



## Sugar-water Colour and Concentration Preferences at an Anna's Hummingbird Feeder in Victoria, British Columbia<sup>1</sup>

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<sup>1</sup>**Editors' Note:** *This project had its origin in November, 2014 and was presented at the Vancouver Island Regional Science Fair in Victoria, BC, in April 2016, when Wishva was old enough to enter the competition. Shortly afterwards, she submitted it to Wildlife Afield for possible publication. Since the article was topical for the current issue with the theme "mentoring", and the journal is still in catch-up mode, it was decided to publish it now even though the issue has a publication date of late 2015.*

### Abstract

During a three-week research project for the Victoria region of the Vancouver Island Science Fair it was determined that Anna's Hummingbirds preferred sugar-water solutions in artificial feeders coloured red and yellow but when absent they readily accepted other colours, even clear. The sugar-water concentration they prefer is 1:1 or a mixture of 50% water to 50% sugar. These results are consistent with other studies on the west coast of North America, including a long-term study completed in Victoria, BC, two decades ago.

### INTRODUCTION

Anna's Hummingbird (*Calypte anna*; Figure 1) has not always been in British Columbia. On the south coast, around Victoria, the smaller Rufous Hummingbird (*Selasphorus rufus*) is the most common species, being present mainly from April to late-August (Campbell et al. 1990). About 60 years ago, the first Anna's Hummingbird showed

up in Victoria (Guiguet 1949) and today it is a very common bird at feeders throughout the year. Unlike that for other parts of its breeding range, mainly in California, it may raise 2-3 families in a year (Campbell 2009). The birds are able to survive cold winters because thousands of people in Greater Victoria feed hummingbirds each year.



**Figure 1.** Over the past six decades Anna's Hummingbird has settled in Victoria and is now a common sight at artificial feeders. It is the only hummingbird, of the five regular species in British Columbia, that is present throughout the year. *Photo by Mark Nyhof,*

Nature and all living creatures have always fascinated me. This is how I discovered my love for hummingbirds. I became curious why hummingbirds do not get “Diabetes” even when they mostly feed on sweet nectar and sugar-water in artificial feeders. An incident that happened on a cold winter morning in my back yard encouraged me to learn more about hummingbirds. When I was replacing my frozen humming bird feeder with fresh sugar-water, perched on a branch nearby was a cold and hungry tiny Anna’s Hummingbird. I held the feeder out to her and immediately she landed on my palm and started feeding, leaving me with a once-in-a-lifetime experience (Figure 2).

I began to think about two research questions:

1. Why do people think that hummingbirds prefer to feed mostly on red feeders and flowers? If this colour were to disappear from this world would hummingbirds become extinct?
2. Do hummingbirds have preferred nectar and sugar-water concentrations?

My scientific approach, hypothesis, and variables considered for this study are summarized in Table 1.

**Table 1.** List of hypothesis and variables for study on colour and feeding preferences of Anna’s Hummingbird in Victoria, British Columbia.

Experiments	Hypothesis	Variable		
		Independent	Dependent	Control
Feeder colour preferences	Favourite colour is red	Time of day	Number of visits; feeding volume	Feeder colour, size and placement; sugar-water concentration
Feeder colour elimination test	Reduced feeding when preferred colours are removed; birds will move to other feeders	Time of day	Number of visits; feeding volume	Feeder colour, size and placement; sugar-water concentration
Preferred sugar-water concentration	Favourite sugar-water concentration ratio is ½ sugar to 1 water	Time of day	Number of visits	Feeder colour, size and placement; sugar-water concentration



**Figure 2.** A trusting, and hungry, Anna’s Hummingbird waiting to be fed on my hand prompted me to ask and later seek answers to common questions about the bird’s feeding preferences. *Photo by Sisira Kosgoda, Victoria, BC, November 29, 2014.*

## METHODS

### Background

This experiment was carried out daily in my back yard in Gordon Head, Victoria, BC, from 25 February to 17 March 2016 from 6:00 am to 7:00 pm. The time period was selected because the feeders are not invaded by wasps, as these insects can present an unwanted variable because they may attack and drive birds away from feeders and disrupt feeding. Also, birds do not have many natural flowers to feed on in late winter and early spring and tend to regularly visit artificial feeders.

### Equipment

#### *Feeder Design and Materials*

Equipment included 11 clear, small plastic cups, 11 metal clasps from mini mason jars, acrylic paints (red, magenta, blue, green, and yellow), 6 suction cups to fix the setup to the house window, tooth picks to attach banners to cups, and a plastic foot ruler. The total cost was \$16.00.

Plastic cups with clasps from mason jars were assembled as mini feeders and hitched onto a foot ruler (Figure 3). This design allowed the position of each feeder to be moved randomly. A small opening was created on the lids for feeding. The outer surface of the feeders (except the feeding area) was painted with five different primary colours based on light and pigment. An additional feeder was clear and unpainted (Figure 3).

Three experiments were considered. In the first two, a clear (i.e. colourless) feeder was added as the control for the experiments. In experiment #3, all feeders had clear cups with a banner attached to each cup, indicating different nectar concentrations.

#### *Monitoring Feeders*

A motion sensitive Logitech webcam (Figure 4), personal computer, Logitech webcam software and Windows movie maker software were used as monitoring tools. The Logitech webcam connected to a computer was mounted right above the feeders to monitor and record videos when hummingbird feeding and visits occurred.



**Figure 3.** I designed the initial equipment for this project, including six feeders of different colours (and clear). Note feeding holes on lids. *Photo by Wishva Kosgoda, February 2, 2016.*



**Figure 4.** Past studies of the feeding habits of Anna’s Hummingbirds have relied on long stretches of personal observations. In this study, a motion sensitive webcam (top) documented hummingbird visits which were recorded in real time directly to an attached computer. *Photo by Wishva Kosgoda, February 2, 2016.*

#### *Sugar-water Concentrations*

Sugar-water concentrations were prepared using white granulated sugar and filtered water. Precise measuring was made using a measuring cup, a 1-mL syringe with the smallest measure of 0.01- mL, and sugar-water storage containers. In the third experiment four different ratios of sugar-water mixtures were made. These were:

1. Two parts sugar to one part water,
2. One part sugar to one part water,
3. One-half part sugar to one part water,
4. One-quarter part sugar to one part water, and
5. No sugar; only water (used as a control).

One drop of red food colouring was added to each solution to maintain the same color (Figure 5). During testing of feeder colour preferences (combination of experiments #1 and #2), all cups were filled with 20-

mL of sugar-water of concentrations of one-part sugar to one-part water. At the end of each day the remaining liquid in the feeders was measured by pouring the balance of sugar-water into the measuring cup and re-filling it up to the 20-ml mark using the syringe. Experiment #2 was a feeder elimination test where one feeder was removed every two days starting from the bird’s most preferred colour to the least preferred, based on the results of experiment #1. Experiments #1 and #2 were performed over a period of 12 and 11 days respectively. In experiment #3, the feeders were filled up to 40-mL of sugar-water solution with varying concentrations. After four days the feeding volume on each feeder was measured and the feeders were filled up to 40-mL. This test was repeated for another four days. In all experiments feeder placements were randomly changed daily. Losses due to evaporation were ignored.

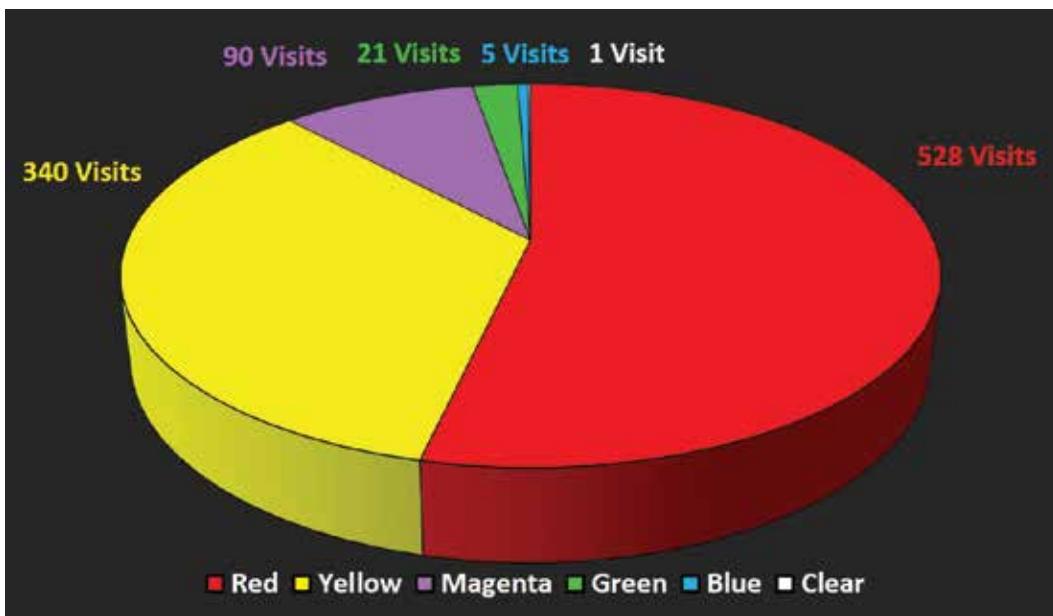


**Figure 5.** Five feeders of similar colour with different concentrations of sugar-water were used to determine hummingbird preferences. *Photo by Wishva Kosgoda, February 2, 2016.*

### RESULTS

Results indicate that Anna's Hummingbirds are attracted to bright colours such as red and yellow. In my study, the colour red (528 visits; 53.6%) and yellow (340 visits; 34.5%) were preferred during 985 visits to six different colours (Figure 6).

However, hummingbirds also fed on sugar-water in feeders with other colours in the absence of preferred colours suggesting that colour is not the main criteria for visiting feeders. When red (most preferred) was removed the number of visits to magenta increased (Figure 7). After yellow was removed the visits to magenta still remained the most



**Figure 6.** The two primary colours, red and yellow, accounted for 88% (868 visits) of all initial feedings (985) in the first experiment on colour preferences.



**Figure 7.** In the colour-removal experiment, Anna’s Hummingbirds eventually resorted to feeding on the clear sugar-water solution. Text on the horizontal axis includes date and number of hummingbird visits.

popular. When magenta was removed visits increased on green; when green was removed blue became the most popular; and when blue was removed hummingbirds fed on the clear solution (Figure 7).

During my three-week study hummingbirds avoided concentrations that were too high or too low. Adult male hummingbirds preferred mixtures of two parts sugar to one--part water, whereas females showed equal preferences of one part sugar to one part water and one-half part sugar to one-part water. Recently fledged young preferred mixtures of one-half sugar to one-part water and occasionally fed on concentrations of one-quarter part sugar to one part water.

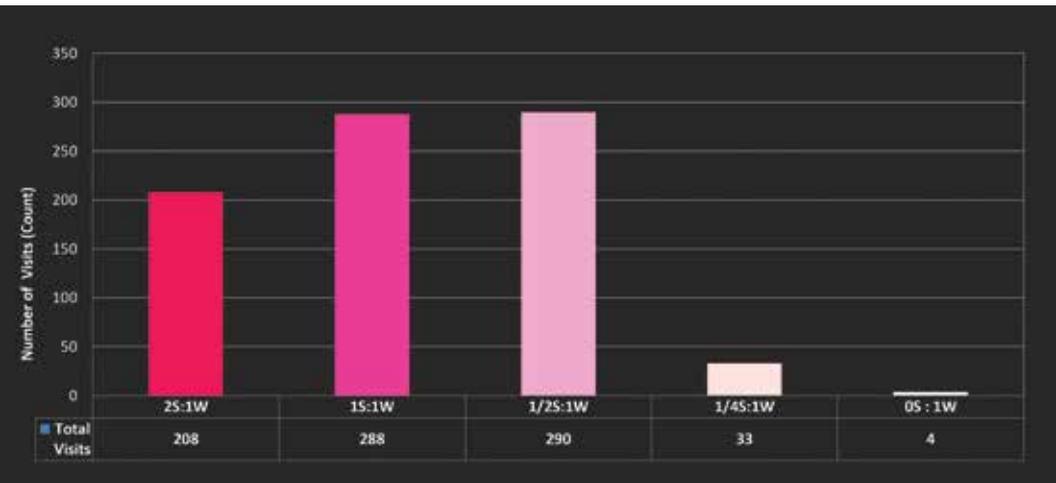
Overall, Anna’s Hummingbirds favoured concentrations of one-half sugar to one part water and one part sugar to one part water (Figure 8). However, the preferred mixture in Victoria, BC, was one part sugar to one part water (50%), which I would recommend, especially during inclement winters. Other interesting facts about Anna’s Hummingbirds noticed incidental to the focus of my study included feeding in response to weather, daily sugar-water consumption, length of individual feedings, time of day for full meals and snacks, and dates when fledglings visited the feeders.

## DISCUSSION

Most people believe that red is the preferred colour for hummingbirds. This is indicated by commercial feeders that have red bases (Figure 9). This assumption may be partly explained because the colours red and yellow in flowers stand out against a green or bluish background in nature (Stiles 1976, Goldsmith and Goldsmith 1979) Also, the colours red and orange are not conspicuous to insects so competition for nectar will not an issue before hummingbirds arrive to feed (Raven 1972).

In a spring study in Arcata, CA, Anna’s Hummingbirds showed a strong preference for red (55.5%) when blue, yellow, and green were offered (Harris-Haller and Harris 1991). It is known that Anna’s Hummingbirds select a colour that provides constant food but they can be trained to accept other colours (Collias and Collias 1968).

Russell (1996) stated, “flowers pollinated by hummingbirds typically are high in sucrose and have little or no glucose or fructose;” therefore, “given a choice of solutions of these 3 sugars, most Anna’s Hummingbirds select a sucrose solution.” Each of these three sugars has similar energy values but when fed all three Anna’s Hummingbirds take the



**Figure 8.** In order of preference, Anna’s Hummingbirds preferred sugar-water concentrations of one part sugar to one part water, one-half part sugar to one part water, two parts sugar to one part water, and one-quarter part sugar to one part water. They did not visit solutions without sugar. Below each bar, “S” refers to sugar-water and “W” refers to plain water for ratios of concentrations.



**Figure 9.** The red base on commercial hummingbird feeders is not as important in attracting hummingbirds as the concentration of the sugar-water mixture. *Photo by Mark Nyhof,*

highest concentrations of sucrose (Russell 1996). The sugar-water concentration most preferred in my study was one part granulated sugar to one part water (50%). These results are similar to other studies in Arcata, CA (50%; Harris-Halter and Harris 1965) and Los Angeles, CA (50-60%; Stiles 1976). The results of a 2½ year study on taste preferences of Anna's Hummingbirds in Victoria, BC, two decades earlier showed that a sugar-water solution of 45.5% sugar to water statistically had the longest mean and highest number of visits (T.N. Campbell 1996). Collias and Collias (1968) found that the sugar-water concentration was more important than color or position in determining feeder choice. †

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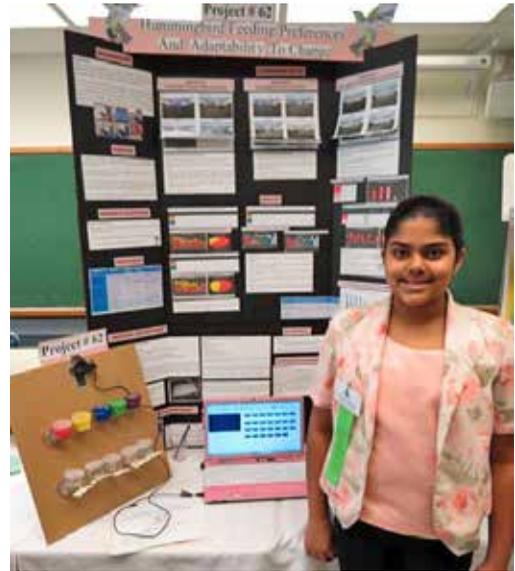
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### ***About the Author***

Wishva (Figure 10) is currently a student in the Challenge Program at Mount Douglas Secondary School. She is fascinated and inspired by nature and the secrets it holds. She completed her study on Anna's Hummingbirds in early 2016 as a Grade 6 student at Arbutus Global Middle School and presented the project at the Vancouver Island Regional Science Fair and placed 4th in the Intermediate (grades 6-7) division. Her study also received the BC Nature provincial award.

Science and Nature are just two aspects of Wishva's interests. She is a platinum award winner for both Kumon math and reading programs and has won awards as a piano performer and composer at the Greater Victoria Performing Arts Festival. Her piano compositions are inspired mainly by nature. During free time Wishva enjoys writing, reading fantasy novels, dancing, drawing, mastering piano and flute, music composing, and cooking.

She aspires to work in the medical field as an adult and believes her path has yet to be formed. She considers this opportunity to be published as an elementary student a great honour.



**Figure 10.** Wishva Kosgoda at the Vancouver Island Regional Science Fair with her project on feeding preferences of Anna's Hummingbirds. *Photo by Gordon Greeniaus, April 15, 2016.*