whether or not to include the “unknown” irrigation type found in the original crop data in the results. By including “unknown” irrigation types the total cropland increases by roughly 500 acres and it was not determined how much of that 500 acres would be associated with an irrigation water right. Due to unknown irrigation types not constituting a significant portion of the crop distribution we omitted it from the analysis.

Potential for Future Research

Future work could be done to expand the GIS models developed by this study and by Digby (2016) to evaluate water rights on smaller scale (larger extent) study areas. Once the models have been corrected and adjusted to function for Whatcom County, it could be applied to other counties or even all of Washington State, all depending on data availability. Making the same leap to other states or entire regions of the United States with the model as the basis may be more difficult given the variety of ecological and agricultural datasets that would be required. Still, the model could be used as an outline or guide to other jurisdictions with various small modifications. In addition, higher-resolution data will of course increase the accuracy of any applicable studies.

Conclusion

The issue of unpermitted water usage is a main concern that once quantified can begin to be addressed. With the aid of GIS software and data from WSDA and the Department of Ecology, this study was able to build on that of Digby (2016) and determine that approximately 36% of irrigated crops within Whatcom County do not have an associated irrigation water right. This estimate is believed to be an overestimate of unpermitted irrigation use in Whatcom County. Regardless, this is issue and finding is problematic because it may play a significant role in contributing to low flows measured by the Department of Ecology in the Nooksack River.

However, this study only scratches the surface of the issue of water rights in Whatcom County. Not addressed in our examination of the data is the pressing issue of *why* some people choose to irrigate crops illegally. What motives, restrictions, or incentives push people to make the decision to drill a well or draw water from a river without a water right? GIS-based studies alone cannot answer these interdisciplinary questions, yet more work on the exact nature and accuracy of the data is necessary in order to understand the nature of the issue. Why is

it, for instance, crop parcels and water rights do not line up? Contacting experts in the field and those with extensive knowledge on the nature of the data and issues surrounding the problem should be a starting point for future analysts working on these issues.

Acknowledgements

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Kasey Cykler, Water Master, Washington State Department of Ecology.

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