

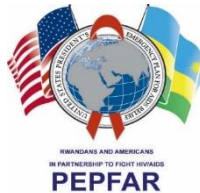


Republic of Rwanda  
Ministry of Health

# FEMALE SEX WORKERS POPULATION SIZE ESTIMATION, RWANDA 2018

## 3-SOURCE CAPTURE – RECAPTURE

22 October 2020



*We would also like to acknowledge the contribution of CDC for their financial and technical support in undertaking this important and innovative survey*


## FOREWORD

It is with great pleasure that we present the final report of the Female Sex Workers Population Size Estimation, Rwanda 2018 using a 3-source capture – recapture method (3SCRC). This is the first survey of its kind conducted in Rwanda using this methodology. The survey estimates the population size of Female Sex Workers (FSWs) at national level to provide the basis for determining the denominators to assess HIV program performance among FSWs in Rwanda with regards to the UNAIDS 90-90-90 targets.

Although different surveys have been conducted focusing on obtaining a reliable number of FSWs in Rwanda, It has been quite a while without any updated estimates, which make the existing estimates out of date given that this population is highly dynamic in nature. It is crucial to have updated information about the number of FSWs to inform program planning. As per the national strategic plan for HIV (NSP 2020-2024), the national HIV program is committed to monitor HIV epidemic focussing on Key population. The data from the 2018 FSWs population size estimation will allow the Ministry of Health through Rwanda Biomedical Centre (RBC) and its partners in planning for HIV prevention and treatment services targeting FSWs in Rwanda.

We address our gratitude to all participants who dedicated their time to participate in this survey. We also convey our gratitude to the survey team, the data collectors, investigators and our partners for their extreme hard work and contribution for the success of this survey. We are also indebted to the president's Emergency Plan for AIDS Relief (PEPFAR) through CDC Rwanda and UNFPA-Rwanda for financial support. Finally, our appreciation goes to FSWs who played the role of peer educators and key informants in the study and the Ministry of the Local Government for survey facilitation and providing access to the survey sites.

To conclude, I would like to highlight that despite the success story of the Government of Rwanda in the fighting HIV, the prevalence remains high among FSWs. It is therefore still very crucial to keep the momentum and even push further related interventions in fighting HIV among this key population group.

  
**Dr Sabin Nsanzimana**  
**Director General, Rwanda Biomedical Centre**



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## Acronyms and Abbreviations

2-SCRC	2 Source Capture- Recapture
3-SCRC	3 Source Capture -Recapture
BBS	Bio-Behavioral Survey
CDC	Centers for Disease Control and Prevention
CI	Confidential Interval
DGHT	Division of Global HIV and TB
HIV	Human Immunodeficiency Virus
FSWs	Female Sex Workers
KP	Key Population
NCC	National Children’s Commission
NISR	National Institute of Statistics, Rwanda
NSUM	Network Scale-up Method
PDA	Personal Digital Assistant
PEPFAR	United States President’s Emergency Plan For AIDS Relief
PSE	Population Size Estimation
PWID	People Injecting Drugs
RBC	Rwanda Biomedical Center
RNEC	Rwanda National Ethics Committee
STDs	Sexually Transmitted Diseases
STI	Sexually Transmitted Infection
UNAIDS	Joint United Nations Programme on HIV/AIDS
UNFPA	United Nations Population Fund
UNGASS	United Nations General Assembly Special Session
VCT	Voluntary Counselling and Testing

## Executive Summary

Female sex workers (FSWs) are disproportionately affected by the HIV/AIDS epidemic. Establishing accurate population size estimates (PSE) is important for prioritizing target populations and planning HIV prevention and treatment services. Reliable PSE for FSWs are challenging using traditional estimation methods, because criminalization, discrimination and stigmatization of sex work keep sex workers hidden.

In August 2018, a PSE of FSWs in Rwanda was conducted using 3-Source Capture-Recapture method, where a portion of street and venue based FSWs were sampled, tagged with unique gifts, and later resampled, with a stringent assumption of sample independence.

In Captures 1 and 2, 1,042 and 1,204 FSWs were tagged respectively. In Capture 3, 1,488 FSWs were only asked about the unique objects distributed at Capture 1 and 2. The estimated population size of the street and venue based FSWs in Rwanda ranges between 8,853 and 23,495 with a median of 13,714 FSWs.

This estimate provides the basis for determining the denominators to assess HIV program performance among FSWs in Rwanda with regards to the UNAIDS 90-90-90 targets.

## 1. INTRODUCTION

Globally, persons who are exchanging sex for money and other non-monetary items are at high risk of acquiring and transmitting HIV and other sexually transmitted diseases. This risk is particularly high for those who exchange sex more regularly as their source of income, including female sex workers (FSWs)(1). The risk of HIV infection is high in this population. Sex work is structured differently around the world and comprehensively capturing and describing the characteristics of this heterogeneous group of may be difficult (2). The nature of this profession makes HIV prevention and control challenging. FSWs have played a key role in HIV transmission to their male clients and subsequently, indirectly to the sexual partners of these male clients (3). In most cases, sex work is stigmatized, or often illegal, which makes the FSWs reluctant to disclose their source of income or profession. A systematic review conducted in 2012, reported the overall burden of HIV among sex workers in 26 low-income and middle-income countries at 12%, with an odds ratio for HIV infection of 13.5 compared to other women of reproductive age and 30.7% of sex workers were HIV positive (4). The 2014 report from Joint United Nations Programme on HIV/AIDS (UNAIDS) stated that the prevalence of HIV among female sex workers was as high as 77% in eSwatini, 62% in Botswana and 46% in Rwanda (5).

In Rwanda, the Ministry of Health (MoH) led response has contributed to a stable national HIV prevalence of around 3% in the last decade (2005-2015)(6). However, HIV prevalence remains higher in specific sub-populations, such as heterosexual couples, FSWs, FSWs' clients, men who have sex with men (MSM), and sexually transmitted diseases (STD) patients(7,8). Key populations (KP), including FSW and MSM, and also discordant couples, are key groups to HIV acquisition and transmission in Rwanda (7). The 2015 Rwanda National Bio-Behavioral Survey (BBS) reported that HIV prevalence among FSWs was 45.8%, and as high as 55.5% in the capital, Kigali (9).

Size estimation of key populations at risk of HIV (e.g. FSWs, MSM) and people who inject drugs (PWID) is essential for understanding the magnitude and burden of the epidemic, developing appropriate prevention and treatment programs, measuring service coverage and allocating resources (12). The lack of population-based estimates is one HIV prevention challenge among FSWs who exchange sex for money (1). Criminalization of sex work, discrimination and stigma keep FSW hidden. Sex workers are mostly unidentifiable during daytime and some hold other occasional jobs, and their work is usually done during nighttime in nightclubs, hotels, bars, and streets. Some proportion of FSWs are home-based and these individuals are even more difficult to include in surveillance work or to engage in HIV prevention and treatment services.

There have been three PSE studies conducted in Rwanda using traditional estimation methods. In 2011, a Rwanda Household Survey (ESPHS) used Network Scale-up method (NSUM) to estimate the size of the FSW population ranging between 25,000-45,000 (10). This population estimation is high compared to the first survey conducted in 2012, which generated around 12,278 FSWs by enumeration, capture-recapture and multiplier methods (11). In 2017, Rwanda Biomedical Center (RBC) undertook a key informant-

driven mapping and census of FSWs hotspots and population size estimation. This more recent work identified 866 hotspots and 13,569 FSWs.

All the above-mentioned estimates focused on obtaining a reliable number of FSWs in Rwanda but produced disparate numbers. Therefore, we embarked on work to employ the most rigorous available methods to accurately estimate the number of FSW in Rwanda. In 2018, Rwanda Biomedical Center (RBC) conducted a national estimation exercise to update the population size of FSWs in Rwanda using a more robust Three-Source Capture-Recapture (3-SCRC) method.

### **1.1. Collaboration and stakeholders**

For protocol development and implementation process, Rwanda Biomedical Centre (RBC) worked closely with US Centers for Disease Control and Prevention (CDC), which includes CDC-Rwanda and the Key Population Surveillance Team, Epidemiology and Surveillance Branch, Division of Global HIV and TB, CDC, Atlanta, US.

### **1.2. Funding Source**

This survey was funded by UNFPA and the President's Emergency Plan for AIDS Relief (PEPFAR) through the CDC under the terms of Grant number GH001612.

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the funding agencies.

### **1.3. Objectives**

The Rwanda FSW-PSE 2018 aimed to estimate the population size of FSWs at national level.



## 2. METHODS

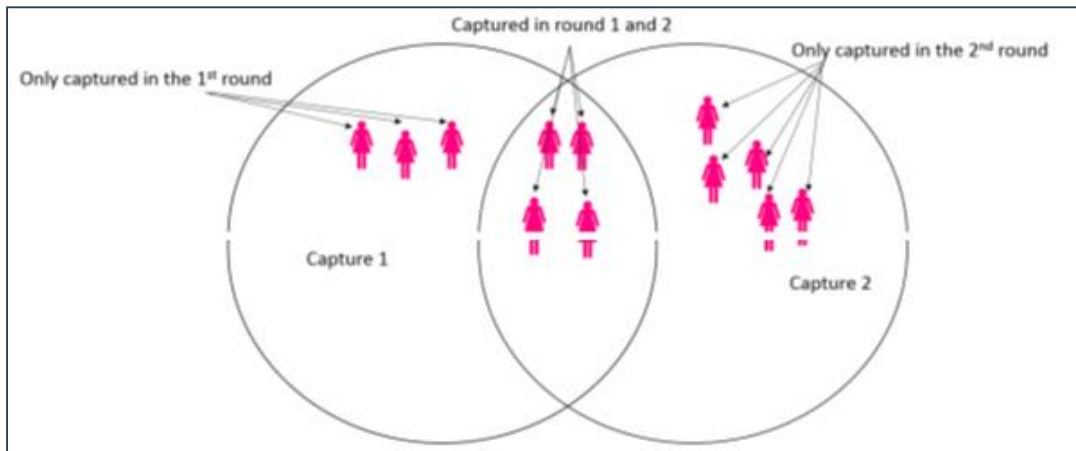
### 2.1. Study Design

This is a cross-sectional national FSW population size estimation activity, using the 3-SCRC.

#### 2.1.1. FSWs population size estimation: Two-Source Capture-Recapture Method (2SCRC)

A 3SCRC method involves three pairs of Captures (Capture 1 & 2, Capture 2 & 3 and Capture 1 & 3). These pairs are used to estimate the population size of FSWs using a repeated Two-Source Capture-Recapture (2-SCRC) method. The three estimates from the 2-SCRC were each compared with the 3-SCRC estimates in order to assess the robustness of the 3-SCRC methods. Each 2-SCRC population size estimate was calculated using the Exact Hypergeometric method (16). The number of FSWs captured in each capture as well as the number of FSWs captured in both captures was used to estimate the population size of FSWs (assuming that the two captures were independent).

**Figure 1: Two-Source Capture-Recapture (2SCRC)**



The formula for the 2SCRC method is provided below:

$$\frac{R}{C} = \frac{M}{N} \quad \text{then} \quad N = \frac{M \cdot C}{R}$$

R is the number common to both captures, C is the number of the second capture, and M is the number of the first capture. The 95% confidence intervals (CI) were calculated using the following equation:

$$SE(\hat{N}) \cong \sqrt{\frac{(C + 1)(M + 1)(C - R)(M - R)}{(R + 1)^2(R + 2)}}$$

$$\hat{N} \pm 1.96 \times SE(\hat{N})$$

Assumptions for 2SCRC:

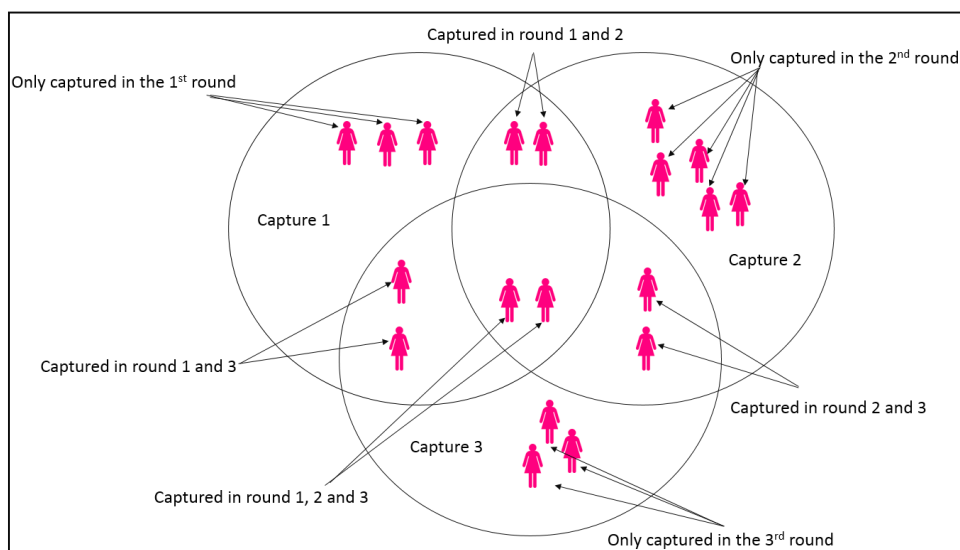
- The population is closed
- There is no loss of tags
- Capture probability is homogeneous over the captures.
- The two samples are independent

### **2.1.2. FSWs population size estimation: 3SCRC Method**

To strengthen the design and produce more robust estimates, the incorporation of an additional source to the traditional capture-recapture study was suggested yielding the 3-SCRC method. The 3-SCRC method is composed of three phases/rounds of (re)captures or tagging the target population.

The number of individuals in each capture, as well as the number of individuals common to two or all three within a specified timeframe, is used to estimate the total number of people in the target population (assuming that the capture rounds are independent). The method allows for heterogeneity in the encounter probabilities without the need to specify a particular parametric model (15). A visual representation is shown below.

**Figure 2: Three-Source Capture-Recapture (3SCRC)**



Assumptions for 3SCRC analysis using Bayesian nonparametric latent-class models:

- The population is closed; no individuals enter or leave the population during the study interval.
- Every individual in the population has a non-zero probability of detection (contact by surveyor) during the study interval.
- Successive sampling events are independent.
- All previously encountered individuals are identified with certainty.

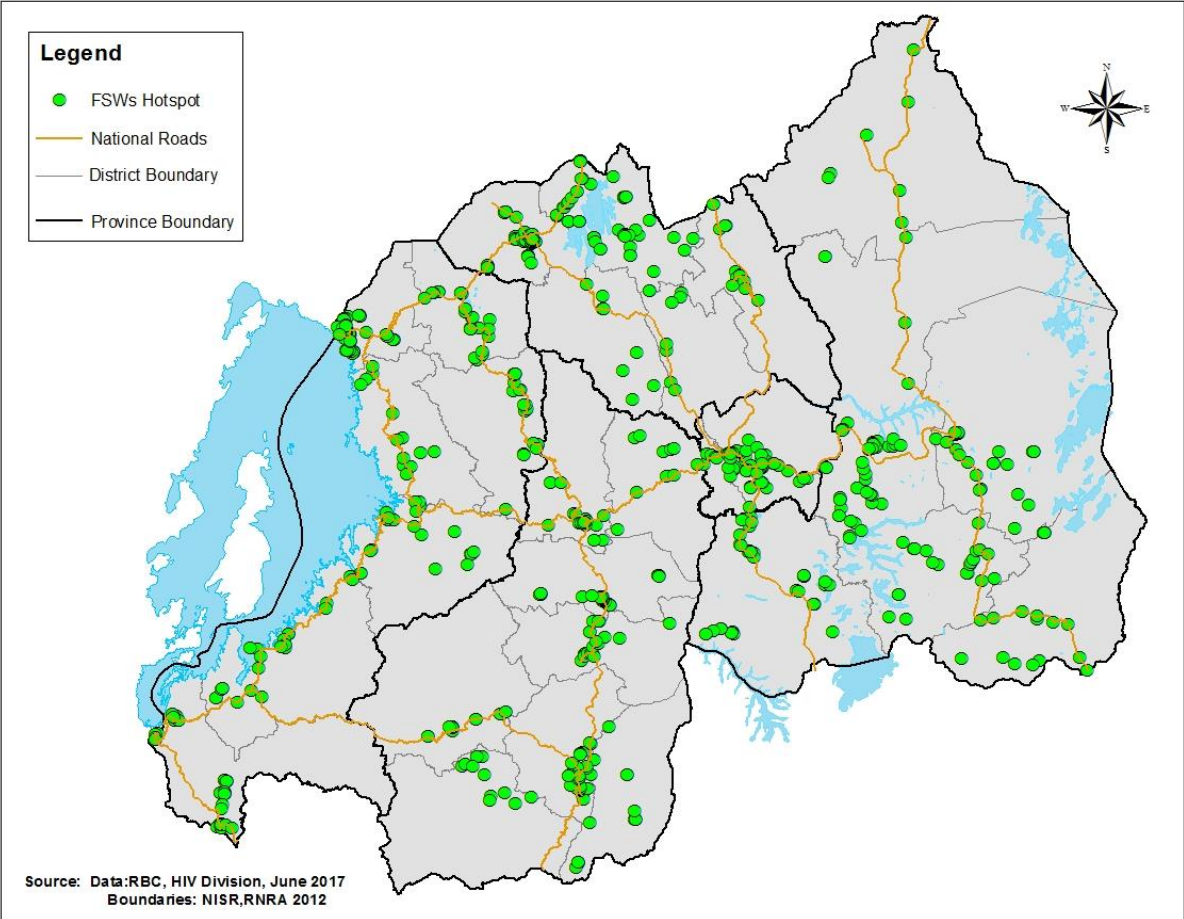
This method was chosen because of its low cost, ease to implement, no assumptions on the prior probability distribution, and true level of uncertainty about the population. The 3-SCRC has been used to estimate population sizes of key populations in parts of Kampala the capital city of Uganda, Democratic Republic of Congo (DRC) and Nigeria (18).

## 2.2. Sampling and Sample size

### 2.2.1. Sampling frame

Information from Rwanda’s 2017 hotspot mapping exercise was used as the sampling frame for this FSW-PSE 2018. That mapping exercise identified 866 hotspots and a rough estimate of 13,569 FSWs (street-based, home based, or venue based) countrywide (Figure 3).

Figure 3: FSWs Hotspots Distribution in Rwanda in 2017



From this mapping dataset, the following information was extracted: the estimated number of FSWs at each hotspot, and administrative location of the hotspots, such as the name of Province, District, Sector, Cell and Village. The sampling was at sector-level, so any sector with at least one hotspot was included in the sampling frame. All the 192 sectors with at least one hotspot were considered for the FSW-PSE sampling.

### 2.2.2. Sample Size

Based on 2017 hotspot mapping PSE of 13,569 FSWs, the number of unique objects to distribute per capture was determined using the unique object calculator from Biological and Behavioral Survey (BBS) guidelines (19). Table 1 illustrates the sensitivity analysis for the final estimated number of unique objects distributed in each capture.

*Table 1 Sensitivity analysis on estimated number of unique objects distributed*

Estimated population size	Desired precision (½ width of CI as % of estimate)	Survey sample size	Survey design effect	Precision on N (½ width of CI)	Number of objects to distribute	Expected number of objects recaptured
15,000	33.0%	1,000	1.0	±4,950	<b>478</b>	32
15,000	33.0%	1,000	2.0	±4,950	<b>958</b>	64
<b>10,000</b>	<b>25.0%</b>	<b>1,000</b>	<b>2.0</b>	<b>±2,500</b>	<b>1,046</b>	<b>105</b>
8,000	25.0%	1,000	2.0	±2,000	<b>827</b>	103
8,000	25.0%	1,000	2.0	±2,000	<b>827</b>	103

Using probability proportionate to size (PPS) method, the number of objects distributed to each sector was then determined based on the total number of FSWs for the sector according to 2017 mapping data. Among every 11 FSW, one unique object was assigned. The ratio was estimated based on 2017 hotspot mapping data considering the sample size (the total number of unique objects assigned per capture). Table 2 shows the projected number of objects that was planned for distribution in the four provinces and the City of Kigali. Appendix A provides the projected number of objects for distribution in each sector within the sample frame.

*Table 2. The projected number of objects to be distributed in the four provinces and in the City of Kigali*

Province name	Projected number of objects for distribution
East	236
North	130
South	187
West	475
City of Kigali	154

### 2.3. Inclusion criteria

Street and venue-based FSWs in all four provinces and the City of Kigali were accepted into the study if they met the following inclusion criteria:

- Self-reported as having sex with men in exchange for goods or money,

- Estimated age 15 years and above (Estimated by the key informants and object distributors), and
- Present at the visited venue/street and identified by the FSW guide

## 2.4. Implementation of the Study

### *2.4.1. Implementation time period and field operation procedure*

The study was implemented within a three-week period from August 1<sup>st</sup>, 2018 to August 22<sup>nd</sup>, 2018. All the three captures followed each other consecutively, each capture lasting for one week. One data collector from the 30-trained data collectors was randomly assigned to one of the 30 Districts of Rwanda in each capture. Once arrived in the selected sector, the data collector was paired with an assigned local FSW guide (key informant) who identified the FSWs congregation sites and guided the data collector to these place(s). The detailed Standard Operation Procedure (SOP) for all three captures is attached (Appendices C, D&E). Visiting time depended on the selected days and hours for each venue/street.

### *2.4.2. Unique Objects Distribution*

#### **Unique object description:**

In order for the survey team to identify tagged FSWs, two unique objects were used: (1) a key holder with a pre-printed unique message in Kinyarwanda: “**Rinda Ubuzima**”, which means “**Protect your life**” in English, and (2) a bracelet with a pre-printed unique message in Kinyarwanda: “**♥ ubuzima**”, which means “**Love your life**” in English. (See Figure 4). The types of objects were selected and designed in collaboration with a local community-based organization and vetted by FSWs key informants. The objects were small and inexpensive bearing little monetary value. The branded message was assumed unique with a memorable design that cannot be found in the study area unless it was distributed by survey team.

The process began with a capture stage. During this stage, sampled FSWs in the venues/streets were captured by providing a unique object (a key holder with a pre-printed unique message). After one week, the second capture began, with sampled FSWs being captured independently with a different unique object (a bracelet with a pre-printed unique message). If the sampled FSW reported to have received a unique object in the last one week, but not having the object with her at Capture 2, a laminated card with real distributed unique objects mixed with several different other objects was used to blind her in the process of selecting the correct object. If a FSW correctly described and selected the object received in the last one week, she was considered as a recapture at Capture 2.

**Figure 4: Images and Designs of unique objects used for capturing FSWs during Capture 1 (left) and Capture 2 (right)**



After one week, Capture 3 was conducted, with randomly selected FSWs being approached and asked whether they had received unique objects in the last 2 weeks. If the selected FSW reported to have received a unique object in the last two weeks, but not having the object with her, a laminated card with real distributed unique objects mixed with several different other objects was used to blind her in the process of selecting the correct object. If a FSW correctly described and selected the object received within the last two weeks, she was considered as being recaptured at Capture 2, Capture 3 or both.

**Figure 5: Laminated card used during Capture 2 and 3**



### **2.4.3. Selection and training for Survey staff**

Thirty data collectors received an intensive one-week training on research ethics, 3SCRC methods, relevant implementation procedures, such as roles and responsibilities for all

field staff, data collection forms, and topics covering confidentiality, documentation, error handling, data quality assurance, data back-up and submitting data from tablets to the server. RBC, CDC-Rwanda and CDC-Atlanta facilitators jointly conducted the training.

Civil society organizations provided a list of names and contacts of key informants working with FSWs at the district-level. The key informants were former/current FSWs assumed to have a better knowledge of the district and linked to a large network of FSWs operating in the same district. Their role was to link the survey team to FSW guides (Operational FSWs) at the sector-level. These guides were current FSWs and were assumed to have better knowledge of the sector and were known and trusted by FSWs in the sector. Before going to the field, the data collectors were instructed to call the local FSW guides upon arrival in the assigned sector to avoid prior mobilization of FSW. If the pre-selected local FSW guide was not available, another Guide was chosen there-and-then based on the specified criteria with the support of the District Key Informant.

#### ***2.4.4. Field Activities***

The PSE activities were conducted during a three-week period, where each capture was initiated and completed within a week to minimize the recall bias and other biases that might be related to time. Based on the capture-recapture assumptions the population under investigation was assumed to be closed (i.e. no change to the population during the investigation), and this aspect was strongly associated with the time used per capture. Minimizing the PSE implementation period was a critical aspect of the PSE approach. The concern being the FSW may lose the unique object given. If the unique object was lost, recalling the type of the object that someone had received would highly depend on the time between captures. After the first capture, all trained data collectors were re-assigned to a different district for the next capture round to fulfill CRC assumption that all FSW will be captured randomly. In addition to that, in each selected sector, a different FSW guide was paired to the data collector per capture.

At the selected sector, a data collector was paired with a FSW guide to visit all FSW venues/streets. At each visited venue/street, identification and visual assessment of the number of FSWs present was done by the FSW guide. The FSW guide identified the peer FSWs present at the venue/street and the data collector made a random selection of FSW whom the FSW guide would approach and provide the unique object. The data collector would record and enter all the data in the tablet using pre-programmed form. For Capture 3, the data collector was paired with a FSW guide to visit the venues/streets in the pre-selected sectors and the guide asked FSW questions about if she had received the first or/and second distributed unique object. The operation process was the same for all the captures using standard operation procedure. To monitoring and managing the fieldwork monitoring, RBC/MOH personnel who were the field provincial coordinators reported to the central-level of RBC to ensure that data collection protocol was correctly followed and conducted at high quality standard. The standard operation procedure flow charts can be found in Appendices C, D and E.

### ***2.4.5. Data collection and monitoring***

Data were collected using a preprogrammed Open Data Kit (ODK) form loaded on Android tablets. Data were sent in real-time to an RBC server and back up of the server data was conducted at midnight daily. Data-entry form captured data on the estimated age of FSWs, geo-coordinates, name of venue/street (physical location of the venue/street and acceptability of the unique object). For data quality assessment, data were downloaded daily for quality checks, such as data logical flow, and completeness of data collection. If an issue was found, the data collector was contacted so the issue was addressed immediately. At the end of each capture, a final Excel data were imported to a statistical analysis software package for further analysis. Data collection instruments are provided in Appendix B.

## **2.5. Human Subjects Considerations**

### ***2.5.1. Survey approval***

This survey was reviewed and approved by the Rwanda National Ethics Committee (RNEC) and was reviewed in accordance with CDC human research protection procedures and was determined to be nonresearch. A waiver of informed consent for all participants was requested and granted because FSWs were not asked for any personally identifiable information nor were they interviewed.

### ***2.5.2. Compensation***

No compensation was provided to FSWs in this size estimation.

### ***2.5.3. Respect of privacy and confidentiality***

The survey protected the anonymity of participants in every way possible to avoid any stigmatization and provide referral system for vulnerable population. FSWs anonymity was ensured as personally identifiable information (PII) were not collected on any data collection tool. Android tablets used for data collection were encrypted with a password. Once the data is submitted to the RBC server, access to submitted data from the tablet was disabled. Once data collection was complete, all data collected were retrieved from the RBC server and stored in a RBC computer protected with a password.

### ***2.5.4. Protection of Human Subjects***

In Rwanda, having sex with an individual under the age of 18 is illegal. Although this study did not ask any individuals about their specific age, the data collectors/guides estimated the age range of the FSW by her appearance into the following categories: 15-17 years, 18-24 years, and 25 years and older. Per study protocol, FSW estimated to be under 18 years by a data collector, were given a service referral form (Appendix F) for local prevention and care and treatment programs that are available to them.



## **2.6. Data Analysis**

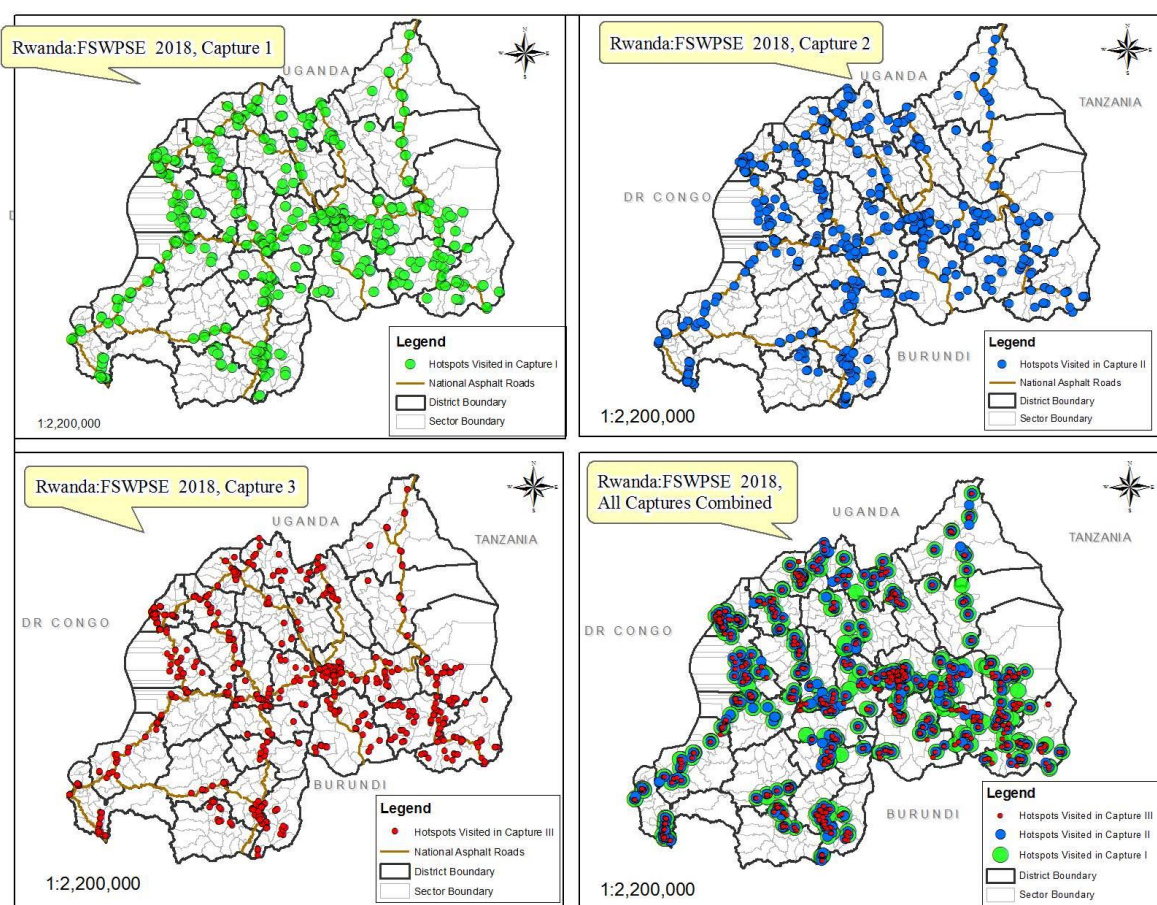
Data analyses were conducted jointly between RBC, CDC-Rwanda and CDC-Atlanta study teams. For sampling and data cleaning, SAS 9.4 and STATA 15 statistical software packages were used. RStudio 3.5.1 software (<http://www.rstudio.com/>) was used for calculating estimates using log linear and Bayesian Latent Class Analysis Modeling. Three combinations of 2SCRC estimates were estimated using the Exact Hypergeometric method and were compared to the 3SCRC estimate. A 3SCRC Bayesian model with Jeffrey's - Hyper Prior was fitted to estimate the population size of FSWs.

### 3. RESULTS

#### 3.1. Description

A total number of 1,042 unique objects were distributed countrywide during Capture 1 and 1,204 during Capture 2. In a three-week survey implementation exercise, 192 sectors were visited countrywide in each capture. Below are the maps for individual captures highlighting venue/street hotspots visited in each capture.

**Figure 6 : Maps for hotspots (venue/street) visited in Capture 1, Capture 2 and Capture 3**



For 1,135 FSWs approached during Capture 1, 1,080 (95.2%) self-reported to be FSWs, of those 1,071 (99.2%) were newly captured. Among those newly captured, unique object acceptance was high 1,042 (97.3%). Of those, 33 were presumed to be under 18 years, and 4 (12.1%) accepted the referral form.

For 1,278 FSWs approached during Capture 2, 1,234 (96.6%) self-reported to be FSWs. 99.4% (1,227/1,234) were newly captured. Among those newly captured in Capture 2, unique objects acceptance was high 1,204 [98.1%]. Of those, 12 were presumed to be under 18 years, and 10 (83.3%) accepted the referral form.

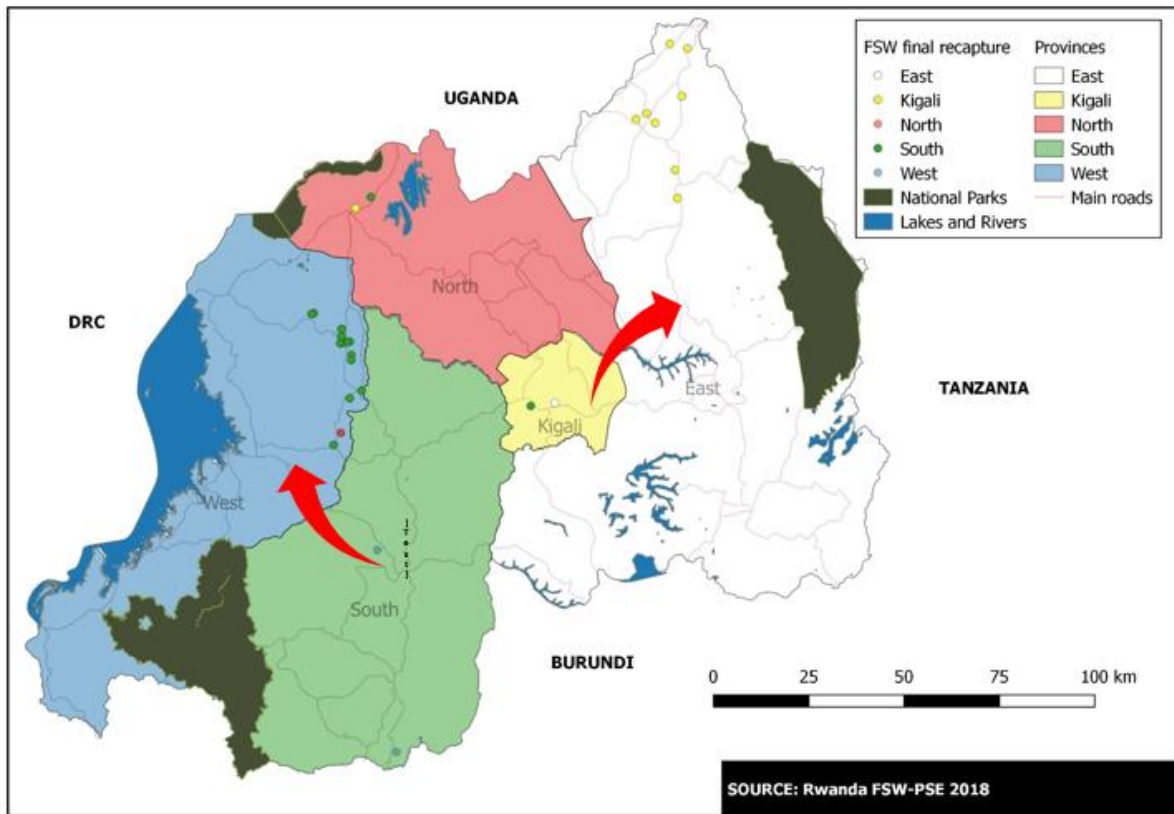
During Capture 3, 1,515 FSWs were approached, 1,494 (98.6%) self-reported to be FSWs and of those 1,488 (99.6%) were newly captured. 15 FSWs were presumed to be under 18 years, and 9 (60%) accepted referral forms. (Table 3).

**Table 3 Description of approached FSWs per capture**

	<b>Capture 1</b>	<b>Capture 2</b>	<b>Capture 3</b>
	<b>n (%)</b>	<b>n (%)</b>	<b>n (%)</b>
<b>FSWs approached</b>	<b>1135</b>	<b>1278</b>	<b>1515</b>
<b>Self-reported to be FSWs</b>			
Yes	1080 (95.2)	1234 (96.6)	1494 (98.6)
No	55 (4.8)	44 (3.4)	21 (1.4)
<b>Already in current capture</b>			
Yes	9 (0.8)	7 (0.6)	6 (0.4)
No	1071 (99.2)	1227 (99.4)	1488 (99.6)
<b>Unique object acceptance</b>			
Accepted	1042 (97.3)	1204 (98.1)	N/A
Refused	29 (2.7)	23 (1.9)	N/A
<b>FSWs presumed to be under 18 years</b>	<b>33</b>	<b>12</b>	<b>15</b>
Accepted referral form	4 (12.1)	10 (83.3)	9 (60.0)
Refused referral form	29 (87.9)	2 (16.7)	6 (40.0)

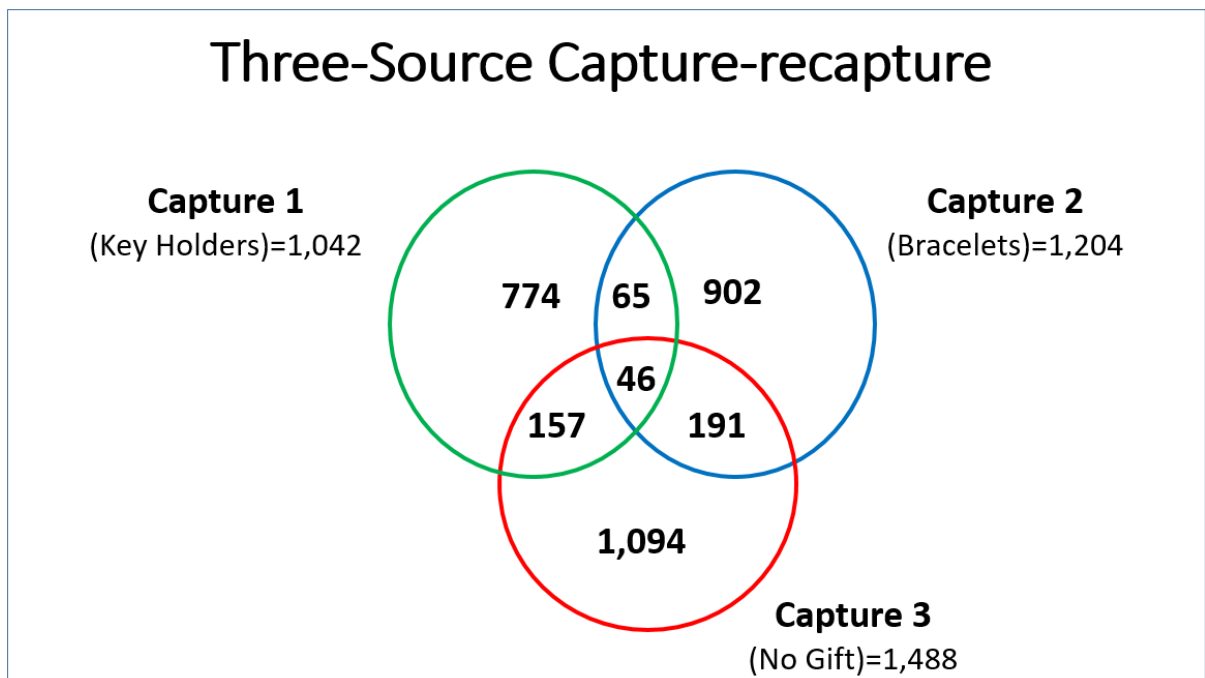
The map in Figure 7 illustrates the movement patterns of FSWs retagged in more than one province. Thirty-four FSWs were captured in more than one province. Eighteen FSWs were first captured in the Southern Province and recaptured in the Western Province. Eight FSWs were first captured in the City of Kigali and recaptured in Eastern Province. Eight other movements were recorded between other provinces. Refer to Appendices I, J and K for details.

**Figure 7 : FSWs captured in more than one province in different captures**



**Note:** The red arrows indicate the direction of observed recapture in a different province. Figure 8 presents the results for single, double and triple captures. The numbers within the diagram were entered into Bayesian 3-SCRC approach, the non-parametric latent class models, to estimate the population size of FSWs in Rwanda.

**Figure 8: Total number of captures and recapture for FSWs in Rwanda 2018**



The table below highlights the two ways used to record recaptures. Only one person out of 36 in Capture 2 who claimed to have received a unique object was unable to identify the object received. Only two persons out of 58 in Capture 3 who claimed to have received a unique object were unable to identify the object received.

**Table 4: Identification of recaptures**

	Re-capture Round	
	Capture 2	Capture 3
<b>Capture 1 (C1)</b>		
<b>Total recaptured From C1</b>	<b>111</b>	<b>203</b>
Shown C1 object	76	147
Correctly identified C1 object	35	56
<b>Capture 2 (C2)</b>		
<b>Total recaptured From C2</b>	<b>NA</b>	<b>237</b>
Shown C2 object	NA	181
Correctly identified C2 object	NA	56

**3.2. FSWs population size estimation using a 2SCRC**

The following table illustrates the point estimates of population size using 2-SCRC for each set of two captures with corresponding 95% confidence interval (CI).

**Table 5: FSWs population size using 2SCRC method**

	<b>Captures</b>	<b>FSW Population size (95% CI)</b>	<b>Adjusted Median (+ 576 FSWs Informants) (Credible Set)</b>	<b>Method/Models</b>
2-SCRC	Capture 1 and 2:	9,167 (7,675 - 10,659)	9,743 (8,251 - 11,235)	Exact Hypergeometric method
	Capture 1 and 3:	5,893 (5,241 - 6,545)	6,469 (5,817 - 7,121)	
	Capture 2 and 3:	5,926 (5,327 - 6,525)	6,502 (5,903 - 7,101)	

**3.3. FSWs population size estimation using 3SCRC Method**

After testing for heterogeneity assumption of selection probability across the three captures and found that they were heterogeneous (Appendix L and M), Bayesian Latent Class Model was fitted.

At the time of the estimation, there was no known prior probability distribution of the FSWs population in Rwanda, therefore, a sensitivity analysis of priors (Jeffrey’s prior, Uniform, Beta (5, 5), Beta (1, 5) and Beta (5, 1)) was conducted. Based on these analyses of priors, Jeffrey’s prior was chosen as it fitted the data well and produce good results. After fitting the model, the population size of street and venue based FSWs in Rwanda was estimated to be within a credible set ranging from 8,277 to 22,919 with a corresponding median of 13,138.

**Table 6: Three Sources Capture-Recapture estimate**

	<b>Median</b>	<b>95% Credible Set</b>
<i>3-SCRC</i>	13,138	8,277 - 22,919

Table 7 below provides the 3-SCRC estimate adjusted for 576 FSWs Guides that facilitated the data collection. As the number of Guides was known and fixed without any error around it, it was added onto the estimate provided by the Bayesian Model.

**Table 7 Three Sources Capture-Recapture adjusted estimate**

	<b>Median</b>	<b>95% Credible Set</b>
<i>3-SCRC</i>	13,714	8,853 - 23,495

## 4. DISCUSSION

The Rwanda FSW-PSE 2018 data provides a national FSWs population size estimate. This is the first time a 3-Source Capture–Recapture (3-SCRC) method was used to estimate the population size of FSWs at the national level.

In 2010, Rwanda’s FSW PSE was estimated using multiple methods namely enumeration and, multiplier in Kigali City and 2-SCRC elsewhere (11). In 2011, a PSE of FSWs was done by USAID, National University of Rwanda, RBC, and UNAIDS titled “Estimating the Size of Populations through a Household Survey (ESPHS)”. The ESPHS 2011 estimated the FSWs population between 25,000 and 45,000 using the Network Scale-up method (NSUM). A year later, in 2012, RBC used a participatory site assessment method adapted from the mapping and census method for FSW PSE resulting in 12,278 FSWs being identified. In 2017, RBC conducted another national FSWs hotspot mapping exercise, resulting in an estimation of 13,569 home, street, and venue based FSWs. This nationwide FSW PSE using a 3-SCRC method estimated a credible set ranging from 8,853 to 23,495 with a median of 13,714 FSWs.

The four estimates from all FSW PSEs done since 2010 used different methodologies therefore cannot be directly compared. However, these recent results can be triangulated with other estimates to better estimate the population size of FSWs in Rwanda. This 2018 estimate derived from a 3-SCRC method using Bayesian latent class approach, has advantage over the others because it produces credible sets (Bayesian probability intervals), which better reflect the true level of model selection uncertainty. The Bayesian latent class approach produces credible sets in the sense that their coverage does not depend on sample size. In addition, credible sets are naturally based on the posterior distribution of the population size given the data and priors, as produced by full Bayesian model averaging. The Bayesian latent class approach incorporates model uncertainty in a natural and mathematically defensible way. Currently, the 3-SCRC method using Bayesian latent class approach is among the best tool available for population size estimation from multiple-source capture-recapture data.

As of January 2019, HIV prevention program data indicates that, approximately 15,000 FSWs were enrolled in a Key Population program in 18 districts of Rwanda. In this FSW-PSE 2018 study, a population size of FSW was estimated to range from 8,853 to 23,495 FSWs. In discussions held with RBC prevention team, it was agreed that, given the number of FSWs enrolled in HIV prevention program, using the upper bound of the credible set provides the best-case scenario for FSWs programing.

Size estimation of key populations at risk of HIV (e.g. FSW and their clients) is essential for understanding the magnitude and burden of the HIV epidemic and estimating the gap in the coverage of HIV prevention program in these populations. The critical importance to knowing the estimated size of FSWs in Rwanda is to enable the HIV prevention program targeting FSW to estimate the denominator of 1<sup>st</sup> 90 in HIV treatment cascade (The proportion of FSWs living with HIV aware of their HIV status). This will inform the development of appropriate prevention and treatment programs, measuring service

coverage, and informing strategic planning and resource allocation to reach FSWs with HIV services.

#### **4.1. Limitations**

The FSWs population size estimation has the following limitations:

- The estimates are limited to FSWs who congregate at hotspots (i.e. street and venue-based FSW). FSWs who do not congregate at hotspot venues such as home-based FSWs are not included in the PSE estimate. A survey, such as an immediate follow up BBS survey would provide the visibility of non-home-based FSWs and improve the estimating results.
- Although we cannot claim that the Bayesian nonparametric latent-class model is an optimal approach, this study will add to our next priors, we should therefore hope for and expect methodological improvements over time.
- The study was powered to generate national level estimates. Therefore, it does not provide subnational unit estimates.

- 

#### **4.2. Challenges**

The FSWs population size estimation presented the following challenges:

In order to meet the assumptions of a closed population, it was important to expeditiously conduct the three captures in the shortest time possible. This necessitated to recruit more enumerators and FSW guides.

Entry into the community required to get an introductory letter from MOH and was supposed to be presented to the local authorities before initiating the fieldwork. An advance party composed of RBC supervisors was sent to introduce the study to the local authorities in the areas covered by the study.

### **5. CONCLUSION AND RECOMMENDATIONS**

We estimate that the population size of FSWs in Rwanda ranges from 8,853 to 23,495. This estimate provides a basis for determining the denominators to assess HIV program performance among FSWs in Rwanda in regards to the UNAIDS 90-90-90 targets. This estimate also provides the FSW population size to be targeted for HIV prevention programs. As this estimate is limited to street and venue based FSWs and since we are expecting an improvement of the method used in this exercise, it is recommended that in the future another FSW-PSE be conducted to provide tighter credible sets.



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## 6. APPENDICES

### *Appendix A: Projected number of objects/gifts to be distributed by Province, District and Sector*

Province	District	Sector	Number of objects
EAST	BUGESERA	Gashora	2
		Ntarama	4
		Nyamata	9
		Nyarugenge	5
		Ririma	12
		Ruhuha	3
	GATSIBO	Kabarore	7
		Kiziguro	2
		Ngarama	6
		Rugarama	1
	KAYONZA	Kabare	4
		Kabarondo	4
		Mukarange	14
		Nyamirama	5
		Rwinkwavu	12
	KIREHE	Gahara	1
		Gatore	6
		Kasarabwayi	2
		Kigarama	5
		Kigina	2
		Kirehe	9
		Mahama	11
		Musaza	1
		Nasho	3
		Nyamugali	3
	NGOMA	Gashanda	2
		Jarama	4
		Karembo	4
		Kazo	4
		Kibungo	18
Mugesera		1	
Murama		1	
Remera		2	
Rukira		2	
Sake		6	
Zaza		1	
NYAGATARE	Karangazi	11	

Province	District	Sector	Number of objects
		Matimba	3
		Nyagatare	3
		Rukomo	1
		Rwamiyaga	4
	RWAMAGANA	Fumbwe	3
		Gahengeri	3
		Karenge	4
		Munyiginya	6
		Musha	7
		Muyumbu	2
		Nyakariro	6
		Nzige	5
		KIGALI CITY	GASABO
Kimihurura	4		
Kimironko	11		
Kinyinya	1		
Remera	15		
KICUKIRO	Gahanga		11
	Gatenga		6
	Gikondo		5
	Kanombe		3
	Kicukiro		3
	Masaka		7
	Niboye		9
NYARUGENGE	Kanyinya		3
	Kigali		1
	Kimisagara		12
	Muhima		23
	Nyakabanda		1
	Nyamirambo		5
	Rugarama		2
	Rwezamenyo	20	
NORTH	BURERA	Bungwe	3
		Butaro	6
		Cyanika	4
		Cyeru	1
		Gahunga	1
		Gatebe	2
		Gitovu	3
		Kagogo	3
		Kinoni	4
		Kinyababa	3

Province	District	Sector	Number of objects
		Kivuye	2
		Nemba	1
		Rugarama	3
		Ruhunde	1
		Rusarabuye	2
		Rwerere	4
	GAKENKE	Coko	2
		Gakenke	2
		kivuruga	2
		Muhondo	4
		Nemba	1
		Ruli	1
		Rushashi	2
	GICUMBI	Byumba	16
		Cyumba	2
		Kaniga	1
		Rukomo	1
	MUSANZE	Busogo	6
		Cyuve	11
		Kinigi	4
		Muhoza	24
		Muko	4
		Musanze	8
		Nyange	1
RULINDO	Bushoki	1	
	Cyungo	1	
	Rukozo	1	
	Rusiga	1	
SOUTH	GISAGARA	Kansi	0
		Kibirizi	0
		Mugarubwa	2
		Ndora	2
		Nyanza	8
		Save	4
	HUYE	Huye	7
		Mbazi	6
		Mukura	6
		Ngoma	8
		Tumba	17
	KAMONYI	Gacurabwenge	1
		Kayenzi	2
		Mugina	2

Province	District	Sector	Number of objects
		Musambira	1
		Nyarubaka	1
		Rugarika	2
		Rukoma	2
		Runda	2
	MUHANGA	Cyeza	2
		Muhanga	8
		Mushishiro	3
		Nyamabuye	23
		Nyarusange	2
		Shyogwe	7
	NYAMAGABE	Gasaka	6
		Kitabi	2
		Tare	4
	NYANZA	Busasamana	29
		Busoro	0
		Gatagara	2
		Kigoma	7
		Mukingo	2
	NYARUGURU	Kibeho	2
		Mata	1
		Ruramba	8
		Rusenge	1
	RUHANGO	Bweramana	5
Kinazi		3	
Ruhango		24	
WEST	KARONGI	Bwishyura	11
		Gashari	3
		Gishyita	2
		Gitesi	2
		Mubuga	2
		Rubengera	20
		Rugabano	2
	NGORORERO	Gatumba	6
		Hindiro	11
		Kabaya	13
		Ngororero	10
		Nyange	2
	NYABIHU	Bigogwe	5
		Jenda	6
		Jomba	4
		Karago	4

Province	District	Sector	Number of objects
		Mukamira	9
		Rambura	16
	NYAMASHEKE	Bushekeri	5
		Bushenge	4
		Kagano	8
		Kanjongo	10
		Kirimbi	4
		Mahembe	6
		Ruharambuga	3
		RUBAVU	Gisenyi
	Kanama		25
	Nyamyumba		31
	Nyundo		0
	Rubavu		30
	Rugerero		19
	RUSIZI	Bugarama	33
		Gihundwe	6
		Kamembe	29
		Muganza	20
		Mururu	6
	RUTSIRO	Gihango	10
		Kivumu	3
		Manihira	4
		Murunda	3
		Musasa	4
		Mushonyi	3
		Mushubati	2
		Ruhango	2
		Rusebeya	2
	<b>Grand Total</b>		<b>192</b>



*Appendix B: Data collection form*

**Capture 1: Distributor's Name:** \_\_\_\_\_ **Date:** \_\_\_\_\_

Questions for FSW	Possible responses	Notes
Name of the Hotspot	District: Sector: Hotspot name:	
Did you give (FSW) a unique object number one (C1)? If yes.... continue	<input type="checkbox"/> Yes <input type="checkbox"/> No	
What is your best estimate of the person's age?	<input type="checkbox"/> Between 15-17 years old (Please provide this person a service referral form, if this box is checked) <input type="checkbox"/> Between 18-24 years old <input type="checkbox"/> Older than 25 years old	

**Capture 2: Distributor's Name:** \_\_\_\_\_ **Date:** \_\_\_\_\_

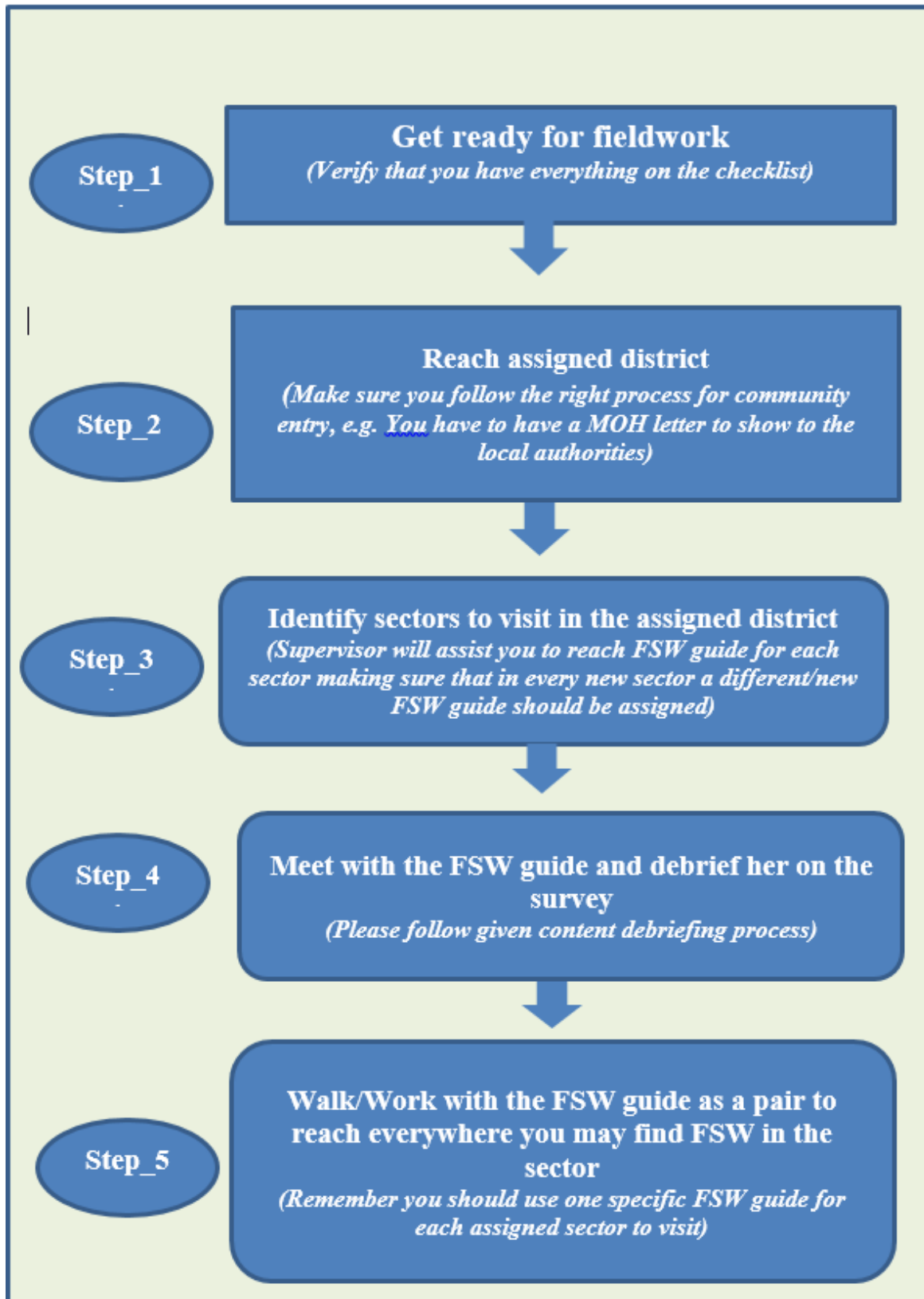
Questions for FSW	Possible responses	Notes
Name of the Hotspot	District: Sector: Hotspot name:	
Did the (FSW) receive unique object one?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Do they have the unique object one?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
If they do not have it, can they describe it?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Did you give (target population member) a unique object two?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
What is your best estimate of the person's age?	<input type="checkbox"/> Between 15-17 years old (Please provide this person a service referral form, if this box is checked) <input type="checkbox"/> Between 18-24 years old <input type="checkbox"/> Older than 25 years old	

**Capture 3: Distributor's Name:** \_\_\_\_\_ **Date:** \_\_\_\_\_

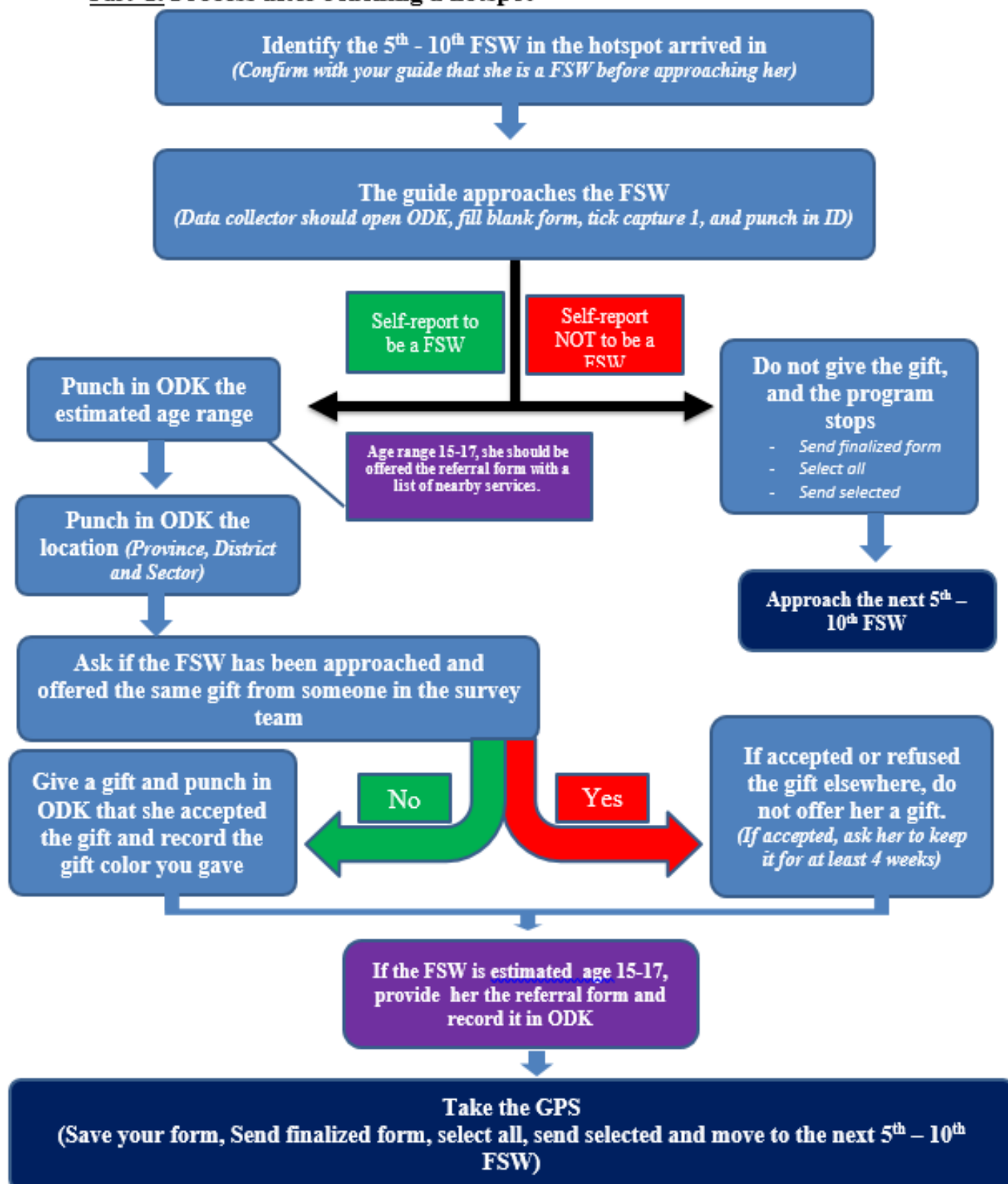
Questions for FSW	Possible responses	Notes
Name of the Hotspot	District: Sector: Hotspot name:	
Did the (FSW) receive unique object one?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Do they have the unique object one?	<input type="checkbox"/> Yes <input type="checkbox"/> No	

<b>If they do not have it, can they describe it?</b>	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>Did the (FSW) receive unique object two?</b>	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>Do they have the unique object two?</b>	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>If they do not have it, can they describe it?</b>	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>What is your best estimate of the person's age?</b>	<input type="checkbox"/> Between 15-17 years old (Please provide this person a service referral form, if this box is checked) <input type="checkbox"/> Between 18-24 years old <input type="checkbox"/> Older than 25 years <input type="checkbox"/> old

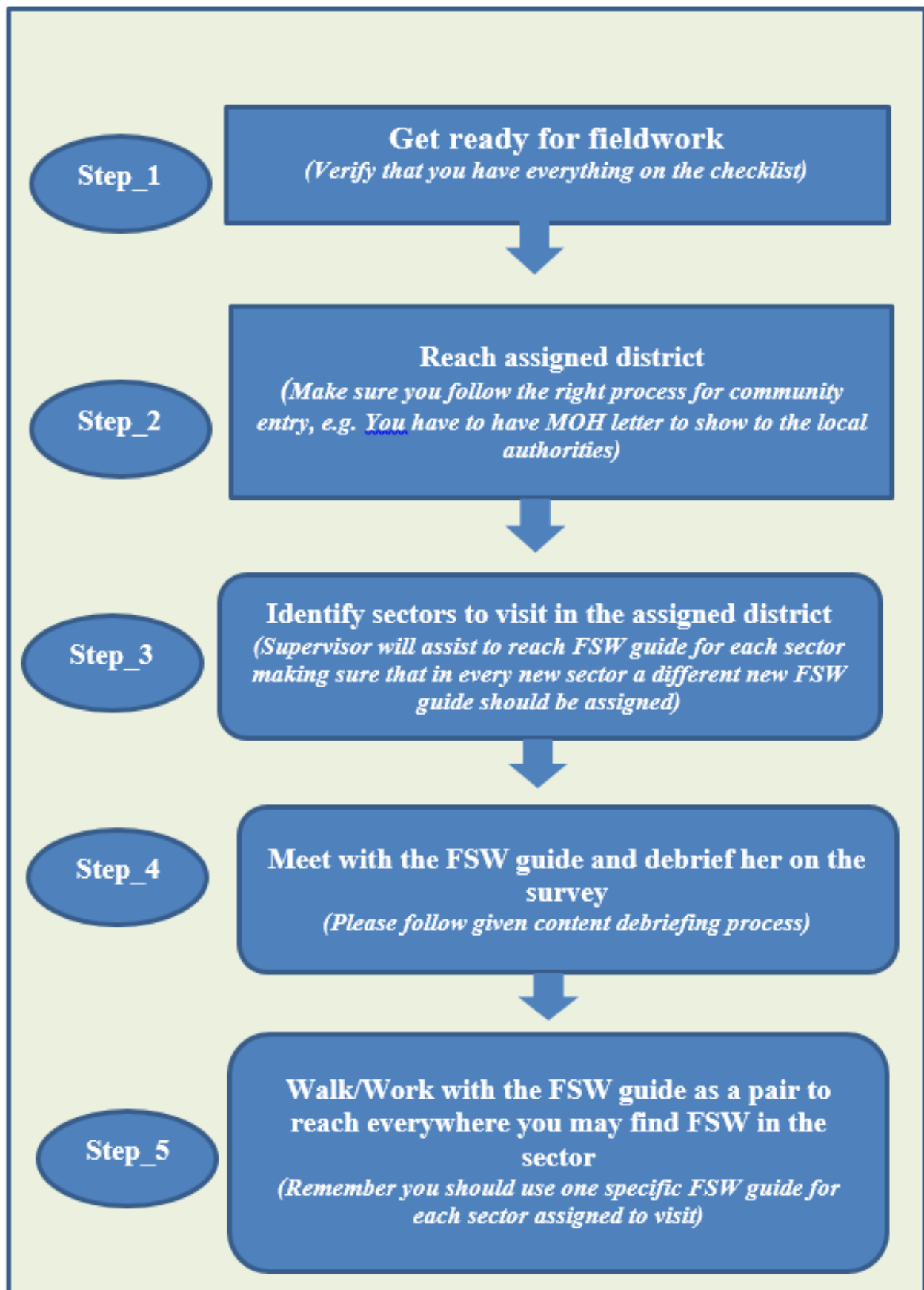
**Part 1: Process prior to approaching a Female Sex Worker**



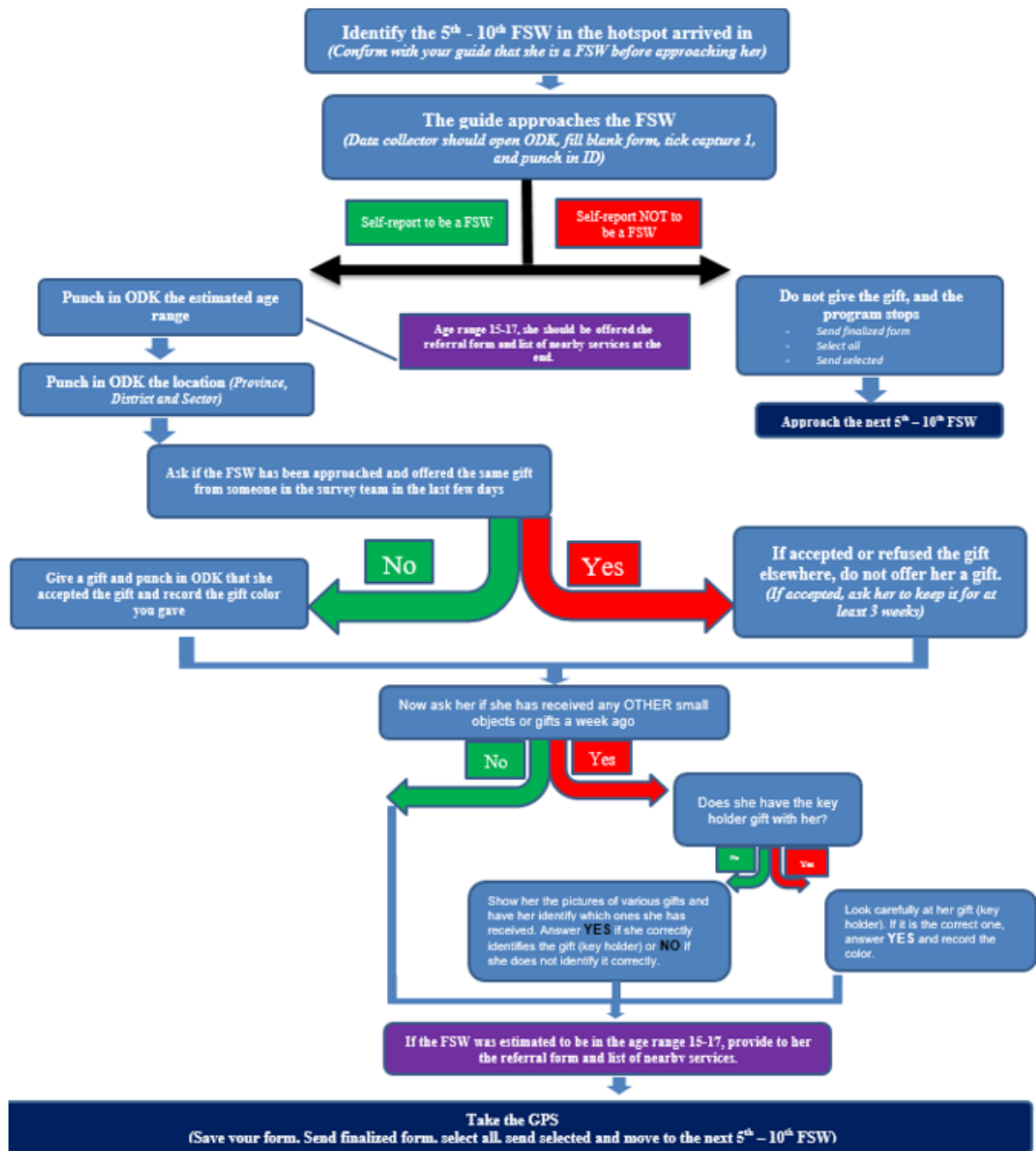
## Part 2: Process after reaching a hotspot



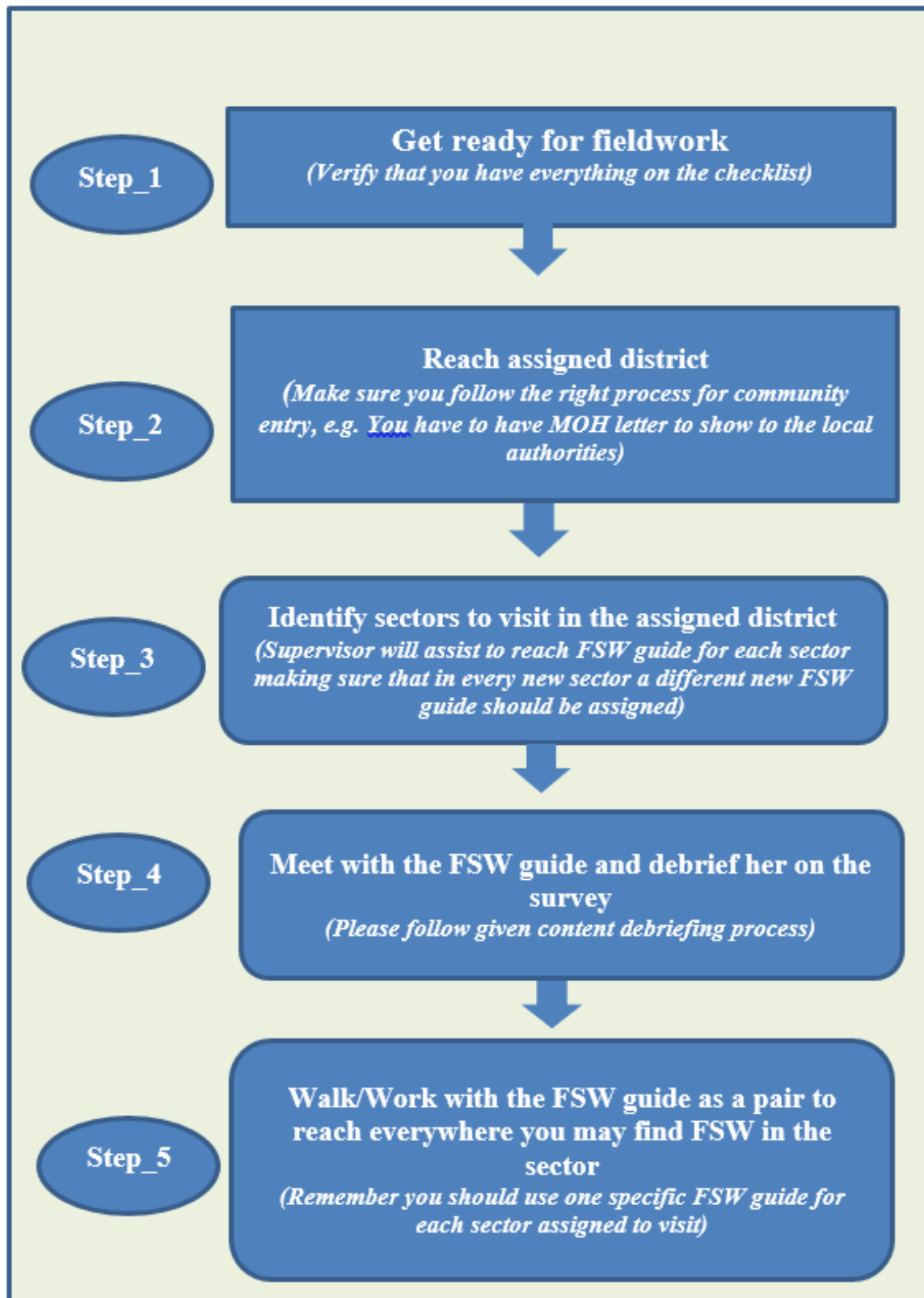
**Part 1: Process prior to approaching a Female Sex Worker**



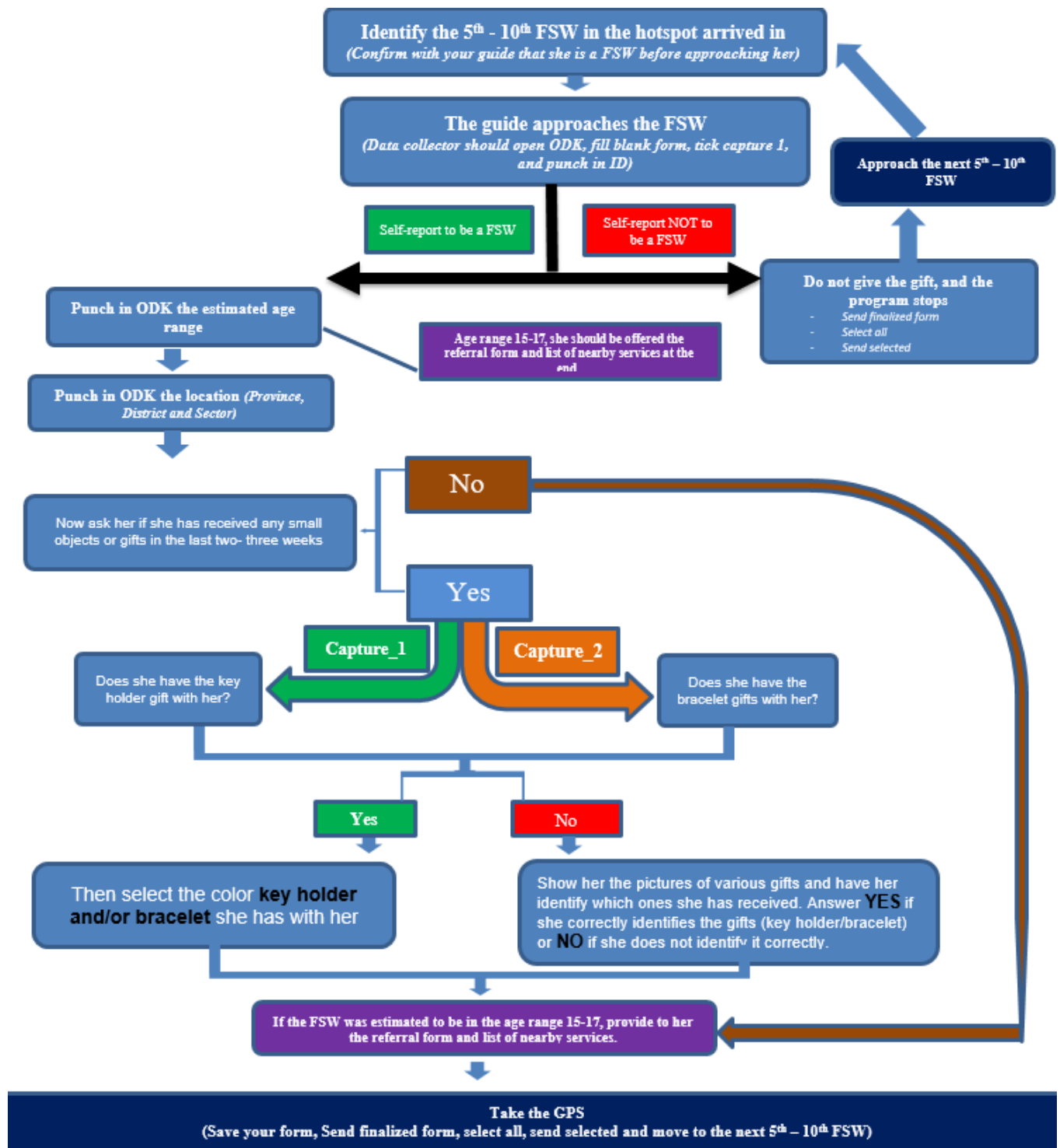
## Part 2: Process after reaching a hotspot



**Part 1: Process prior to approaching a Female Sex Worker**



## Part 2: Process after reaching a hotspot





Appendix F: Service Referral Form



INSTITUTE OF HIV/AIDS, DISEASE PREVENTION & CONTROL  
HIV-AIDS, STIs & Other Blood Borne Infections Division

**CONFIDENTIAL REFERRAL NOTE For FSW BETWEEN 15-17 YEARS**

*(Note de Référence confidentielle)*

We are referring to you:

*(Nous vous référons):*

- On ...../...../20..... [Date of referral]  
*(En date du ...../...../20..... [Date de transfert])*
- The client who has the code N°.....  
*(Le client dont l'identifiant unique est .....)*
- Age: ..... years  
*(Age de .....ans)*

This person is referred to your health facility for comprehensive HIV Prevention and management including psychosocial support, GBV, legal aid services and other services provided at this health facility.

Please assist her with all necessary care/support.

Name of health facility referred to: \_\_\_\_\_ Person to contact: \_\_\_\_\_

*(Nom de la FOSA de référence)*

*(Personne à contacter)*

Done at ..... Date : ..... / ..... / .....

*(Fait à)*

*(Date)*

Stamp of RBC/IHDPC (*Cache* du RBC/IHDPC)

**Appendix G: Number of captured FSWs by estimated age category and province**

Province	Estimated age groups									Total		
	15 - 17			18 - 24			25+			C1	C2	C3
	C1	C2	C3	C1	C2	C3	C1	C2	C3			
Kigali	6	1	3	63	76	98	84	111	71	153	188	172
South	5	5	1	102	111	116	108	124	129	215	240	246
West	11	3	4	144	152	193	181	240	363	336	395	560
North	4	2	2	49	90	61	72	63	83	125	155	146
East	7	1	5	84	84	146	122	141	213	213	226	364
<b>Total</b>	<b>33</b>	<b>12</b>	<b>15</b>	<b>442</b>	<b>513</b>	<b>614</b>	<b>567</b>	<b>679</b>	<b>859</b>	<b>1,042</b>	<b>1,204</b>	<b>1,488</b>

*Appendix H: Estimated number of objects planned to be distributed and actual number of objects distributed per capture and province*

	Planned	Objects Distributed		
	C1 & C2	C1	C2	
<b>Kigali city</b>	<b>155</b>	<b>153</b>		<b>188</b>
Gasabo	44	44	53	
Kicukiro	44	43	51	
Nyarugenge	67	66	84	
<b>East</b>	<b>236</b>	<b>213</b>		<b>226</b>
Bugesera	35	31	32	
Gatsibo	16	16	13	
Kayonza	39	33	39	
Kirehe	43	35	40	
Ngoma	45	42	45	
Nyagatare	22	21	21	
Rwamagana	36	35	36	
<b>North</b>	<b>139</b>	<b>125</b>		<b>155</b>
Burera	43	29	48	
Gakenke	14	13	14	
GICUMBI	20	21	26	
Musanze	58	58	63	
Rulindo	4	4	4	
<b>South</b>	<b>214</b>	<b>215</b>		<b>240</b>
Gisagara	16	17	23	
Huye	44	43	44	
Kamonyi	13	13	18	
Muhanga	45	45	46	
Nyamagabe	12	12	18	
Nyanza	40	41	40	
Nyaruguru	12	12	15	
Ruhango	32	32	36	
<b>West</b>	<b>456</b>	<b>336</b>		<b>395</b>
Karongi	42	29	47	
Ngororero	42	39	45	
Nyabihu	44	15	28	
Nyamasheke	40	39	44	
Rubavu	161	92	90	
Rusizi	94	89	98	
Rutsiro	33	33	43	
<b>National</b>	<b>1,200</b>	<b>1,042</b>		<b>1,204</b>

**Appendix I: Observed mobility of FSWs during Capture 2 (1 week period)**

<b>Color of key holder (Capture 1 object) shown or described</b>						
<b>Province</b>	Orange	Green	Blue	Red	White	Total
Kigali City	15					15
South		24	1			25
West			25			25
North				18		18
East					30	30

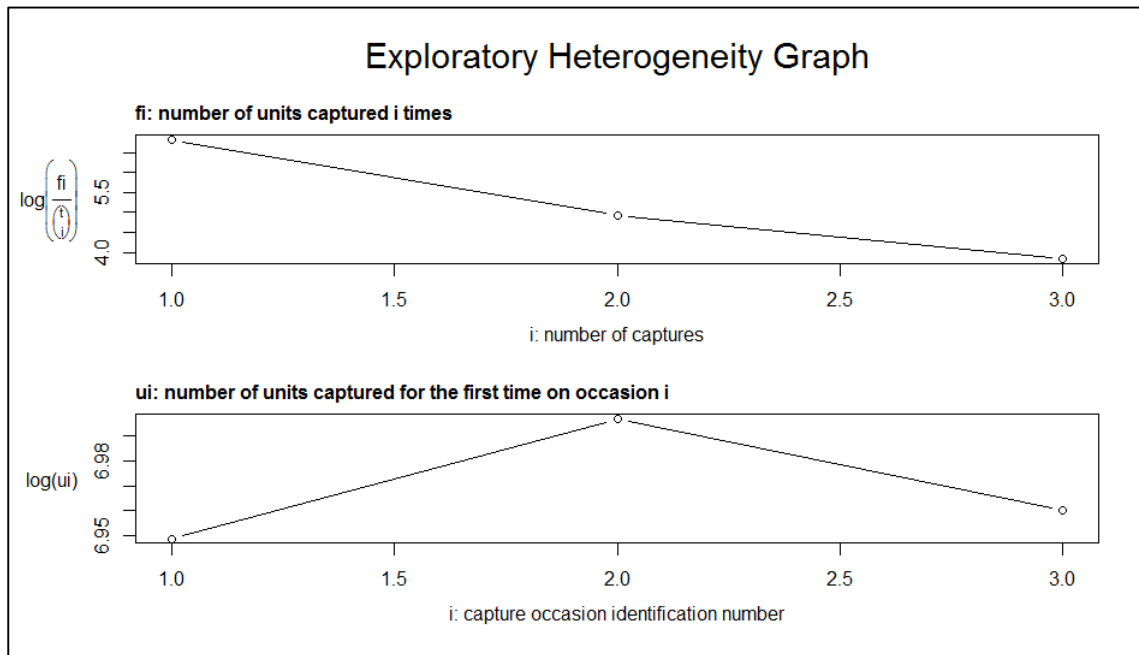
**Appendix J: Observed mobility of FSWs during Capture 3 (2 weeks period)**

<b>Color of key holder (Capture 1 object) shown or described</b>						
<b>Province</b>	Orange	Green	Blue	Red	White	Total
Kigali City	30					30
South		46	1			47
West		7	63	1		71
North	1			18		19
East	5				31	36

**Appendix K: Observed mobility of FSWs during Capture 3 (1 week period)**

<b>The color of Bracelet (Capture 2 object) shown or described</b>						
<b>Province</b>	Orange	Green	Blue	Red	White	Total
Kigali City		1			1	31
South		47				47
West		11	90	1		102
North		1		23		24
East	3				30	33

**Appendix L: Exploratory Heterogeneity Graph**



**Appendix M: Sensitivity analysis for 'prior' probability distribution selection**

