

Crash Data Reporting and Analysis – An Oregon Case Study

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Abstract. Motor vehicle crash underreporting is a serious problem as it masks the total impact of highway crashes and may skew our understanding of high crash frequency locations and the need for appropriate countermeasures. It is generally understood that highway crashes are underreported, but the extent of the underreporting is often not clear. Using a case study along one Oregon highway, this paper estimates the magnitude of crash underreporting during 2000. The crashes reported by the Oregon Department of Transportation (ODOT) for a state highway (OR-18) were compared with the record of crashes as reported by an incident management program. Several parameters such as location, time of day and crash description were used to determine whether the same crash had been recorded by the two independent data sources. Crash data are compiled by ODOT from individual drivers and police crash reports. The roving incident responders attend to incidents/crashes on the highway and dispatch the information to the traffic management center through a computer aided dispatch system. Presently there is no mechanism that combines the two data sources. Given that many states now have incident response programs in place, suggestions are provided regarding how useful information can be extracted and archived in order to improve the compliance rate for statewide crash reporting.

BACKGROUND

The Oregon Department of Transportation (ODOT) has summarized motor vehicle crash records since 1941 and began publishing crash data in 1948. The ODOT Crash Analysis and Reporting (CAR) Unit compiles crash data from individual driver and police crash reports submitted to the Department of Motor Vehicles (DMV) as required by Oregon state law. These data are stored in a database and summaries are published annually. Like most states, the state of Oregon has set threshold limits for crash reporting based on the estimated property damage and personal injury. Oregon law currently requires that any crash on a public roadway resulting in a fatality, bodily injury or damage to one person's property in excess of \$1,000 be reported to the DMV. In Oregon, submittal of crash report is the responsibility of the individual driver. However, approximately 33% of all reported crashes are also investigated by a police officer.

As part of its traffic management function, the Oregon DOT has developed an Incident Response (IR) program. The program was originally developed for the urban freeways of Portland but has since been expanded to include the less metropolitan southern Willamette Valley. ODOT Region 2, which is responsible for this area of the state, has assigned incident responders to patrol several key highway segments, assisting state and local police forces and individual motorists during a wide variety of traffic events. Incidents include crashes, breakdowns, spilled loads or

other random events that reduce the capacity of the road leading to vehicular delays. Incident management is a critical public safety and traffic management technique. The IR personnel help relieve non-recurrent congestion through quick incident detection, verification, response, and removal/clean up. In addition, the IR personnel notify the proper authorities, through the traffic operations center (TOC), of other types of roadway problems that will impact traffic flow or the safety of motorists or responders. Each incident is recorded in a computer aided dispatch (CAD) database. Oregon Route 18 (OR-18) is one of the key routes managed by the IR program and was chosen for analysis.

OR-18 has a length of 51 miles and is a rural, mostly 2-lane highway. There are some short sections with 4 lanes that account for a total of almost 6 miles of the route. The highway passes through four counties: Lincoln, Tillamook, Polk, and Yamhill. OR-18 serves as the main route between Salem, the state capital, in the Willamette Valley and the Pacific coast. The corridor serves tourist destinations amongst them being the Spirit Mountain Casino at Grand Ronde.



Figure 1: Route 18 Location Map

Figure 1 shows a map of ODOT Region 2, highlighting the location of OR-18. Along this route there is also a 19-mile safety corridor between Grand Ronde and Sheridan. This section was declared a safety corridor in 1996 due to a large number of fatalities. Traffic crashes on OR-18 claimed three lives in 1995, three in 1996, two in 1997, six in 1998, and eleven in 1999. In addition to these fatal crashes, all types of crashes have been reported to account for almost 75% of the non-recurrent delay along this corridor. The Valley Junction Automatic Traffic Recorder (ATR) recorded a mean average daily traffic (ADT) of 22,000 vehicles per day for all weekend days in 2000 along this section of OR-18 (see Figure 1). The ADT increased 33% between 1995 and 2000 with no increase in the capacity of the facility (Bertini et al., 2001).

Thus, in Oregon, for certain highways, there are two separate and distinct sources of crash data: (1) the statewide crash data maintained by the ODOT; (2) the crashes reported by the IR program on the days, times and at the locations they are actually patrolling.

Unreported crashes (those not in the state's database) can be considered of two types: 1) those that meet the minimum threshold and are not reported; and 2) those that are not required to be reported. It is well known that not all qualifying crashes occur in both of these categories. However, what is not known is the extent to which it occurs, or what portion of the total crash picture is represented by unreported crashes. Figure 2 presents a Venn diagram showing the total crash sample space for a region where an IR program is operational. The area shown is not meant to represent scale, rather it is for graphical purposes only. Total crashes that occur include crashes recorded by the ODOT only is represented by area 'a', the IR personnel only by area 'i', those recorded by both the IR personnel and the ODOT by area 'b', those that do not meet the minimum threshold for reporting by area 'm', and an unknown component of area 'a'. The unknown crashes, shown by hatched lines in Figure 2, are neither reported to ODOT nor captured by IR and yet meet the minimum threshold for crash reporting.

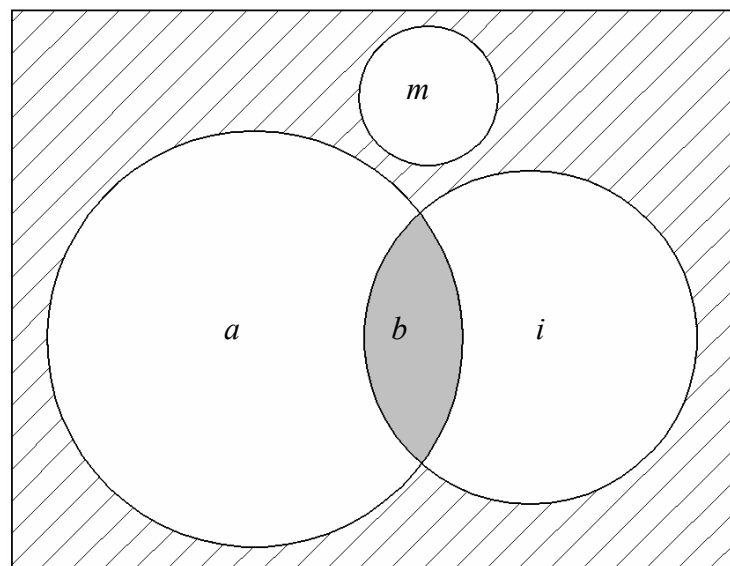


Figure 2: Total Crashes in a Region

The objective of this paper is to fuse data reported by IR personnel with data reported to ODOT for the year 2000 by cross-correlation. The potential magnitude of crash data underreporting is thus estimated. For the purpose of this paper, the crashes reported through the Region 2 IR were referred to as “Incident” data and the ODOT CAR data were referred to as “ODOT” data.

The contents of this paper include a literature review on crash data underreporting followed by a general description of the Incident data and ODOT data used in this study. This is followed by a description of the preparation of Incident and ODOT data for matching purposes. There is a section devoted to describing how the Incident data were matched with ODOT data before the final results and conclusions are presented.

CRASH UNDERREPORTING LITERATURE REVIEW

There is a substantial amount of literature available on the subject of road crashes that acknowledges the problem of crash underreporting. One recent study (U.S. DOT, 2002) estimated that there were 41,821 fatal crashes, 5.3 million injury crashes, and 28 million property damage only (PDO) crashes in the United States including both police-reported and unreported crashes in 2000. It was also estimated that 21% of these injury crashes and half of the PDO crashes were not reported. The total estimated cost of all motor vehicle crashes (reported and unreported) for the same year was \$230.6 billion including \$25.6 billion (11%) attributed to travel delay. This total was equivalent to approximately \$820 for every U.S. citizen and 2.3% of the U.S. Gross Domestic Product. The study used several data sources, including the Fatality Analysis Reporting System (FARS), to estimate the number of fatal crashes on U.S. public roads. It was noted that although the FARS census provides an accurate count for fatalities, there is no equivalent data source for injuries. The actual injury count was estimated from several other sources, including the Crashworthiness Data System (CDS), the General Estimates System (GES), the National Automotive Sampling System (NASS), the National Health Interview Survey (NHIS), and injury estimates provided to the Federal Highway Administration (FHWA) by individual states. Several methods were used to combine these data to provide a more realistic estimate for injury related crashes. The study applied the ratio of PDO involved vehicles to injuries to the 2000 injury total to estimate actual PDO crashes that likely resulted. Finally, it was concluded that underreporting likely occurred when the injured party was at fault and did not wish to involve police due to concerns about insurance or legal repercussions, or when minor bicycle or pedestrian injuries occurred. Also, a variety of administrative, clerical, or procedural errors may result in the injuries being unrecorded. For example, life flight or ambulance transport may occur prior to police arrival, or information on the injured parties may not be provided to police. Estimates of unreported injuries vary by injury severity with nearly one quarter of all minor injuries and almost half of all PDO crashes remaining unreported. In contrast, it is believed that all critical or fatal injuries are properly reported.

In the Nationwide Personal Transportation Survey (Hu and Young, 1990) differences between crashes for which police reports were filed and those for which no police reports were filed were estimated. Reportable crashes were considered to be those with damage above \$500 and

involving an injury. Of 6,830 survey respondents who were involved in crashes, 5,400 crashes (78%) were found to have filed a police report and the remaining 1,430 (21%) did not. Many drivers were unaware that they were required to file a report. The ratio of reported to unreported crashes (4 to 1 respectively) was found to be greater than the U.S. DOT's previous experience of 2 to 1. This study found that single-vehicle crashes were more likely to be unreported than multiple-vehicle crashes. Also, police-reported crashes resulted in a larger proportion of more serious injuries than did unreported crashes. A total of 92% of unreported crashes resulted in PDO.

There is also an ODOT study that evaluated median barrier crossovers and clearly portrayed the seriousness of unreported crashes in Oregon (Sposito and Johnson, 1998). An evaluation of the effectiveness of a three-cable barrier was conducted on a 14-mile segment of Interstate 5 (I-5) between Salem and Portland. The study relied on the Oregon State Police data and a construction contractor's repair location data. The site was reported to have an average median width of 15.2 meters, posted speed limit of 65 miles per hour and average of 73,000 vehicles per day in 1997. The study revealed that the cable median barrier was hit 53 times between December 1996 and March 1998, or once every nine days, based on contractor repair records. The highest impact frequency location (milepost 265) had 9 impacts but only 7 were reported in the ODOT database. The study reported that of 53 impacts/repairs, 27 crashes (51%) had no crash report filed. Other states have also experienced a discrepancy between the number of police-reported accidents and the number of repairs.

Crash underreporting is not only a problem in U.S. but also faces many other countries such as the United Kingdom, Canada, Germany, and the Netherlands (Hauer and Hakkert, 1988). When comparing police reported crashes and crash cases reported to local hospitals, insurance companies and garages, it was observed that crash underreporting was substantial. For all countries studied, approximately 95% of fatalities were reported. A total of 20% of injuries that required hospitalization did not appear in police records and of all injuries sustained in motor vehicle crashes, approximately half were estimated to be unreported to police. The likelihood of reporting PDO crashes was estimated to be even lower. These results showed that the probability that a crash would be reported depended on the severity of the outcome, the age of the victim, his/her role in the crash, and the number of vehicles involved.

Another study showed that crash underreporting was a universal problem as it analyzed data from 13 countries in Europe, Asia and North America and determined the extent to which crash reporting levels differed among these countries (Elvik and Mysenm, 1999). This comparison was not performed on rigorous grounds because each country has different limits for reportable crashes. The sources of data included hospital and insurance records. Significant differences among countries in the reporting level for injuries treated in hospitals were found. The reporting levels for these injuries ranged from 21 - 88%. Reporting was found to be incomplete at all levels of injury severity. The mean reporting level in the study was 95% for fatal injuries according to the 30-day rule, 70% for serious injuries, 25% for slight injuries, and 10% for very slight injuries. Reporting levels were highest for vehicle occupants and lowest for cyclists. This pattern was observed to be consistent across countries.

Concluding the literature surveyed for the present study, crash underreporting seems to be a serious problem that should be addressed by research because safety analyses and associated recommendations are based on reported crashes rather than the actual number of crashes that occurred. The literature showed that almost all states in the U.S. face the problem of crash underreporting. While fatal crashes are reported with certainty, there are data gaps in the reporting of injury and PDO crashes. Both the study for Oregon and experience of the U.S. DOT suggest that the ratio of reported to unreported crashes is around 2 to 1.

INCIDENT RESPONSE DATA

IR personnel patrol their assigned highway segments, provide required services, and record and/or report information for each incident including the time they received the call, possible time at which the incident occurred, whether OSP was on the scene, the approximate location of the incident (by reporting the milepost and county), time the incident was cleared or resolved, the nature of the incident (brief description of the scene) and whether any assistance was sought, such as a call for an ambulance or a tow truck. The data associated with a crash are recorded under dispatch code 1216 by the Region 2 traffic operations center (TOC).

The computer aided dispatch (CAD) data includes the following 15 fields (Bertini et al., 2001):

ID	Identification number (not used)
CAD_NUM	Incident number
CALL	Call type (not used)
DATE	Date
UNIT	Unit responding (not used)
TIME_RCVD	Time call received
CLEAR	Time call cleared
LOCATION	Location (highway number, etc.)
REMARKS	Remarks
REMARKS2	Additional Remarks
ARRIVED	Time arrived
DISPO	Disposition code
CA	Command area (not used)
COUNTY	County, and
DISP_RMKS	Dispatchers remarks

The DISP_RMKS field included comments by the responder including roadway characteristics, weather, number of people involved in the crash and their gender. This facilitated comparison with the ODOT data. The OR-18 IR program is in effect for ten hours each Friday, Saturday, Sunday, and Monday; the days with the highest traffic volumes. Normally the IR personnel begin their patrol at 8:00 a.m. and finish by 6:00 p.m. However, there can also be instances when they

are required to respond to crashes at other times. Such crashes are generally of a serious nature (involving an injury or fatality). This was confirmed by the data analysis.

ODOT DATA

The ODOT statewide computerized crash data contains a substantial amount of information about collisions. These data are available for all state highways in Oregon. The raw ODOT data consisted of coded information that was interpreted using a code manual (ODOT, 1997). The fields used for the study are shown below:

Date/Day-Time	Six-digit code (MMDDYY).
County/City	Jurisdiction location.
MileP	Milepost, distance in miles.
First/Intrsect	Closest intersecting crossroad to the roadway on which crash occurred.
Road Char / Direc-LOC	Type of roadway (straight etc.) and direction from intersecting roadway to crash location.
Inter, or, (Median), Type/Turn Legs	Type of intersection or number of lanes and median type involved at the crash location.
Weath Surf-light	Weather and surface conditions (rain, fog; dry, ice) and light conditions (daylight, etc.)
Type Acc-Coll	Crash type and type of collision to represent the physical relationship of vehicle(s) at the time of collision based on their intended path of travel.
Class	Crash class describes severity: property damage only (PDO), injury (INJ), and fatal (FAT).
Participant/Sevrty	Extent of injuries for each involved party.
Veh Owner/Type	Vehicle type
Res-Lic/Age-Sex	Residence and license of driver, occupant numbers, age for involved persons, sex and operator status.
Move/Fr-To	Intended vehicular movement, including direction of travel.
Event/Cause	Event is any incident or situation contributing to or involved in the

	crash. Cause is the determination of the overall crash cause(s).
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PREPARING INCIDENT DATA

The IR program database for OR-18 was first sorted for crashes and then by date. This separated the crash data from other types of incidents for the year 2000. At this point, the data were also scanned for duplications or other anomalies.

There were 76 crashes reported in 2000 during IR hours on OR-18. To locate each crash more precisely, the location (LOCATION) and remarks (DISP_RMKS) fields were examined. While some crashes were identified by exact locations, landmarks or crossroads identified others. Based on previous research (Bertini et al., 2001) and a series of database queries, a milepost value was generated manually for each crash as necessary. In order to facilitate comparison with Incident data, ODOT data was also adjusted into a similar format.

PREPARING ODOT DATA

The ODOT crash report lists every reported crash for the year. Therefore, to match these data with the IR program data, ODOT data were sorted by year and then by day of the week. The locations were also checked for matches with the archived IR program data. For the year 2000, there were 106 total crashes reported to the ODOT system on OR-18. Further, since the IR personnel were on duty from 8:00 a.m. to 6:00 p.m., four days a week, ODOT data were sorted by reported crash times. It was revealed that there were 70 crashes that occurred on Fridays, Saturdays, Sundays, and Mondays. Of these 70 crashes, 50 crashes occurred within the work hours of the IR personnel and 6 other crashes occurred after 6:00 p.m.. These 6 crashes were retained because they were also reported in the Incident database as injury crashes. This indicated that the IR personnel had responded to these incidents, perhaps on request from the TOC. The remaining 14 ODOT reported crashes occurred outside of the times that IR personnel were on-site. A total of 56 ODOT database crashes could now be compared with the 76 crashes appearing in the Incident database.

A total of 52 of the ODOT-reported crashes had milepost values assigned to them. The remaining four had a milepost error codes in the location fields but had county codes assigned. Since all other information about these crashes was present in the crash report, it was safe to conclude that all 56 crashes occurred within the limits of the study corridor. These 56 crashes comprised 53% of the total number of crashes reported to ODOT for this section of OR-18 in 2000.

MATCHING THE INCIDENT AND ODOT DATA

The crash data from the two sources were compared according to their county, milepost, time of day, date and crash description. These criteria were used to conclude whether the same crash had been recorded by the IR program and reported to the ODOT database. Matched crashes are shown in Table 1.

Of the 76 crashes contained in the IR program archived data, 19 appeared to match entries contained in the ODOT database. For all other crashes, none of the criteria (description, county, milepost, time of the day or date) matched. When matching the data, some flexibility was included when entries were not exactly the same. The incident responders report the time they received the call to respond to a particular crash, while the crashes reported to ODOT describe the approximate time a crash occurred. Also, the two sources of data reporting are different and some variation in time and location for the same crash is expected. For example, the first crash shown in Table 1, has the crash occurrence time reported by the driver as 4 a.m. where as IR personnel reached the site of crash between 7:03 and 7:29 a.m. This variation, however, is very small (0 to 6% for 18 of the matched crashes and about 13% for one crash) for the locations reported.

Table 1: Matched Entries for ODOT Data

S.No.	Date (same both)	Call Rcvd IR	Time Cr. Occur	County (same both)	Milepost		Nature	
		Incident	ODOT		Incident	ODOT	Incident	ODOT
1	10/09/00	7:03 AM	4:00 AM	Lincoln	3	3.00	SEVERE	PDO
2	06/10/00	1:05 AM	12:00 AM	Lincoln	3.2	3.00	SEVERE	INJ
3	12/24/00	2:29 AM	2:00 AM	Lincoln	4.0	4.00	SEVERE	INJ
4	01/17/00	8:50 AM	7:00 AM	Lincoln	6.0	5.90	SEVERE	INJ
5	12/18/00	1:45 PM	1:00 PM	Tillamook	13.0	14.00	PDO	PDO
6	11/17/00	2:58 AM	2:00 AM	Polk	16.73	17.00	SEVERE	INJ
7	10/08/00	4:56 PM	4:00 PM	Polk	20.2	20.20	SEVERE	INJ
8	06/04/00	3:21 PM	3:00 PM	Polk	21.2	21.18	SEVERE	INJ
9	09/04/00	3:06 PM	2:00 PM	Polk	22.0	22.00	PDO	PDO
10	01/14/00	11:01 PM	8:00 PM	Polk	23.1	23.50	SEVERE	INJ
11	07/01/00	3:36 PM	3:00 PM	Polk	23.1	23.87	SEVERE	INJ
12	01/01/00	3:08 PM	2:00 PM	Polk	21.2	24.00	SEVERE	INJ
13	11/11/00	10:14 AM	10:00 AM	Polk	27.2	27.13	SEVERE	INJ
14	11/26/00	3:31 PM	4:00 PM	Yamhill	34.73	34.77	NA	INJ
15	01/31/00	8:01 AM	7:00 AM	Yamhill	43.03	43.02	SEVERE	INJ
16	05/01/00	6:32 PM	6:00 PM	Yamhill	43.03	43.02	PDO	PDO
17	10/21/00	2:59 PM	3:00 PM	Yamhill	45.0	44.50	SEVERE	FAT
18	09/22/00	3:52 PM	3:00 PM	Yamhill	43.02	46.50	SEVERE	INJ
19	06/04/00	9:18 AM	9:00 AM	Yamhill	45.16	52.47	SEVERE	INJ

* This is generated crash severity index based on information from Incident Database. Refer to Data Analysis.

An incident tree shown in Figure 3 was generated based on the comparison of Incident and ODOT data. It presents an overall picture of the crashes by time, day and data source. After matching the two sources of crash data, it was revealed that the IR program reported 57 crashes

that were not reported to ODOT taking into consideration only the days and hours when the IR personnel are on duty. Also, there were 37 crashes (Friday through Monday) that had not been observed by the roving IR personnel.

Further, analysis of crashes was performed for crash type, counties that reported highest crashes, and mileposts with high crashes, for the two databases.

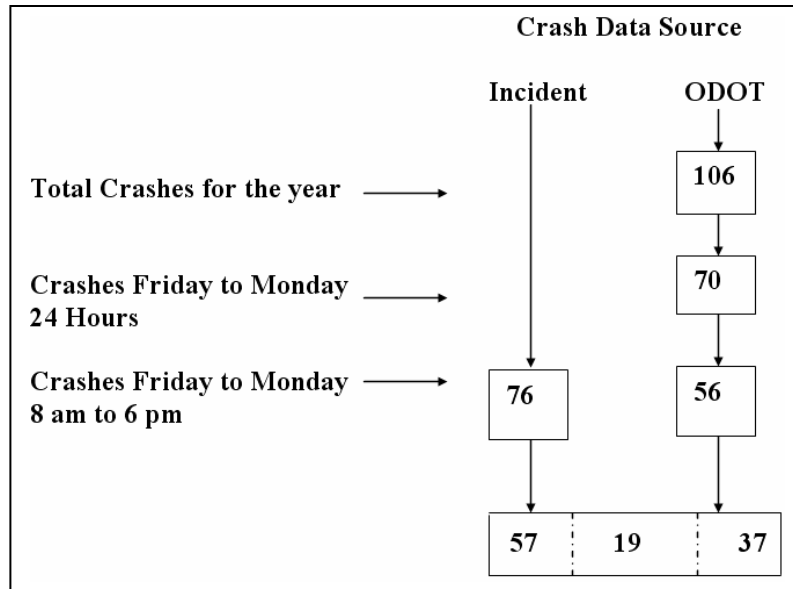


Figure 3: Incident Tree for OR-18, 2000

DATA ANALYSIS

For the year 2000, there were 39 injury crashes and 63 PDO crashes reported to ODOT out of the total of 106 crashes. The analysis of data within the time limits specified in the study shows that ODOT data included 56 crashes of which 2 involved fatalities, 22 included injuries and 32 were PDO. For crashes not observed by the IR personnel, 1 was fatal, 8 were injuries, and 28 were PDO crashes. Data by crash type from the two data sources are shown in Table 2.

Table 2: Crash by Type for Incident and ODOT data (8 a.m. to 6 p.m.)

Crash Type	IR		ODOT but	
	ODOT	(Incident)	not IR	IR but not ODOT
Fatal Crashes	2	52	1	37
Injury	22		8	
PDO	32	19	28	15
Indeterminate	0	5	0	5
Total	56	76	37	57

Since the IR program archived data does not require specification of the crash class, 'remarks' for the crashes were used to establish a crash index. This index determined whether the crash was "severe" in nature, or with no injury but with reportable property damage (PDO). A "severe" crash was considered to be one that either specified 'injury,' reported 'medics on scene' or mentioned 'OSP at the site of the crash.' This was done since any crash with medics, injuries or OSP on the scene was an indication that it was more severe than PDO.

The analysis for IR reported crashes showed that of the 76 crashes, 52 were severe, 19 PDO, and 5 indeterminate. For the 57 crashes that did not match the ODOT data entries, 37 were severe, 15 PDO and 5 indeterminate. Based on the literature (U.S. DOT, 2002), almost all fatal crashes are reported. The problem of crash underreporting is usually associated with either injury or PDO related crashes. Since the 37 crashes were reported in the Incident data and not in the ODOT data, one can make the assumption that these were all injury crashes. Thus, the total number of injury crashes that were observed by both the databases was 14 ($51 - 37 = 14$, or, $22 - 8 = 14$). Similarly, the number of PDO crashes that appeared in both data sets was 4 ($32 - 28 = 4$, or, $19 - 15 = 4$).

For fatal crashes that occurred on OR-18, 2 crashes were reported to ODOT. However, only one of them appeared in the Incident database. It is possible that one of the severe injury crashes observed by the IR program was later coded as a fatal crash, since an injury related to the crash that causes death up to 30 days is considered a fatal injury by the ODOT crash data. There were no other records that suggested a crash was fatal in nature. We have no reason to believe that there was any underreporting of fatalities that may have occurred on the highway.

The frequencies of crashes for the four counties through which OR-18 passes are shown in Figure 4. A highway passing through different jurisdictions is patrolled by different enforcement agencies and this can affect the number of crashes that get reported. The figure shows the crashes as reported by the two data sources. The highest numbers of crashes per mile as reported by ODOT occurred in Lincoln County (1.43) followed by Polk (1.14), Yamhill (0.96) and Tillamook (0.43) counties. The Incident database showed the highest number of crashes per mile occurred in Polk (2.56), followed by Lincoln (1.62), Tillamook (1.08) and Yamhill (0.70) counties.

The longitudinal crash locations (by milepost) were also determined from the databases, as shown in Figure 5. An increment of 3 miles was chosen to represent crashes along the corridor. Numbers of crashes falling within each 3 mile-segment were determined from both ODOT and Incident data. In Figure 5, bars above the zero line mean that there were higher number of crashes reported by the Incident data and the bars below mean that the ODOT reported more crashes for those locations. In all, the ODOT reported higher numbers of crashes than the Incident data for five locations, i.e., from mileposts 33 to 36, 39 to 42, 45 to 48, and 51 to 52.65. Comparatively, the Incident data included higher numbers of crashes than the ODOT data for twelve locations beginning from mileposts 1 to 24, 27 to 33, 42 to 45 and 48 to 51. There were two sections between mileposts -0.22 to 1 and 36 to 39 where both the databases recorded the same number of crashes. However, detailed analysis indicated that these were not the same crashes.

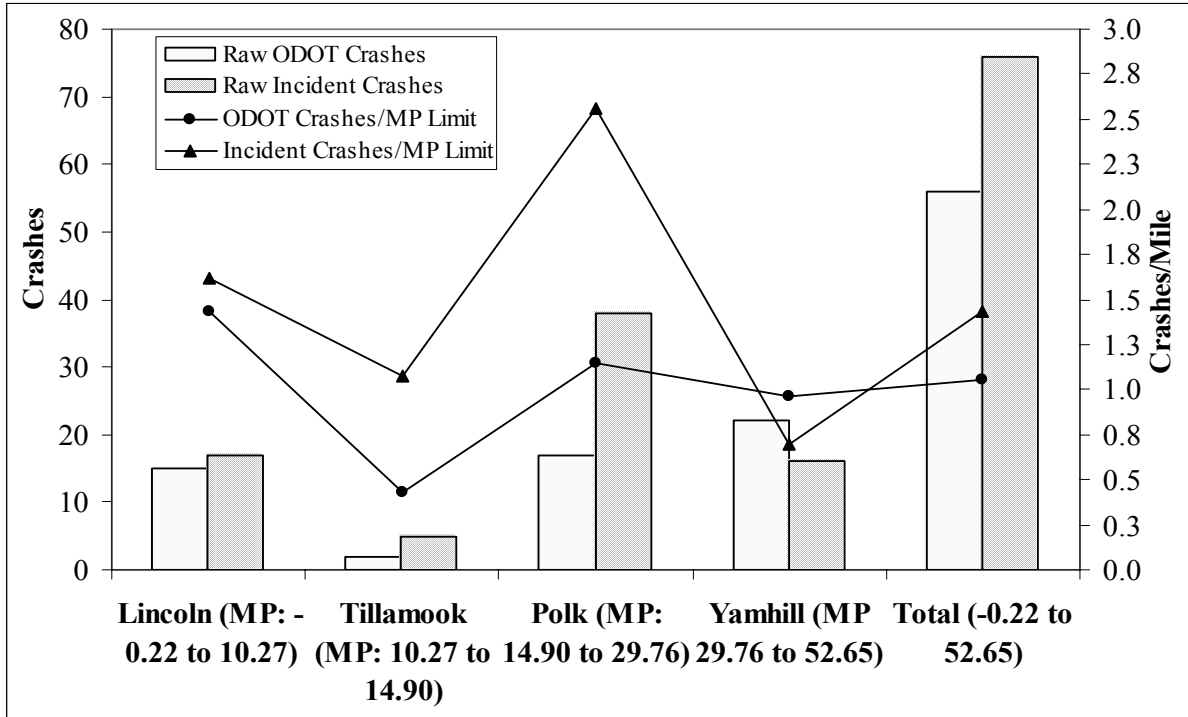


Figure 4: Crashes as Reported by Incident and ODOT Databases, 2000
(Friday to Monday, 8 a.m. - 6 p.m.)

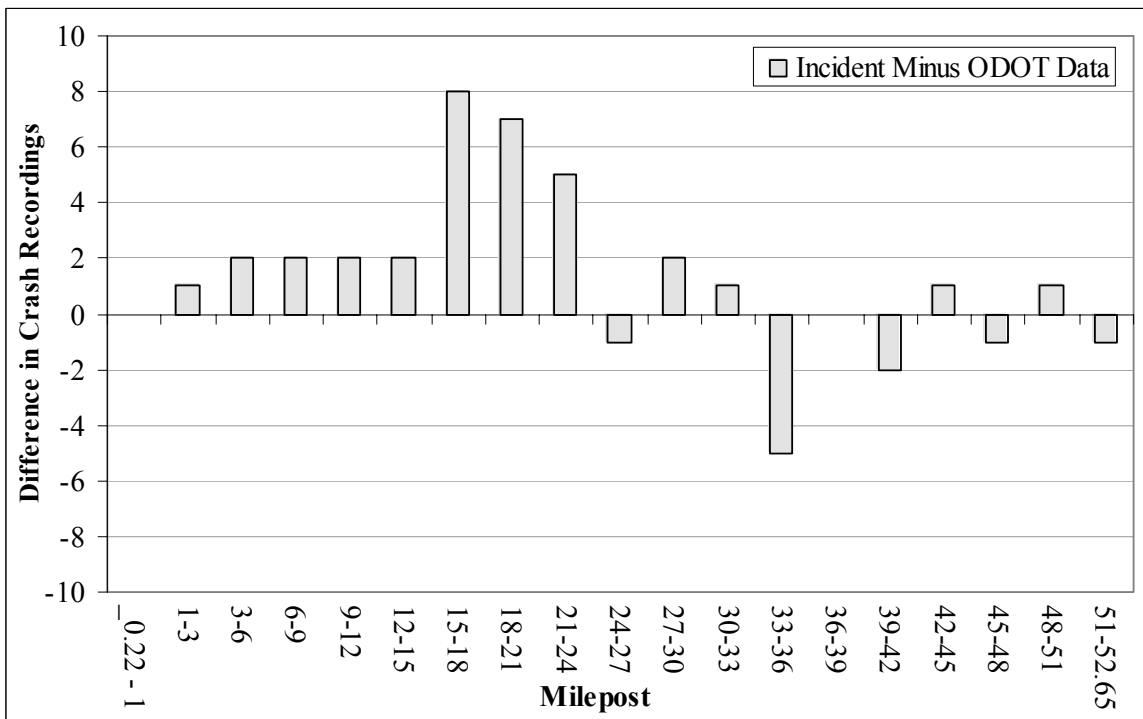


Figure 5: Comparison of Crashes, OR-18 for 2000

RESULTS

Analysis of data revealed the crashes that met the minimum threshold of reporting and had gone unreported for 2000 for OR-18. A total of 106 crashes were reported to ODOT for the year of which 56 crashes were recorded Friday through Monday, 8 a.m. to 6 p.m., and were considered as matching with Incident data. The remaining 50 crashes were not considered for matching. As both ODOT and Incident data recorded the same 19 crashes, there were an additional 37 crashes that were only on ODOT's crash listing for these days and times. Table 3 summarizes the crash data results.

The Incident data included 76 crashes and 57 (76 - 19 = 57) that were not reported to ODOT. Therefore, the total number of crashes that occurred on Friday through Monday, in the year 2000 based on the aggregates of the two data sources is estimated to be 113 crashes (37 + 57 + 19 = 113 crashes), ignoring the hours when the IR personnel were not on duty.

To extrapolate the underreporting rate for all 168 hours per week, the estimated numbers of crashes that would have resulted are:

Table 3: Crash Data Results - 2000

Crashes Recorded Friday Through Monday, 8 am to 6 pm		
Source	Actuals	% of Total Crashes
ODOT	56	49.6
Incident Data	76	67.3
Both (Matched)	19	16.8
ODOT Only	37	32.7
Incident Only	57	50.4
Both (Total)	113	100
Crashes Entire Year, 2000		
Source	Actuals	% Under Represented
ODOT	106	...
Estimated	214*	50

* (37 + 57 + 19 + 50*(113/56) = 214)

$$\text{Total crashes} = o + i + b + \left(\frac{i}{d} \left(\frac{c}{d} \right) \right) \quad \dots \dots \text{(Equation 1)}$$

where, o = crashes reported to ODOT for Friday through Monday, 8 a.m. to 6 p.m.

i = crashes in Incident data only

b = crashes recorded in both ODOT and Incident database

- l = crashes reported to ODOT not considered (not Friday through Monday 8 a.m. to 6 p.m.)
- c = Total crashes recorded by either system (or, $o + i + b$)
- d = Crashes reported to ODOT for Friday through Monday 8 a.m. to 6 p.m. (or, $o + b$)

Or, the total crashes = $37 + 57 + 19 + 50 * (113/56) = 214$ crashes.

Therefore, the percentage of crashes underreported is = $(1 - (106/214) * 100) =$ approximately 50%.

Based on the analysis presented above, crash rates (i.e., crashes per million vehicle miles traveled (MVM)) were determined for OR-18 based on the ODOT crash data and the number of crashes estimated for the four days IR is on duty for 2000. The number of estimated crashes was calculated for each mile limit using equation 1. Crash rates were determined based on the following formula:

Crash Rate = $((N) \times 1,000,000) \div (L \times ADT \times D)$, where

N = Number of Crashes,

L = Length of Section

ADT = Average Daily Traffic

D = Number of Days

The ADT was obtained from ODOT, 2000. The numbers of days is the time that the highway was operational while the IR personnel were on duty; in this case it was constant at 208 days. Crash rate results are shown in Figure 6. Clearly there are more crashes estimated as shown by the hatched line than were reported for each location. The highest crash rates were estimated at 4.2 MVM between mileposts 15 and 18 (88% above reported), followed by 2.4 MVM between mileposts 21 and 24 (54% above reported). ODOT reported data indicate the highest crash rate of 1.3 MVM between mileposts 3 and 6. The lowest crash rate recorded was 0.1 MVM between mileposts 18 and 21 and 36 to 39, and 0.2 as estimated for mileposts 36 to 39.

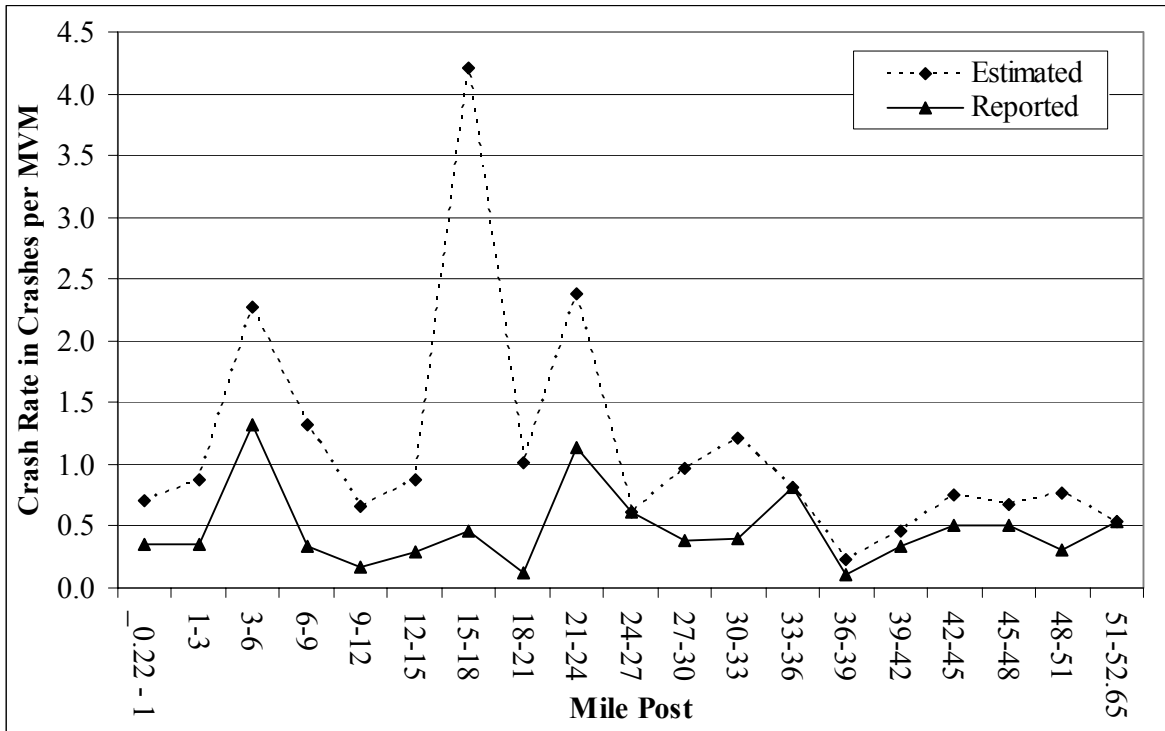


Figure 6: Crash Rates as Reported by ODOT and as Estimated based on Four Working Days Per Week

CONCLUSIONS

We used crash data reported to ODOT and Incident data reported by incident response personnel for a highway for one year in order to estimate the magnitude of crash underreporting. It appears that substantial numbers of crashes were not reported to ODOT that actually met the minimum threshold for reporting. Unreported crashes amounted to about 50% of the total crashes for the year 2000 for this highway segment. It is acknowledged that the 50% underreporting rate may be on the low side since an unknown number of crashes may have occurred that were not observed by the incident responder. For calculating the total number of actual crashes that occurred on OR-18 in 2000 we would require data from IR personnel for all 24 hours for all days of the week. From the literature reviewed and also from our data, it is clear that nearly all fatalities are reported. As a solution to crash underreporting of injury and PDO crashes, common reporting probabilities could be estimated through continued research. Once estimated, they should be applied to the actual reported injury or PDO crashes and then published as statistics likely to be used in future studies.

The IR personnel work for 10 hours per day and four days per week. Without doubt there are more crashes that occur during times when the IR personnel are not on duty. As future research it may be worth observing how the number of crashes recorded increases with the increase in IR investment. Also, it would be beneficial if hospital records, ambulance data, and data from

insurance companies were matched with the ODOT data and Incident data to validate the estimate of the total number of crashes. For locations where IR is not in place, only hospital and/or insurance data could be used. Agencies should also multiply the final crashes estimated by this method by a factor that would account for the unknown crashes that could not be captured at all. Of course if we compare several sources of data, the unknown component of crashes should decrease. This way the real magnitude of a safety problem can be evaluated and the resources that are used for countermeasures will be applied in the most efficient way.

Finally, it would be also be helpful if the Incident data format could be modified to add the time a crash occurred along with the time the call was received and cleared. ODOT could also consider adding to the information that was reported to the TOC at the time the incident was in progress, thereby making it more informative. Data editing could be done at the end of the day and could include verifying mileposts, time the crash occurred, crash type and added remarks. This could make reporting of crashes missed by the ODOT data easier and more accurate.

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