

SECTION 5.5.2.2

USING GIS TO DOCUMENT CALIFORNIA RED-LEGGED FROGS (*Rana aurora draytonii*) & THEIR REPRODUCTIVE HABITAT WITHIN THE CARMEL RIVER WATERSHED

SEPTEMBER 2004

**PREPARED BY:
JESSICA WHEELER, FIELD BIOLOGY ASSISTANT**

Objective

Geographic Information Systems (GIS) was used for the analysis of California red-legged frog (CRLF) (*Rana aurora draytonii*) locations and habitat characteristics to determine the CRLF population distribution, reproductive habitat, and potential reproductive habitat within the Carmel River Watershed. This GIS database will serve as a tool to enable the Monterey Peninsula Water Management District (MPWMD) to track the CRLF population in restoration projects and to evaluate how water resources affect CRLF habitat on the Carmel River, Monterey County, California. It will also serve as an educational tool for other public agencies and the community to gain understanding about the ecology of CRLF in our region.

Introduction

MPWMD has recorded sightings of CRLF along the Carmel River since 1989. On June 24, 1996, pursuant to the Endangered Species Act of 1973, CRLF were determined to be a “Threatened” species. The distribution of CRLF within California has been reduced. Therefore, the population of CRLF within our region becomes important for the recovery of the species within California (Map 5.5.2.2-1 historical and current CRLF range). Although the main goal of this report is to summarize information about CRLF reproductive habitat, adult CRLF distribution and movements throughout the entire watershed should be considered to understand CRLF ecology.

Many of the tributaries and adjacent ponds have not been surveyed and/or the survey data is outdated. There is a substantial survey bias for CRLF in the main stem of the Carmel River while the data is scant for the rest of the watershed. A summary of all surveyed areas included in this report is shown in Map 5.5.2.2-2. Map 5.5.2.2-3 summarizes reports of all CRLF sighting data (all life stages) that were gathered.

Methods

CRLF data for the Carmel River watershed were gathered and consolidated into databases and mapped using ArcView 8.3. This information follows in three sections below.

- I. Data Sources
- II. Data Organization
- III. Data Analysis of Potential Reproductive and Reproductive Habitat (Mapping)

I. Data Sources

The data for this project came from five main sources:

A. CRLF survey data from the *Interim Draft of the Biological Assessment of CRLF for the Carmel River Dam and Reservoir Project, Monterey County* (Ecosystems West Consulting Group, 2001) was reviewed for all CRLF location and life stage references.

1. The above biological assessment was created from two data sets. A portion of the MPWMD data set was created from historical data that is summarized below (a). The 2000 data were collected by Ecosystems West Consulting Group(b).

a. MPWMD CRLF sightings from 1989 to 2000 were used to document existing conditions at the San Clemente Reservoir site and 18 miles of CRLF habitat between the San Clemente Dam and the Carmel River Lagoon.

b. GPS data collected in 2000 were used to define CRLF habitat along 11 miles of the main stem from the San Clemente Dam upstream through the proposed Carmel River Dam and Reservoir project area and ending one mile upstream of the proposed inundation zone.

These locations were plotted in digital format on orthophotographs from the hard copy of the report maps (annotated Power Point maps on scans of color aerial photographs). Digital raster graphs of USGS topographic maps were also used. The GPS data were not post-processed; however, all data point placement was corrected on the orthoimagery. These data sets were then reviewed by MPWMD staff and Dawn Reis, the principal investigator and author, to ensure positional accuracy.

B. Additional MPWMD historical records were summarized to complete the MPWMD data set.

1. MPWMD's incidental CRLF sighting data obtained during steelhead rescues (2000-present) and from river monitoring activities were incorporated into the database.

2. MPWMD's river restoration pre-project surveys were summarized and incorporated into the database. This included the *CRLF (Rana aurora draytonii) Monitoring Report for the Carmel River In-Stream Habitat Restoration Project at DeDampierre Park, Monterey, California* (Reis, 2002).

3. Data were used from a GIS class project done by Cameron Chabre at California State University Monterey Bay.

C. The Mullen data set was created from David Mullen's original survey notes and maps from his 1993 contract with MPWMD (Mullen, 1994). These notes were reviewed for information that was not included in the *Interim Draft of the Biological Assessment of CRLF for the Carmel River Dam and Reservoir Project, Monterey County* (Ecosystems West Consulting Group, 2001). Additional layers were created from Mullen's data that show the location of the tributaries and ponds that were surveyed. These layers are represented on Map 5.5.2.2-2.

D. The 2002 & 2003 datasets used in this report originated from two reports acquired from the U.S. Fish and Wildlife Service.

1. *2003 Annual Report for Permit #TE-057714-0 Under section 10(a)(1)(A) of the ESA* for submission to the United States Department of Interior Fish and Wildlife Service, (Reis, 2003) Note: This 2002 data summary has a 2003 date.

2. *California Red-legged Frog Tadpole Surveys and Translocations During the California-American Water Company 2003 Water Withdrawal in the Carmel River, Monterey County, CA: The United States Fish and Wildlife Service Biological Opinion (1-8-99-FW-7)*, (Reis, 2003).

The purpose of CRLF surveys in 2002 and 2003 was to identify and monitor potential CRLF tadpole habitat areas of the Carmel River that may be impacted by pumping water from the alluvial aquifer. The resulting dewatering of the river can occur before CRLF tadpoles complete metamorphosis (Reis, 2003 and Reis, 2003). The potential habitat surveys were conducted from Highway one to River Mile 17, which is approximately 1.6 miles downstream of the San Clemente Dam and near the California American Water Company's (Cal-Am) Carmel Valley Filter Plant.

E. Palo Corona CRLF locations were included in CRLF sightings Map 5.5.2.2-3.

Incidental sightings and reconnaissance survey data from the Palo Corona Ranch were used (Lynn Overtree and Dawn Reis unpublished data). These data were edited to include only those CRLF sightings that occurred in the Carmel River watershed with the

exception of Animas Pond, which is not in the Carmel River watershed, but does fall within the MPWMD boundary.

F. Surveys have also been carried out at the Santa Lucia Preserve. These location data are included in Table 5.5.2.2-1; however, these data are not on the map as GPS locations were unavailable.

II. Data Organization

The data sets that were derived can be placed into two main categories. These data sets are summarized in Table 5.5.2.2-2.

A. Data that can be queried is one data set.

B. A supplemental or source information data set can be accessed if there are further questions.

A CD of this memorandum includes the ArcGIS 8.3 map documents, shapefiles and associated data sets used for this project. Additional information can be requested from MPWMD.

III. Data Analysis of Potential Reproductive Habitat and Reproductive Habitat (Mapping)

The data sets summarize CRLF habitat within the Carmel River Watershed although there is a substantial survey bias for CRLF in the main stem of the Carmel River. Analysis was done to identify reproductive and potential reproductive habitat. The data were then mapped. The table below summarizes which data sets were used to create each map. Three maps were created from the reproductive habitat data and two maps were created from the potential habitat data.

A. Reproductive habitat was defined by the presence of egg masses and/or tadpoles. The maps listed below identify sites where eggs or tadpoles were present.

Map	Data Set
Map 5.5.2.2-4	MPWMD_Hist_Query.dbf Mullen_Query.dbf
Map 5.5.2.2-5	2000PotentialHabitat_CRFLPresenceData.dbf (Queried for known habitat) 2002Tad_Monitoring_Query .dbf
Map 5.5.2.2-6	2003Tadpole_Monitoring_Query Data.dbf

B. Potential reproductive habitat was defined by the presence of substrate for CRLF egg-mass attachment and calm water between the months of March and June. Water velocity is important to consider when evaluating CRLF reproductive habitat. High flow conditions can flush eggs or tadpoles downstream. (Schmieder and Nauman 1994). The maps listed below identify sites that have the potential for egg and tadpole habitat.

Map	Data Set
Map 5.5.2.2-7	2000PotentialHabitat_CRFLPresenceData.dbf 2002Potential_Habitat_Query.dbf
Map 5.5.2.2-8	2003Potential_Habitat_QueryData.dbf

Results

Separation of the data sets for the mapping process was defined by how the data were collected. A discussion of this is included below.

Map 5.5.2.2-2 is a summary of all surveyed areas included in this report. Map 5.5.2.2-3 summarizes reports of CRLF sightings (all life stages) that were gathered. Data from the Santa Lucia Preserve are not on the map; however, it is included in Table 5.5.2.2-1 as GPS locations were not available.

The MPWMD and Mullen data sets represent incidental CRLF tadpole sightings and sightings of tadpoles during surveys for CRLF adults. These data sets show that there are higher concentrations of CRLF reproductive habitat in the areas upstream of San Clemente Dam and in the lower Carmel Valley from Robinson Canyon Road bridge downstream to the Highway One Bridge (Map 5.5.2.2-4).

The 2000, 2002 and 2003 CRLF data sets were collected using identical methodology. Comparative analysis of the 2002 and 2003 CRLF data sets was possible as the data sets were collected in the same area for two consecutive years. The 2000 data was included in this map; however, the data is not discussed in the analysis as only one year of data was available.

In 2002, 67 sites were identified as potential reproductive sites. Actual reproduction occurred in 25 (37%) of these predicted sites. Of the 25 reproductive sites only site (0.021B) occurred in an area that was not designated as a potential reproductive site (Reis, 2003) (Maps 5.5.2.2-5, 5.5.2.2-6, 5.5.2.2-7, and 5.5.2.2-8).

The 2002 survey shows that three reaches of the Carmel River had concentrations of CRLF reproductive habitat (Map 5.5.2.2-5).

1. Twelve sites were in the reach that extended from ~0.82 miles downstream of Schulte Road bridge to ~0.20 miles upstream of Robinson Canyon Road bridge (1.02 miles).
2. Three sites were in the reach that extended from ~0.38 miles downstream of Don Juan bridge to ~0.68 miles upstream of the Don Juan bridge (1.06 miles).
3. Seven sites were in the reach that extended from ~1.14 miles downstream of DeDampierre to ~0.58 miles upstream of deDampierre (1.72 miles).
4. Three additional sites were outside of these reaches.

In 2003, 54 sites were predicted to have potential for reproduction. Actual reproduction occurred in 28 (52%) of these predicted sites. Of the 28 reproductive sites only site G5 occurred in an area that was not designated as a potential reproductive site (Reis, 2003).

In the 2003 survey, three reaches of the Carmel River had concentrations of CRLF reproductive habitat (Map 5.5.2.2-4).

1. Seven sites were in the reach that extended from ~0.41 miles downstream of Schulte Road bridge to ~0.46 miles upstream of Schulte Road bridge (0.87 miles).
2. Six sites were in the reach that extended from Don Juan bridge downstream ~0.46 miles.
3. Eleven sites were in the reach that extended from ~0.89 miles downstream of the confluence with Garzas Creek to ~0.78 miles upstream of Garzas Creek (1.67 miles).
4. Four additional sites were outside of these reaches.

In 2002 and 2003, the potential reproductive habitat extended farther downstream than the actual reproductive habitat. In 2002 there were 13 sites in the reach extending from below Valley Greens Drive bridge to the Highway One bridge that were suitable as reproductive habitat, but where reproduction did not occur or was not successful (compare Maps 5.5.2.2-3 & 5.5.2.2-5). In 2003 there were 9 sites in the reach extending from ~0.33 mile below Schulte Road bridge to the Highway One bridge that were suitable as reproductive habitat, but where reproduction did not occur or was not successful (compare Maps 5.5.2.2-4 & 5.5.2.2-6). Note that the surveys in 2002 and 2003 did not include the Carmel River lagoon.

Discussion

It is likely that the adult CRLF presence is underrepresented in the data sets due to the lack of focused survey efforts for adults. Surveys for adults CRLF need to be conducted during nighttime hours during the spring, summer and fall.

Map 5.5.2.2-2 is a summary of all surveyed areas included in this report. This map may be used as a guide to aid in the determination of where CRLF surveys need to be conducted in the future. All waterways including ponds, tributaries, and vernal pools need to be considered when evaluating CRLF habitat parameters within the watershed. Mark Stromberg of Hastings Reserve recommended summarizing USGS 15 minute quad maps where vernal pools and ponds are brightly colored (1921 reprinted in 1940). Pool locations should be verified in the field and assigned coordinates using a GPS receiver or other similar method for determining location. To understand the CRLF populations, surveys must also be conducted within specific time frames for given life stages with seasonal hydrologic changes considered.

Analysis of the potential reproductive habitat locations and the actual reproductive locations indicated that there were differences. MPWMD historical data (Map 5.5.2.2-4) show that in 1997, 1998, 1999, and 2001 there were 7 CRLF reproduction sites in the lower Carmel Valley between the San Carlos Bridge and the Highway One Bridge. The 2002 and 2003 data (Maps 5.5.2.2-7 & 5.5.2.2-8) show that there was potential reproductive habitat in this reach of the river; however, evidence of reproduction was not observed in this reach (Maps 5.5.2.2-5 &

5.5.2.2-6). One possible explanation for the difference in these data sets is whether water was present dry season.

The hydrologic regime in the reach between the ocean and the Valley Greens Drive bridge affects CRLF reproduction. In most years, the lower six miles of river goes dry as a result of water extraction as early as June or July. Preliminary analysis of the hydrologic data showed significant variations in water quantity and duration of flow in CRLF reproductive habitat during 1995-99 and in 2001 at the Highway One Gage. Scouring during the flood events in 1995 and 1998 may have created a more complex river channel with more off channel pools. CRLF tadpole presence in this region may have been influenced by wet conditions during this period. In 1995, the Carmel River flowed to the lagoon for nearly the entire year and was continuous throughout 1998. The presence of frogs in the lower river may have been due to a longer duration of flow in 1998 that led to more suitable CRLF reproductive habitat. In addition, wetter conditions in 1995 and 1998 may have created more access overland and encouraged adult CRLF to move to the lower region of the Carmel River. Adult CRLF could also have moved upstream from the Carmel River lagoon or overland from upland areas such as the Palo Corona Ranch.

The timing and duration of peak flows and water availability in the river channel and in off channel pools are factors that should be considered for CRLF reproductive habitat. The timing and duration of high flow events affect successful CRLF egg attachment and development in the Carmel River watershed. Analysis of the Highway One gage in the lower Carmel River shows that the riverbed is usually dry until December or January and that there are generally high flushing flow events in January and February. In coastal systems in California, CRLF can begin breeding as early as November. However, as CRLF eggs can be washed away in high flow events (Schneider & Nauman, 1994) it is likely that most CRLF in this watershed would lay their eggs during the month of March. Reis and Gunderson have observed CRLF egg masses in the Carmel River in February and March.

To understand the impact of drier years on habitat, the availability of water and the length of time needed for CRLF reproduction becomes important. In general CRLF tadpole eggs hatch 6-14 days after they are laid (Jennings 1988). CRLF eggs develop into tadpoles in 20-22 days and tadpoles usually complete development in 11-20 weeks (Bobzien et al. 2000, Storer 1925, Wright and Wright 1949). In rare instances, CRLF tadpoles will also over winter (Bobzien et al. 2000). To complicate matters, tadpole development is affected by water temperature and metamorphosis can be accelerated with higher temperatures, although temperatures exceeding 25 degrees Celsius can retard development or be lethal. In summary, CRLF development rates vary greatly but are usually between 15 to 25 weeks. Reproduction may depend on the availability of water throughout much of the dry season. CRLF tadpoles have been known to complete metamorphosis as late as early fall (October 22, 2003 in isolated pools of the Carmel River, Reis 2003).

Maps of CRLF locations are biased towards the main stem due to the lack of survey effort or reported surveys elsewhere in the watershed. In addition, maps of CRLF reproductive locations are biased toward the areas that have been systematically surveyed for CRLF as opposed to incidental sightings for adult frogs. MPWMD may have more incidental sightings in the lower

six miles of the Carmel River as a result of steelhead rescue efforts and at steelhead population survey sites. The reach between San Clemente Dam and Los Padres Dam has been surveyed for reproduction and potential reproductive habitat as represented in the 2000 data set for the San Clemente Reservoir area.

The lack of data about egg mass presence in the Carmel River is due to the timing of surveys. CRLF egg masses can be present from November through April (USFWS, 2002). Most of the data collected on the Carmel River was done in June-October in 2000, 2002, and 2003. Therefore, egg masses were not detected.

The Carmel River is a dynamic system that is always changing. High flows each winter can alter pond and pool areas. Some areas may be scoured while others are filled. Water levels also fluctuate depending on the water year. Therefore, differences in the survey data from year to year can be expected. Some breeding habitat is lost in some years while other habitat is created. In 2003, seventeen of the known 2002 CRLF tadpole locations were not present and there were twenty new CRLF tadpole locations (Reis, 2003).

The data in this report concerning the upper reaches of the Carmel River Watershed serves as good base line information; however, the need for more current survey data exists. Mullen 1993 reported ~50 CRLF at a 2-3 acre man-made pond at the Tanbark settlement on the Miller fork. He felt that this population might have increased the population in the tributary below. He also surveyed Quail Lodge Golf Club, Carmel Valley Ranch and Golf Resort, and Rancho Cañada golf courses for CRLF presence in 1993. CRLF were found at one Quail Lodge Golf Club pond on the East side of the 15th fairway (Mullen, 1993)

Some of these ponds have served as habitat for CRLF in the past (Mullen, 1993). Ponds managed for vegetation, pesticide use, fertilizer minimization, and predator elimination, such as bullfrogs, could help to increase the reproductive sites for CRLF. Additionally CRLF can travel as far as 2 miles (3 kilometers) overland in wet weather outside of riparian corridors with no regard to topography or vegetation (Bulger *in litt.* 1998). Thus a buffer area should also be considered as an extension of CRLF general habitat.

The following private property interests may hold additional CRLF data that may be useful in the future: Palo Corona Ranch, Hasting Reserve, Rana Creek Ranch, Rancho San Carlos/Santa Lucia Reserve, Oak Ridge Ranch and others. Data from these properties could be useful in documenting CRLF in the Carmel River Watershed.

Peter Trenham, USGS, did one study concerning CRLF critical habitat and seasonality on Oak Ridge Ranch. This study is summarized in the California Natural Diversity Data Base. This database should also be searched for other CRLF studies done in the Carmel River Watershed.

Conclusions and Recommendations

In the *Recovery Plan for the California Red-legged Frog (Rana aurora draytonii)*, the U.S. Fish and Wildlife Service recommends a population monitoring program that would consider four to five CRLF generations (a 15-year time frame) during an average precipitation cycle (USFWS, 2002). Nearly all CRLF sightings reported since 1989 for the Carmel River Watershed have been in the Carmel River main stem. However, it is likely that the adult CRLF presence is underrepresented in the data sets due to the lack of focused surveys. In addition, large areas of the watershed, including the Carmel River Lagoon, pond areas shown on USGS topographic maps, tributaries, and the upper reaches of the Carmel River have not been systematically surveyed for any life-stage of the frog. Until confirmed otherwise, all ponds within the Carmel River watershed should be considered potential CRLF habitat and surveys of presence/absence and the potential for reproduction should be carried out in these areas.

Maps showing reproductive habitat reflect data on the main stem of the Carmel River and do not show reproductive habitat in tributary drainages. Care must be taken not to assume that CRLF reproduction occurs only along the main stem of the Carmel River and to recognize that data sets in other areas of the watershed are missing. Maps derived from GIS layers for 2002 and 2003 show important areas of CRLF reproduction in the main stem near Schulte Bridge, Robinson Canyon Bridge, Don Juan Bridge, Garzas Creek, and in the vicinity of the deDampierre baseball fields. Data from the 2000 survey shows reproduction and a high concentration of potential reproductive habitat in the San Clemente Reservoir area. Additional 2003 data about CRLF reproductive habitat at the Santa Lucia Preserve, as well as for projects related to the San Clemente Dam, may be available through the USFWS. These data were not available during the construction of this GIS project.

Comparative analysis of the current population density in the Carmel River Watershed to other similar known CRLF populations would lend insight into the relative health of the population.

Future studies and surveys for CRLF should follow a study design aimed at documenting all life stages and reproductive habitat areas. Determining a consistent methodology and the timing for surveys will allow data collection that accurately portrays the CRLF population over time and will reduce the possibility of sampling bias. For example, day surveys for egg masses would need to be done earlier in the season, whereas repeated surveys for adult CRLF need to be conducted during nighttime hours in the spring, summer and fall. Also, any monitoring plan should account for habitat that is dynamic. For example, due to natural scour and the movement of sediment during winter storms, the river bottom changes nearly every year. Therefore, it would be incorrect to assume that reproductive sites remain in the same form or location from year to year. To fully understand CRLF population dynamics, night surveys for adult frogs, day surveys for reproduction (tadpoles), and reproductive habitat surveys should be carried out on a regular basis.

References

Bobzien, S., J.E. DiDonato, P.J. Alexander. 2000. *Status of the California Red-legged frog (Rana aurora draytonii) in the East Bay Regional Park District, California*. Oakland, California.

Bulger, J. 1998. *Wet season dispersal and habitat use by juvenile California red-legged frogs (Rana aurora draytonii) in forest and rangeland habitats of the Santa Cruz Mountains*. A research proposal submitted to U.S. Fish and Wildlife Service, Sacramento, CA.

Chabre, Cameron. 2001. *Using GIS to Document CRLF Habitat on the Carmel River May 2001*. GIS project for MATE program Monterey Peninsula College.

EIP Associates, 1993. *Survey Results for California Red-legged Frog (Rana aurora draytonii), Southwestern Pond Turtle (Clemmys marmorata pallida), California Spotted Owl (Strix occidentalis occidentalis) in the Carmel River Drainage System*. Prepared for the Monterey Peninsula Water Management District prepared by EIP Associates, San Francisco, California.

MPWMD, 1992-2003. *Carmel River Basin Surface Water Resource Data Reports. Water years 1992-1995, 1996-1999, 2000-2003*. Monterey Peninsula Water Management Districts' In-house Technical Memo prepared by G.W. James.

Jennings, M. 1988. *Natural history and decline of native ranids in California. Pages 61-72. In Proceedings of the conference on California herpetology*. H.F. DeLisle, P.R. Brown, B. Kaufman, and B.M. McGurty, (eds). Southwestern Herpetologists Society Special Publication (4): 1-143

Mullen, David A. July-August, 1993. Field Notes. Written while working on the Monterey Peninsula Water Management Districts' Monterey Peninsula Water Supply Project, Monterey County, California.

Mullen, David A. August 1994, revised November 1996. *Resource Management Plan for the California Red-legged Frog (Rana aurora draytonii) and the Southwestern Pond Turtle (Clemmys marmorata pallida) in the Carmel River Valley* for the Monterey Peninsula Water Supply Project. Prepared by David A. Mullen for the Monterey Peninsula Water Management District.

Mullen, David A. November 11-13, 1996. *Biological Data Report. Results of the Preconstruction Surveys for California Red-legged Frog (Rana aurora draytonii) Along the Carmel River, Monterey County, California*. Prepared for the Department of The Army Corps of Engineers, San Francisco District, prepared by David Mullen.

USFWS, 2002. *Recovery Plan for the California Red-legged Frog (Rana aurora draytonii)*. Region 1, U.S. Fish and Wildlife Service, Portland Oregon, May 28, 2002.

EcoSystems West Consulting Group, 2001. *Interim Draft of the Biological Assessment of CRLF for the Carmel River Dam and Reservoir Project, Monterey County*. Prepared for Monterey

Peninsula Water Management District, U.S. Army Corps of Engineers, California- American Water Company, prepared by Ecosystems West Consulting Group, Dawn Reis, Principal Investigator.

Reis, Dawn. 2002. *CRLF (Rana aurora draytonii) Monitoring Report for the Carmel River In-Stream Habitat Restoration Project at DeDampierre Park, Monterey, California*, Prepared by Dawn Reis, Ecological Studies.

Reis, Dawn, 2003 *Annual Report for Permit #TE-057714-0 Under section 10(a)(1)(A) of the ESA* for submission to the United States Department of Interior Fish and Wildlife Service by Dawn Reis.

Reis, Dawn 2003. *California Red-legged Frog Tadpole Surveys and Translocations During the California-American Water Company 2003 Water Withdrawal in the Carmel River, Monterey County, CA: The United States Fish and Wildlife Service Biological Opinion (1-8-99-FW-7)*, Prepared by Dawn Reis Ecological Studies.

Schmieder, R.R. and R.S. Nauman. 1994. *Effects of non-native aquatic predators on premetamorphic California red-legged frogs (Rana aurora draytonii)*. University of California, Santa Cruz. 12 pp.

Scott N. and Rathbun G. 1998. *Essays provided to Ina Pisani in response to a working draft of the California Red-legged Frog Recovery Plan*.

Storer, T.I. 1925. *A synopsis of the amphibian of California*. University of California Publications in Zoology 27:1-342.

Wright, A. H. and A. A. Wright. 1949. *Handbook of frogs and toads of the United States and Canada* (third edition) 640p. Ithaca, NY: Comstock Publishing Company.